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Cover: Black Kite, Milvus migrans govinda

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Acknowledgements should be brief and pithy. Biological names of birds and mammals should be italicized and lists follow the nomenclature of Roberts (1991-2, 1997) or Birds by Inskipp, T. Lindsay, N. and Duckworth, W. (1996).

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Population estimates of Himalayan goral *Naemorhedus goral bedfordi* in Sakra Hills district Buner, Khyber Pakhtunkhwa Province, Pakistan

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Abstract
There are about 700 Himalayan gorals in the wild today including 50 distributed in Sakra Hills according to figures estimated by the wildlife specialists. The figures are largely estimates because naturally secretive gorals are difficult to direct count in their forest habitat. In the absence of reliable counts from earlier times a systematic survey was carried out between 09-11 February, 2010 in Sakra Hills to provide a clear overall present picture of population estimates and the factors involved in the rapid decline of the protected species.

Key Words: Himalayan goral, Sakra Hills, population estimates, decline, conservation

Introduction

Every part of the world is home to different forms of animal life. Each particular part of land or water possesses an animal of its own kind. From the geographical point of view, we find a lack of uniformity. All countries have certain proportion of species peculiar to themselves in addition to those which they harbour in common or rare with other regions.

Pakistan has a wide gradient of altitudinal as well as climatic variability. World's highest peaks in the North to the coasts on Arabian Sea in the south support a great diversity of vegetation types varying from sub-tropical dry regions and thorn forests to the moist and dry-temperate forest regions of the high mountains. These vegetation zones provide an opportunity to harbour a variety of wildlife. These factors together with the transitional location of the country, fauna shows affinities to those of Palaearctic, Ethiopian as well as to the Oriental region and this is cause of low level endemism in Pakistan. Due to a variety of reasons and factors, we have lost much of our biological and natural resources during the past five or six decades, therefore existing biodiversity invites focused conservation efforts to protect it. Increasing human population and political instability has resulted in deteriorating environmental health especially in Khyber Pakhtunkhwa Province and the same was driving force to conduct the present study of an Oriental species the **Himalayan goral** (*Naemorhedus goral*). The animal population was periodically monitored by Provincial Wildlife Department (PWD) during the past few years and after the post-conflict era a need was realized to assess the status and distribution of this species dispersed sporadically in small populations at Sakra Hills of the Khyber Pakhtunkhwa Province, Pakistan.

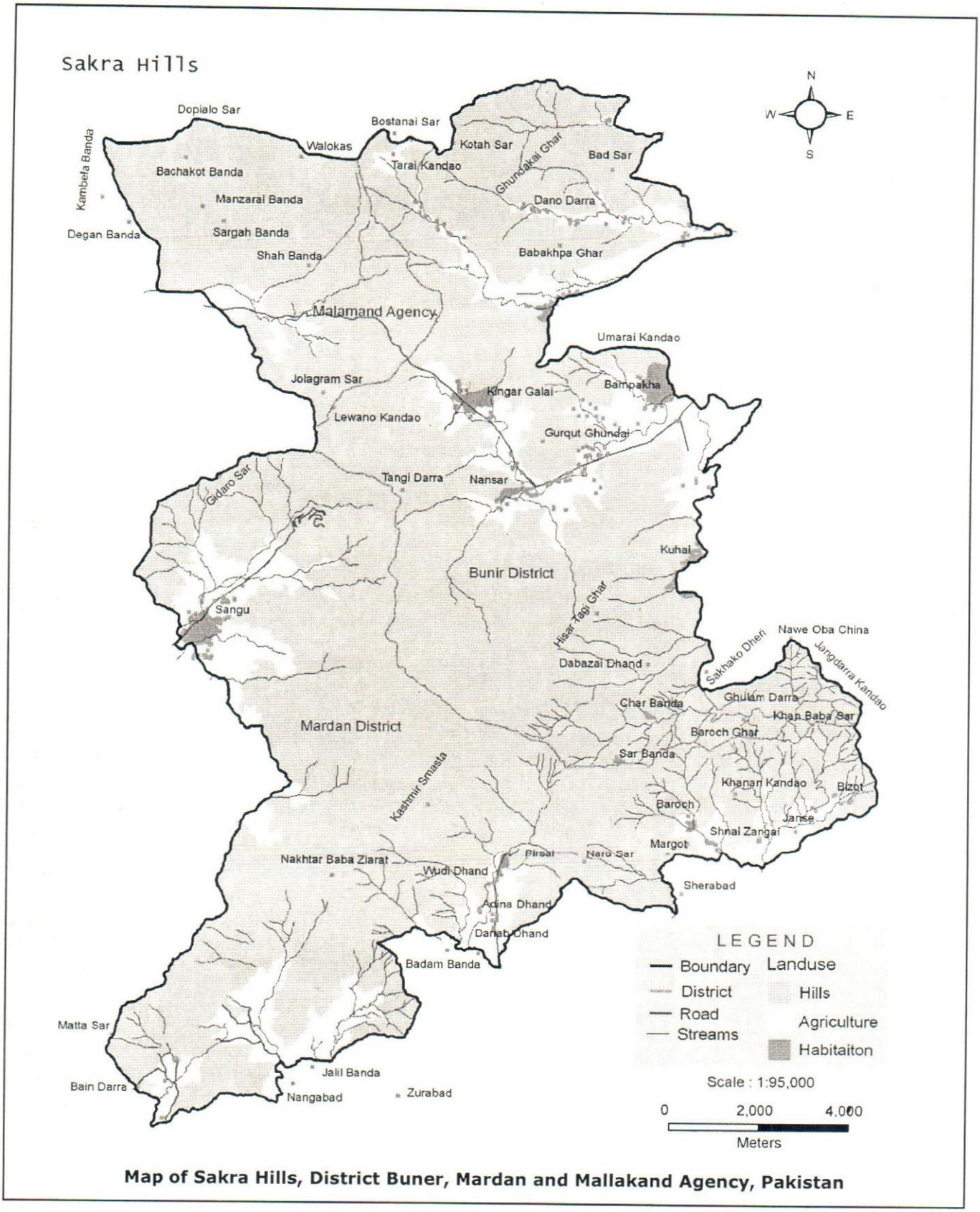
Sakra Hills are situated in the sub-tropical pine region of western highlands of the country including areas of the districts Mardan, Buner and Malakand Agency. Road access entry from its southern side will be guided from Mardan city traveling at a metalled road of some 40 km through Rostum and then to a nearby village called Pir Sai situated at 925m altitude from the sea level (asl) coordinating at 34°-25´-32.4´N and 072°-16´-10.5´E. From Pir Sai a rough contracted narrow track is traversed through subtropical bushy forest bringing up to a small village known as Sar Banda situated at 1140m (asl). From this village one can clearly view the southern aspect of Sakra Hills range posing right in the north not far from 5-6 kilometers by a mountain track.

Biogeographical Location

The study site, Sakra Hills being located in the west of Indus – the western highlands of Pakistan - is an interesting region which coincides at the extremity of western Lesser Himalayas and at the southern turn of the Hindukush mountain range.

Physical Features

The mountains and hills linked with Sakra Hills form a barricade between Pakistan and Afghanistan. Some



Map of Sakra Hills, District Buner, Mardan and Mallakand Agency, Pakistan

rivers flowing through the region have formed passes through which armies, people and cultures have moved in and out of south Asia which has altered its history and changed culture. Among them the Khyber Pass is the most important which connects Peshawar (Pakistan) with Kabul (Afghanistan). A connected chain of hill-ridges situated in the western parts of Khyber Pakhtunkhwa province called Sakra Hills positioning at some of the core habitat points (N34°-26′-38.5′ E072°-14′-56.5′, Alt. 1853m; N34°-26′-58.3′ E072°-15′-17.3′, Alt. 1790m; N34°-27′-13.2′ E072°-15′-26.7′, Alt. 1900m and N34°-27′-03.3′ E072°-15′-19.6′, Alt. 1850m) of Himalayan goral. The area is rugged and mountainous with precipitous slopes divided by ravines and broad valleys.

Many parallel ridges are connected at both sides of the main mountain ridge. The main axis of mountain range is north-north-west/south-south-east rising averagely 500-700m right from the valley floors. To the south-east facing slopes are relatively gentle while the north-west facing are steep and more precipitous dropping straight down to several hundred meters divided by deep gullies and gorges. The drainage system of the mountain range is closely related to the orientation of the main ridges. South-east facing slopes drain easterly and the west facing slopes westerly.

The Species

Himalayan goral, *Naemorhedus goral goral* Hardwicke, 1825

Taxonomic Position: Two subspecies are recognized by Wilson and Reeder (2005): *Naemorhedus g. goral*, and *Naemorhedus g. bedfordi*.

Red List Category: Near Threatened ver 3.1, Year Published: 2008.

Assessors: Duckworth, J.W. & MacKinnon, J. (2008).

Reviewers: Harris, R. & Festa-Bianchet, M. (Caprinae Red List Authority)

The animal belongs to the family caprinae of order ungulates and it averages the size of a small goat sparsely distributed in the Northern Pakistan including Marghalla Hills, Punjab; Azad Jammu and Kashmir; and wider parts of Khyber Pakhtunkhwa province. Further, it extends eastwards to southern China (Tibet), Bhutan, northern India and Nepal (Groves and Grubb 2005).

Taxonomic Features

The Species has been divided into two sub populations; the grey goral *Naemorhedus goral goral* Hardwicke 1825, occupies the western ranges of the Himalayas and the brown goral *N. goral hodgsoni*, Pocock 1908, found in the eastern Himalayas ranging from India to Nepal. The separation as a subspecies occurring in Pakistan on the basis of pelage colour looks questionable (Roberts, 1997); actually there is no much difference in the coat colour when encountered in the winter. Summer populations or in the sub adult forms coat colour looks greyer while in the winter it looks dark-brown in Pakistan. This confusion should be resolved in the two subraces occurring as *hodgsoni* and *bedfordi*, thus the race *bedfordi* should be called as grey goral and the *hodgsoni* as brown goral because the *hodgsoni* is the synonym of *N. goral goral* (Groves and Grubb, 1985).

Himalayan goral also called as gray goral, is a small size stockily built animal and stands the height of about 65-71cm at shoulder height (Lydekker, 1907). Body length typically varies from 95-130cm and weighs 25-35 kg (Nowak, 1991). Both sexes have small horns almost of equal size slender shaped curving backwards. The face of the animal looks as deer-like face with sharing characters of large bell-shaped ears and large eyes. The ears are conically curved inside with white hair. It has small facial glands, male does not have a beard, and female has four mammae. In addition to other characters in the form of skull, the species is distinguished from its closely related serows that they do not possess a gland below the eye and not a corresponding depression in the skull. In contrast to the wild goats, the tail is little longer bearing with a mixture of long black and grey hair. The legs are strapping and looks like a goat. The front throat bears whitish whereas back of the neck and over the shoulder it has black and grey hair (Roberts, 1997).

General Ecology and Distribution

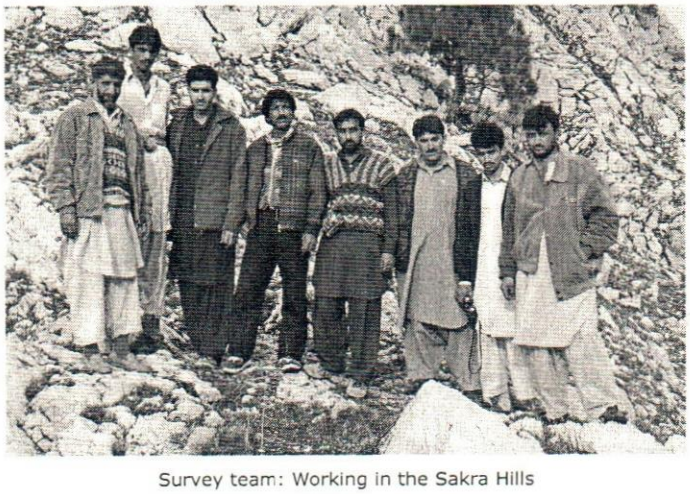
Himalayan goral is found in the outer Himalayan foothills and in the southern Hindukush ranges usually between 850m and 2000m altitude. It is believed that the animal is distributed in Murree hills and Marghalla range in association with chirpine and thorny clumps of barberry *Berberis ceratophylla* about 820m to 1500m (Roberts, 1997). In Swat, they occur in mountains up to 1950m having precipitous cliffs fairly vegetated, they further extend to Indus Kohistan, the Boga Marg valley in

Hazara, and in some parts of Neelum Valley, Azad Jammu and Kashmir beyond Ath Muqam. They also have been reported in district of Buner, Swat, Mardan, Haripur and Kaghan valley district Mansehra (Khyber Pakhtunkhwa), Poonch, Kotli, Muzaffarabad in Azad Jammu and Kashmir (AJ&K), Marghalla and Murree Hills in Punjab. Formerly, it has been encountered from Malakand Agency, Dir and possibly in Cherat Hills behind Nowshehra (Roberts, 1997).

Himalayan goral is not gregarious therefore are encountered in small groups of 2-4 animals. Male adults live usually isolated. They are active in late evening and early morning and prefer to feed shadier hill slopes avoiding bright sun light. They can usually live 14-15 years like its other allied forms. Female usually gives birth to a single offspring after a gestation period of 240 days (captivity record) and the female reaches sexual maturity at the age of 3 years (Roberts, 1997).

Material and Methods

It is supposed that exact estimation of animal abundance is often difficult, which involves several factors influencing counts of terrestrial species. Factors that affect the accuracy of aerial counts have been identified by Coughly (1974). Ground counts or Transect Method (Anderson et al., 1976) have been implicated commonly all over the world; the method is employed because of its extensive benefits, low cost and effort, harmless and fearless to wildlife species. Several investigators (Schaller, 1977; Mitchell, 1989; Johnson, 1997a; Roberts, 1997; Frisina et al., 1998, 2000, 2003; Shafique, 2003, 2004, 2006) have successfully used the transect method modifying it to raise its effectiveness according to the location of the area and to the suitability of the investigator. In different ecological regions, encountering terrestrial species particularly ungulates it has provided most accurate estimates on abundance. Available and supportable resources enable the present investigators to follow the technique of Johnson (1997a), Frisina et al., (1998, 2000) and Shafique (2006).



Survey team: Working in the Sakra Hills

A short preliminary survey was conducted for three days in February 09-11, 2010 in the core potential habitat of Himalayan goral at Sakra Hills, district Buner. The survey was conducted immediately following two days of heavy showers in the area which is considered a favourable time in encountering foot impressions on the wet ground.

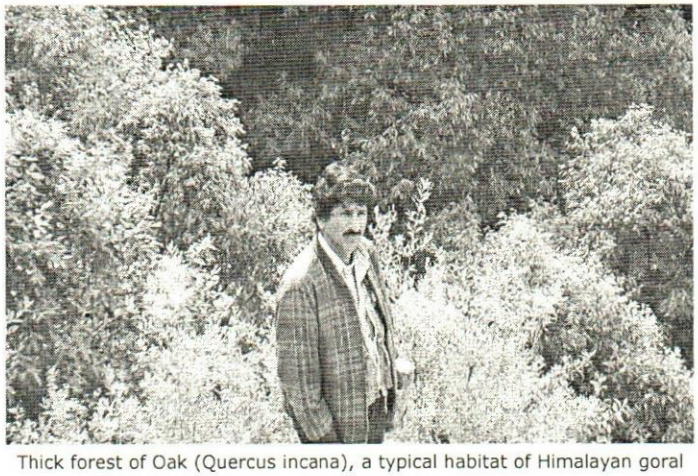
Regarding the methods applied in this survey, all efforts were used to locate physical appearance of the animal as well as other signs as foot prints and faecal pellets. Assistance was also taken from their body hairs left on their resting grounds. For the confirmation that such signs were left by the goral or other animal, assistance was sought from the local guides and hunters who had good knowledge to identify the signs the animal had left. The survey team consisted of 7 persons who walked parallel covering about 500m width of a hill ridge, in the late evening and early morning. For observations, assistance was also taken of binoculars (10X50) and spotting scopes (10X60).

Results and Discussion

Habitat Use of Himalayan Goral

Studying the habitat of wild fauna is an integral part of management of protected species. A good habitat is mainly governed by the availability of abundant fodder and water sources in association with shelter for survival of the species. The present study deals with the population status of Himalayan goral in Sakra Hills which are located in the western highlands of the country, the extremity of the western Himalayan foothills that falls in the sub-tropical pine forest zone providing ideal environmental conditions (habitat) to harbour the species. The present habitat terrain used by the species was rugged mountainous consisting of fairly dense cover of grasses and thorny thick bush layer. The animal was strictly confined to the precipitous vertical cliffs and specifically northern aspects which were relatively cooler and vegetated with the dense stands of white oak *Quercus incana* in the depressions of hill ridges providing best hiding places to the species. Between the depressions and cracks of vertical cliffs and broken rocks and ledges grew some clumps of grasses of *Aristida cyanantha*,

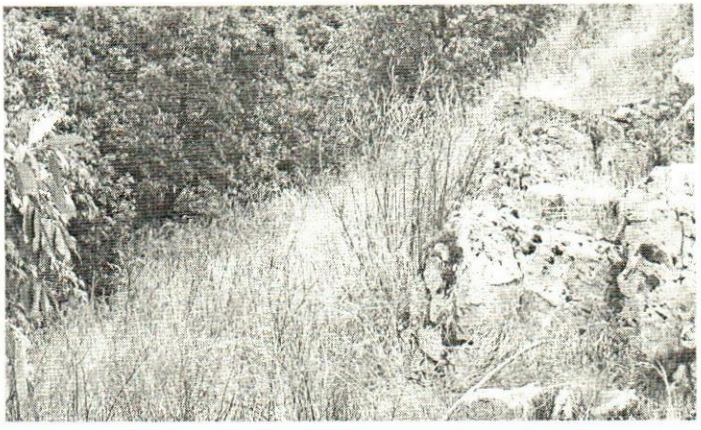
Apluda aristata and *Themeda anathera* which were widespread between the pure stands of baloot - white oak *Quercus incana* and hill ridges. During the day time, the goral was available best places for concealing themselves very quickly and cleverly under the clumps of long grasses or under crevices and caves which were the characteristic features of this habitat. During the warm season to avoid scorching heats of the weather they were provided dense shades to facilitate under the canopy of associated oak forests.



Thick forest of Oak (Quercus incana), a typical habitat of Himalayan goral

Unlike the northern aspect the slopes facing south receiving the direct rays of sun have naturally a dry aspect, a higher temperature than those facing north and hence the important tree flora restricted to this angle consisted of chirpine *Pinus Roxburghii*, date palm *Phoenix dactylifera*, injeer *Ficus roxburghii*. Some other common plants included as kikar *Acacia modesta*, phulai *Dodonaea viscosa*, barberry *Berberis ceratophylla* and olive *Olea cuspidata* were the unique features of this range.

Sakra Hills being located in the western highlands of the country fall in the subtropical pine zone ranging from 950m at the valley bottom 2000m asl, some of the highest peaks of the habitat. The main stronghold of the species lied between 1650m to 1950m which was an ideal environment for such a species like goral observing all the environmental variables perfect to sustenance and survival in natural conditions. The range might have experiencing warm summers (21°-32°C) and cool/cold winters (0°C–10°C) averaging as a general rule. Indeed, summers are comparatively short and winters are long and cool which lasts for nearly seven months from October to April. During the coldest month (January), the mean monthly temperature drops below 10°C but the minimum temperature below the freezing point.



A distinct habitat: dense forest of baloot and grasslands together with providing shelter and grazing field

Direct Observations

During the first two days search, we observed one animal each day from a distance of about 750m. Being very agile the animal ran quickly and concealed itself in the cracks of hill cliffs, hence we tried to locate but remained unsuccessful due to the inaccessibility of the landscape.

Indirect Observations

Third day in the morning we observed foot tracks on the wet ground of an adult animal which may definitely be considered a female because it was followed by a small kid crossing over the mountain top from southern aspect to the northern side where they entered into the oak forest to a safer abode. They might have passed the night in the open forest and before the approach of bright light (dawn) they moved themselves for diurnal activity to some safer abode.

Dropping

Thirteen samples of fresh droppings were encountered on the trails, some in the oak forest and others out of the forest on the grazing sites. We also explored some resting sites in the rocks identified with the presence of their faecal pellets and hair.

Predation

Collection of two samples of predator's faeces certainly identified the hair of hunted goral. The first author precisely examined the samples and confirmed goral hair without any confusion and it was also verified by a local hunter who was a member of the survey team and had good indigenous knowledge on it. The large amount (size) of the faeces confirmed the predator as leopard *Panthera pardus* who had

hunted the goral.

Population Estimates

Only a little information over the past few years is available through personal interviews, no concrete data on the status of species is available on paper. We conducted systematic survey accurately searching over the large area which was about 50% of the total occupied range of the species in Sakra Hills, especially the north-eastern aspects of the main mountain range which were believed to be as the most preferred and core area of the species. The population currently estimated at most conservative level gathered from all accounted signs consisted of only 25 animals in the surveyed area.

Being strictly crepuscular nature, they emerge from their hidings in early morning or late in the evening for grazing, they avoid the bright sunlight and therefore are not easy to sight. Enough animals were not sighted despite a thorough search over the surveyed area. The team was unable to locate any animal in areas of south and west facing slopes identified largely as goral habitat but at present these were mostly disturbed by human activities such as fires, grazing and fuel wood collection (pers. observations). However, the total population present in species whole range in Sakra Hills will be aggregated by the population estimated from the surveyed area. Therefore, the total population estimated at most conservative level in district Mardan and Buner of Sakra Hills consisted of only 25 pairs or 50 individuals.

The available data on the goral populations suggests that a total of around 330 individuals occur in the whole province of Khyber Pukhtunkhwa (Anonymous, 1988); distributing 56 in Mardan, 152 in Swat, 51 in Abbotabad, 99 in district Mansehra and 27 in Kohistan (Anonymous, 2003). In Marghalla Hills, Anwar (1989) carried out a study on goral population, he reported 50 gorals existing throughout in this range while on the countrary, Sheikh and Molur (2005) reported only 30-40 individuals occurring in the same range.

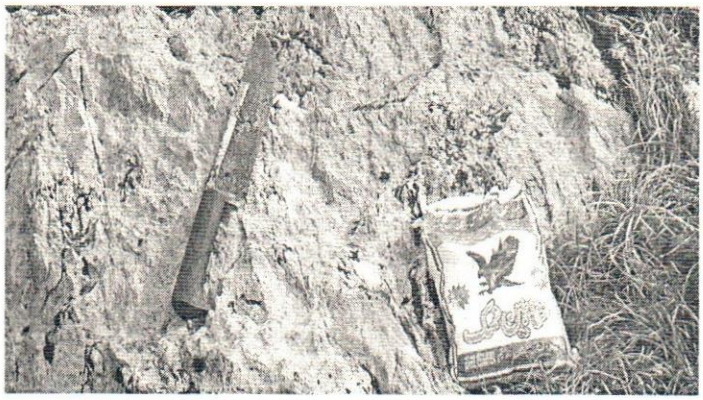
In Azad Jammu and Kashmir (AJ&K) it occurs in some parts of Neelum Valley, in district Kotli it is patchily distributed at three places, in district Muzaffarabad the Himalayan goral inhabits the Machiara and Gamot Game Reserves. The Department of Wildlife and Fisheries accounted from all its distribution range in AJ&K describing 285 individuals of the species (Anonymous, 2002).

All the species of goral are endemic to Asia. There are reliable reports suggesting persistent decline in its global distribution (Singh and Singh, 1986), including Pakistan (Anonymous, 1989; Roberts, 1997). The species has been categorized as endangered with decreasing range and declining populations (Mead, 1989), and near threatened by IUCN (Shackleton, 1997), and placed it in appendix-I (CITES). It is classified as Vulnerable in Pakistan (Sheikh and Molur, 2005), suggesting that the species is going to face extinction if the present trends of persecution of the species are continued.

If all the populations distributed in wide-territorial range of Pakistan are accumulated they meet the figure nearly 700 animals of the species. Fukhar-i-Abbas et al. (2008) estimated 681 individuals of goral populations throughout its distribution in the territorial limits of the country. In view of the species patchily dispersal and distantly isolated in small populations, they are gradually declining. The earlier reported figures compared with the follow up reports are not validated, they show a gradual and sharp decline in populations. Accordingly, in the present situation, authors therefore believe that there are not more than 500 individuals of the Himalayan goral existing throughout its distributional range within the territory of Pakistan.

Threats

The most important single cause of habitat degradation is poverty of local people resulting in their direct dependence on grazing, cutting of wood for domestic use and sale. All these practices are seriously detrimental to the habitat of Himalayan goral.



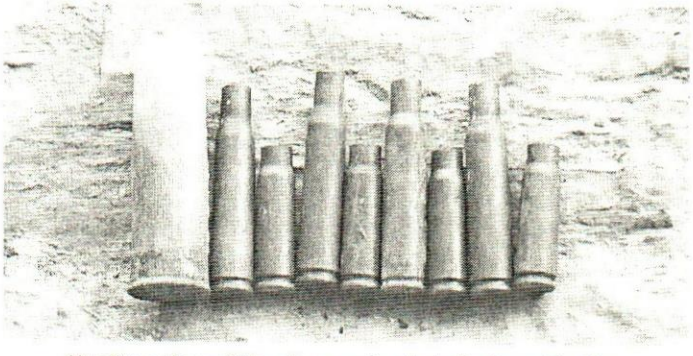
Stuff used for cooking by hunters which they left in the habitat of Himalayan goral

The main cause of goral decline is attributed to extensive hunting by the local people in this area

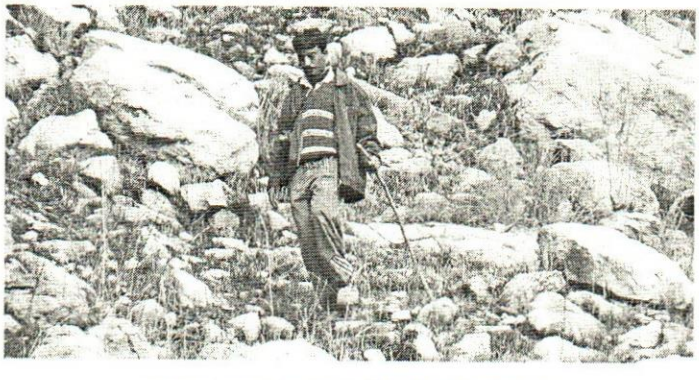
(pers.obs); disturbance, loss of habitat due to expanding human settlements and competition with domestic livestock are other common factors.

The other most and distinctive threat to habitat in this area is fires which are purposely caused by the locals especially by the professional livestock herders, turning larger areas of south-facing slopes into denuded barren scrub resulting in major loss of the goral habitat (photographs). These areas have been altered into open pastures in the interest of grazing livestock.

Cooking tools used in the habitat of Himalayan goral



Hunting: few of the dozens fired shells found in the habitat of Himalayan goral



Habitat loss: purposely fires have burnt the food and shelter of wild species

Biodiversity loss: purposely fires have burnt the nest of a bird of prey, identified by bones, skull and feathers

Conclusion and Suggestions

Himalayan goral is an impressive small animal neither looks like a goat nor an antelope, its uniqueness considered to be a "goat antelope" characterizing the features of both the true goat and antelope; it occupies the middle ranges of the Himalayas and is endemic to Asia (Zhiwotschenko 1990, Singh and Singh 1986). Recent population declines throughout its range in Pakistan and particularly in Sakra Hills threaten the survival of the species and its habitat will require a significant commitment by the Provincial Wildlife Department to enforce pertinent laws, and manage current and future survival of the species.

According to the Organization for Conservation of Environment and Nature (OCEAN), few years back in 2003 a biodiversity conservation project was launched by UNDP in Sakra Hills which they actively participated and worked for biodiversity conservation. In an initial survey carried out for the census of ungulate populations, they estimated only 25 animals of goral and 22 animals of markhor occurring throughout their range in Sakra Hills.

The project authorities chose local people residing in villages around Sakra Hills to form Village Conservation Committies (VCCs), and set their minds to protect the values of biological species which they had in their areas. The representatives took fanatical interest and worked with the objectives of the project. Within few years the deteriorating populations of goral when got protection showed a rapid increase growing fewer to larger populations consisting of 250 animals at the time when project ended in 2007. With the cessation

of this project all activities of OCEAN and the VCCs towards protection also broke down. Later, the conflict which occurred between the Taliban Groups and Government made it further impossible and unsafe to continue conservation efforts in the area. Since these studies, there appear to have been no further work until we conducted the survey to conclude the current status of the species which suggested a great decline of the goral populations.

Unfortunately, both poaching and overgrazing are prevailing in most parts of this mountain range. Indeed many people don't realize that the species occurring in this part of the region is highly protected. They frequently admitted the poaching which appeared to be pervasive. All people we interviewed, either directly involved in hunting or knew those who poached, informed us that this trend of hunting was possible because of lack of law enforcement activities and shortage of staff and/or loose control by the Provincial Wildlife Department over the area. They also added that the population of goral is today certainly much lower than it was encountered few decades earlier. The animals frequently moved down around the human settlements. Therefore, immediate actions and active management is necessary to discontinue grazing and preclude fires in the habitat including active anti-poaching activities. At a minimum the core area which ranges above 1400m and largely supports breeding sites, is required to be protected from all kinds of disturbance.

Representatives of OCEAN with the author: Due to the sensitive situation of the area OCEAN made possible this study in Sakra Hills

For the purpose of conservation in such areas like Sakra Hills where local people consider biological resources as source of their livelihood and the basis of their existence, they must be compensated by providing necessary alternatives. It is concluded taking all factors into account, the creation of a breeding sanctuary in Sakra Hills encompassing only 30% of its total area above 1400m altitude would essentially provide protection and population growth to many hundreds, particularly of Himalayan goral which, in turn will benefit other most important and threatened species like markhor and leopard. In Pakistan, this area is incomparable site which has a lot of potential to harbour goral populations in greater numbers. The area being situated in the monsoon belt receives a sufficient amount of precipitation which enables to grow a large number of distinct species of flora providing a variety of food resources and shelter for wildlife species.

Conservation is required a better understanding of the Himalayan goral biology and ecology, a deficient studied area in the country required to be investigated in the larger concept to protect goral populations, and continued systematic seasonal surveys would determine the population growth trend. Additional research is required to enable more effective management of the species and its habitat.

If the small populations occurring in Sakra Hills are not given proper protection it is not likely to survive long because the area is easily accessible within few hours even not beyond the approach of a child ageing around twelve. During our expedition, an evening at sunset we heard frequent gun fires by the hunters from the nearby northern side of the mountain ridge (Buner side), and also the other evening we came across 4 hunters near the cave situated at the height of 1560m where we stayed at nights. They came from a nearby village known as Chorbanda and exchanged dialogue with our local guides, and returned back after they observed the situation was not in favour of their activities (hunting). In the present circumstances, it is suggested to develop a management plan for Himalayan goral with the option of a sanctuary or community managed game reserve for future use as trophy hunting of goral to protect its living populations in Sakra Hills. Habitat alteration and interference by grazing and hunting is required to be taken care of viable populations are to be maintained.

Conservation Status

According to IUCN criteria the Himalayan goral has been kept under the category of vulnerable. The species is Vulnerable to Extinction because it has wide range of distribution with small isolated

populations surviving under great pressure. The authors estimated the total populations presently occurring throughout its range in Pakistan are not exceeding 500 individuals and believed to be in significant decline at a rate of about 10% over three generations or in ten years. The taxa included in the "Vulnerable" category are those of which most or all populations are gradually decreasing because of over-exploitation, extensive hunting for food and destruction of habitat or other natural environmental factors. Therefore, it will take no long in the present adverse factors that the species would be on the verge of extinction in such areas as Sakra Hills.

Extinctions

The lion which was once common in the region is now struggling for future sustenance in small populations confined only to the Gir forest of Gujrat in India. It still occurred in Sindh during the nineteenth century (Murray, 1884B), the last slaughtering record is at Kot Diji, Sindh in 1810 (Kinnear, 1920) and also supposed to have been hunted at the beginning of the nineteenth century in the thorn forest of the old Hakra river in district Bahawalnagar, Punjab. The tiger, of course is extinct in Pakistan. Murray while describing the fauna of Sindh in 1884 identified the Indus riverine forest tracts in Khairpur State was its last refuge. The last surviving record in Sindh was a female tiger which was shot by Col. McRae (Eates, 1968).

The late Nawab of Bahawalpur, Sir Sadiq Muhammad Khan described the tales how his father had shot 13 tigers within the State territory in the Indus riverine forests and perhaps, the last surviving animal was shot by him in 1906 (Roberts, 1997). Murray (1884) also documented that cheetah were still widespread in dry foothills country to the west of Indus in Balochistan. In the recent past many Savannah species for example blue bull and black buck were widely spread over large areas of the south-eastern parts of the country which now have been vanished in the wild. Similarly, the specific genera of ungulates of the riverain forests of Indus disappeared or near to be extinct due to man-made changes in the environment. In our parts of the country we have also lost swamp deer (Eates, 1968), the great Indian rhinoceros (Beveridge, cited in Roberts, 1997), red deer, Himalayan tahr and the tiger. Probably we have also lost the fishing cat while the future survival of the hog deer, Himalayan musk deer and **Himalayan goral** is critically at risk.

References

Anderson, D. R., Laake, J. L., Crain, B. R. and Burnham, K. P. 1976. Guidelines for line transect sampling of biological populations. Utah. Coop. Wildl. Res. Unit, Logan, Utah. 27pp.

Anonymous. 1988. Wildlife of NWFP of Pakistan. Annual census report. NWFP Wildlife Department, Peshawar. 48pp.

Anonymous. 1989. Endangered and Threatened Wildlife and Plants. US Fish and Wildlife Service Report No. 50 CFR 17.11-17.12.

Anonymous. 2002. Annual census report. AJ&K Wildlife Department, Muzaffarabad. 23pp.

Anonymous. 2003. Annual census Report, NWFP Wildlife Department, Peshawar. 37pp.

Anwar, M. 1989. Development of a management plan for grey goral. Lessons from blackbuck and cheer pheasant reintroduction attempts. PhD Thesis. University of Uttah, USA. Unpublished.

Caughley, G. 1974. Analysis of vertebrate populations. John Wiley and Sons, New York. 234 pp.

Duckworth, J. W. & MacKinnon, J. 2008. *Naemorhedus goral*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2.

Eates, K. R. 1968. 'An Introduction to the Vertebrate Fauna of sindh and Khairpur State' Chapter 3, Part 1, Mammalia, pp. 33-52. Written in 1952 and published in West Pakistan Gazetteer - Sindh region, Government of West Pakistan.

Fukhar-i-Abbas, F., Akhtar, T. and Mian, A. 2008. Food & Feeding Preferences of Himalayan Gray Goral in Pakistan and Azad Jammu and Kashmir. Zoo Biology, 27(5): 371-380.

Frisina, M. R., Woods, C. A. and Woodford, M. (1998) Population trend of Suleiman markhor (*Capra falconeri jerdoni*) and Afghan urial (*Ovis orientalis cycloceros*), with reference to habitat conditions, Torghar Hills, Balochistan Province, Pakistan. unpublished report to the United Sates Fish and Wildlife Service Office of International Affairs and Society for Torghar Environmental Protection (STEP). 12 pages.

Frisina, M. R. 2000. Suleiman markhor (*Capra*

falconeri jerdoni) and Afghan urial (*Ovis orientalis cycloceros*) population status in the Torghar Hills, Balochistan Province, Pakistan. unpublished report to the United Sates Fish and Wildlife Service Office of International Affairs and Society for Torghar Environmental Protection (STEP). 16 pages.

Frisina, M. R., Awan, G. A. and Woodford, M. H. 2003. Status of Blanford's urial (*Ovis orientalis blanfordi*) and Sindh ibex (*Capra aegagrus blythi*) on the Dureji Game Management Area Balochistan, Pakistan. Report submitted to US Fish and Wildlife Service. USA. 24pp.

Groves, C. P. and Grubb, P. 1985. Reclassification of the serows and gorals (*Naemorhedus*:Bovidae). In: *The Biology and Management of Mountain Ungulates,* (Ed.): S. Lovari. pp. 71-76, Croom Helm, USA.

Johnson, K. A. 1997a. Status of Suleiman markhor (*Capra falconeri jerdoni*) and Afghan urial (*Ovis orientalis cycloceros*), populations in the Torghar Hills, Balochistan Province, Pakistan. In: Mufti, A. M., Woods, C. A. and Hassan, S. A. (eds.): Biodiversity of Pakistan. Florida Museum of Natural History Gainesville. pp. 469-483.

Kinnear, N. B. 1920. The Past and Present Distribution of the Lion in South–East Asia, *JBNHS*, Vol. 27, No. 1, pp. 33-39.

Lydekker. R. 1907. 'The Game Animals of India. Burma, Malaya and Tibet', Rowland Ward, London. pp 409.

Mead, J. I. 1989. Naemorhedus goral. Mammalian Species. 335:1-5.

Mitchell, R. 1989. Status of large mammals in the Torghar Hills, Balochistan. Unpublished report to US Fish and Wildlife service, Office of International Affairs. 17pp + 2 figures and 2 tables

Murray, J. A. 1884. 'A note on *Neomeris kurrachiensis*' Ann. and Mag. Natural. History., Vol. 13.

Murray, J. A., 1884B. 'The Vertebrate Zoology of Sindh', Richardson, London.

Nowak, R. M. 1991. Walkers Mammals of the World. 5th edition. John Hopkins University Press, Baltimore Maryland. 1:1-642.

Roberts, T J., 1997. *The Mammals of Pakistan* (Revised Ed.) Oxford University Press, New York, 525 pp.

Schaller, G. B. 1977. Mountain monarchs: Wild sheep and goats of the Himalaya. Wildlife Behavior and Ecology Series, University of Chicago Press. Chicago, IL. pp.

Shafique, C. M. 2003. Some Aspects of Bio-Ecology of Ayubia National Park, District Abbotabad, NWFP. Ph.D. Thesis submitted in University of Karachi. 438pp.

Shafique, C. M. 2004. Ecology of Flying Squirrels of Ayubia National Park, NWFP – Pakistan. Report submitted to WWF-Pakistan, Lahore. 71pp.

Shafique, C. M. 2006. Status of Suleiman Markhor *Capra falconeri jerdoni* and Afghan Urial *Ovis vignei cycloceros* with relation to community-based trophy hunting in Torghar Conservancy, Balochistan Province, Pakistan. Report submitted to Chair, Sustainable Specialist Group (SUSG) Central Asia, United Nation Development Programme (UNDP).

Shackleton, D. M. 1997. Why Caprinae? Conservation Priorities and Options. General Conservation Actions and Implementation. In: SHACKLETON, D.M. (ed.) and the IUCN/SSC Caprinae Specialist Group: Wild Sheep and Goats and their Relatives. Status Survey and Conservation Action Plan for Caprinae. Chapter 2, 11 and 12. IUCN, Gland, Switzerland and Cambridge, UK.

Sheikh, M. K. and Molur, S. 2005. Status and Red List of Pakistan Mammals based on Pakistan's Conservation Assessment and Management Plan for Mammals. IUCN Pakistan. 344pp.

Singh, S. P. and Singh, J. S. 1986. Structure and function of the Himalayan oak forests. Proc. Indian Acad. Sci (Plant Sciences). 96: 159-189.

Zhiwotschenko, V. 1990. Goral (genus Naemorhedus). Grizmeks Encyclopedia of Mammals. Vol.5: pp. 506-507. McGraw Hill Publishing Company, New York.

Rec. Zool. Surv. Pakistan 20:11-25 (2011)

Population status of Himalayan ibex *Capra ibex sibirica* in connection to introduce community-based sustainable trophy hunting programme in Neelum Valley, Azad Jammu and Kashmir, Pakistan

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Abstract
Sustainable use through trophy hunting is a valuable tool for conservation particularly of threatened biological species which provides many incentives to the people and communities to combat poverty, and to achieve sustainable development with the implementation of effective conservation measures. One of the richest components of biodiversity in Pakistan recognized is widely occurrence of large variety of wild ungulates distributed along the mountain chains from the southwest foothill desert eco-regions of Sindh and Balochistan to northeast high mountains of the country. In the present study we carried out field work in the upper Neelum Valley, Azad Jammu Kashmir to determine the population viability of a biological species, the Himalayan ibex as a part of justification for such hunts meeting the criterion of sustainable use at most conservative level. Because of the limited area surveyed, this census provided a minimal estimate of the size of the population. The population appears to be declining in view of the earlier reports which suggested immediate strict measures to be taken to bring the populations quickly to a higher level that could meet the degree of viability in support of the Programme.

Key words: Neelum Valley, Himalayan ibex, habitat, sustainable use, trophy hunting programme, management , conservation

1. Introduction

Aim of better management and conservation of caprinae established the concept of community-based sustainable use of the caprinae taxa through a mechanism called trophy hunting programme. Pakistan with its spectacular history, broad latitudinal spread and immense altitudinal range span a remarkable number of the world's ecological regions. These range from the mangrove forest in the south fringing Arabian Sea to the spectacular mountains in the north where Hindukush, Himalaya and Karakorum meet. Between them many other eco-zones of unique global importance spread over extensive areas; the Salt range and Potohar plateau, the upper and lower plains of Indus, and Balochistan plateau - deserts and peneplains, extensive areas of undulating sand-dunes and extensions of semi-deserts typified by Thal, Cholistan and Thar desert. These typical zones symbolize distinctive habitats supporting a rich diversity of fauna and flora.

Pakistan is one of the most important countries, which has a rich diversity of wild ungulates particularly the caprins consisting of at least 12 sub races grouped under 7 independent taxon (Roberts, 1997 & Hess et al., 1997). In distribution, they range varied habitats from the southern hill deserts to the high alpine cliffs of the Karakorum, Hindukush and Himalayas. The under debate species is known as Himalayan ibex *Capra ibex sibirica.* It belongs to the tribe caprini of order ungulates which is distributed in the northern parts of the country in alpine and sub-alpine ecoregion. The present study focused on status, distribution and population abundance of its distributional range in upper Neelum valley, Azad Jammu and Kashmir (AJK) in response to introduce a Programme – community-based sustainable use through trophy hunting.

The modern concept of trophy hunting is a form of technical sport hunting that may perhaps have been practiced for as long as man has hunted. Usually the animals are selected as trophies that are old-aged and have passed their prime breeding times. In addition, they are equipped with large armament such as horns, antlers or tusks. Consequently, trophies are invariably males and the animals most frequently considered as trophy species are ungulates or carnivores (Coughley, 1977; Schaller, 1977). Trophy hunting usually involves a hunter seeking the largest individual in a taxon or geographical area (Frisina et al., 2000). It is important and fact that almost all ungulate species hunted for trophies show marked sexual dimorphism and are polygynous (that 1 male mates with several females, while a female mates usually with only one

male). As a consequence of polygyny, removing some males from a population does not necessarily affect the reproductive capacity (growth rate) of the population. The value of trophy hunting in conservation is that hunters are prepared to pay relatively large amounts of money for the privilege of hunting trophy animals. If the money is used to conserve the populations from which the trophies are taken, then the programme might be sustainable and successful. Population and habitat restoration is the most important goal that might be achieved creating a protective umbrella for biodiversity in general. And, also the major amount is equitably shared in local communities for uplift the social and economic values initiating other development projects in their areas (Shackleton, 2001).

1.1. Background

The idea of trophy-hunting in the sub-region appears to have evolved after the British entered into this area in 1891 (Arshad, 2001, Shackleton, 1997) and according to the records it was a British hunter who first shot a markhor in Astore, Gilgit-Baltistan (Northern Areas) and named it as the Astore markhor *Capra falconeri falconeri.* Following this hunt, foreign hunters started driving in an attempt to add record trophies of wild animals from this mountainous region as specimens for their museums (Rasool, 2001). In 1991, IUCN with support of UNDP and in co-operation with local people and the Aga Khan Rural Support Program (AKRSP) initiated a planning process for the protection of ungulates particularly the caprins through trophy hunting involving local communities in the overall programme - the sustainable use of biological species involving local communities.

1.2. Species: Capra ibex Linnaeus 1758; Ibex

Capra [ibex] sibirica Pallas, 1776; Siberian or Himalayan Ibex, also called Asiatic Ibex

Himalayan Ibex Capra ibex sibirica (feeding session of male group)

1.2.1. Taxonomic Status

It is still to be resolved that *Capra sibirica* is a distinct species, some authors consider it as *Capra (ibex) sibirica* (Shackleton, 1997), some regards it *Capra ibex sibirica* as a subrace (Corbet and Hill 1991, 1992, 1993; Roberts, 1997). Wilson and Reeder (1993) awarded full specific rank following Heptner et al. (1961). Fedosenko and Blank (2001) identified four subspecies: these are *Capra sibirica hagenbecki* distributed in Mongolia's Gobi desert, *C. s. sibirica* inhabits in Altai mountains, *C. s. alaiana* in the Tien Shan range and *C. s. sakeen* in the Pamirs, Hindukush and Karakorum based on slight difference in horn and pelage colour characteristics. *Capra s. dementievi* has been recognized as a new species which is distributed in the mountains of Kunlun near their confluence with Karakorum and Pamirs. Wilson and Reeder (2005) disagreed that *sibirica* is split into so many subspecies; they believe that these subspecies are synonyms of the same. Taxonomic status of the species is not still clear (Mallon et al., 1997; Shackleton, 1997).

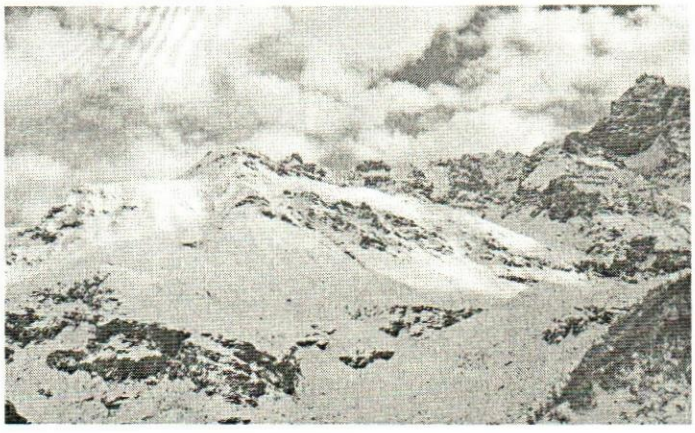
1.2.2. Conservation Status

According to the IUCN Red List Category; the Himalayan ibex is categorized as Least Concern in view of its wide-ranged distribution assumed the large population (Reading and Shank, 2008; Baillie and Groombridge, 1996).

1.2.3. Geographical Distribution

Members of the genus Capra appeared in the Pleistocene, probably from a tahr-like ancestor. Fossil records show its occurrence once extending the Atlantic coast of Europe. The origin of modern Caprini happened during the Pleistocene, the period of glaciation (Schaller, 1977).

Himalayan ibex inhabits mountain terrain of central and north eastern Afghanistan through the mountain ranges of Pamirs, Mongolia Tibet with the border of Xinjiang (Schaller, 1998) to north India, eastern Kazakhstan, Kyrgyzstan, north-eastern Uzbekistan and northern Pakistan (Schaller, 1977; Roberts, 1997). They are found in southern Siberia, Altai Mountains and Tajikistan (Shackleton, 1997). Further they are extending from Tibet, Pir Panjal range to the inner and western Himalaya (Stockley, 1936). They occur relatively in arid precipitous mountain slopes well above the tree line from 3600m to over 5000m in Pakistan (Roberts, 1997).



Mountain habitat in Upper Mori areas

Ibex feed on alpine vegetation, herbaceous plants and shrubs. The species is basically diurnal but in other parts of the world it has been seen feeding in the dark but most active at early morning and late afternoon during the feeding session. Inhabiting high mountain ranges they feed mainly on alpine grasses. During winter when food is scarce and snow layer is too deep they cannot expose the ground vegetation by digging even with their strong feet, they have been seen crossing lower valleys in search of food descending down to even at 2100m altitude. In northern Pakistan they are found in Baltistan in Karakorum and Harmosh range, and Shighai valley in Gilgit. The largest population inhabits the upper Hunza, the Khunjerab valley (Blumestein, 1992B). Populations still commonly occur in Ishkoman and Yasin. In Chitral they occur plentiful along the left bank of Chitral River some kilometers downstream at Garam Chashma (pers. obs.). They also survive in Chilas and Indus Kohistan, Malika Parbat in district Mansehra, Khyber Pukhtunkhwa Province. In Azad Jammu and Kashmir they are reported occurring at Mussian peak on the north-east side of Machiara (Roberts, 1997), Gamot and upper Neelum valley in the connecting mountaineous ranges of Mansehra, Chillas and Astore but the areas of Gilgit and Baltistan are stronghold of the species.

1.2.4. Taxonomic Position

In Caprinae species, males average larger than females, three males of Himalayan ibex which were caught from Baltistan weighed as 88kg, 85.3kg and 88.8kg respectively (Stockley, 1936). European ibex weighed 153kg from Gran Paradiso Sanctuary (Koller, 1972). Caprinae have the largest and most elegant horn shapes. Many species of caprinae grow annual rings that can be used to determine age of the animal (Giest, 1966).

Himalayan male ibex are significantly larger and heavier than the females, they possess large sized horns, and females also have a pair of smaller, thinner horns which develop considerably more slowly than the males. The ibex horns appear at sexual maturity and continue to grow through rest of its life. Males can also be differentiated by the presence of beard (Roberts, 1997).

1.2.5. Ecology and Behaviour

Himalayan ibex is typically confined to the precipitous mountainous terrain. The ibex is gregarious like all other goats, they mostly live in groups. The ibex is inhabitant of high altitude and its inaccessible habitat advantages the ibex grazing at high altitude of difficult mountain slopes. They constitute usually larger groups varying from 6 to 30 individuals. Himalayan ibex infrequently have been encountered in largest groups above 50 individuals in Khunjerab valley, northern areas of Pakistan (Blumestein, 1994). In early autumn and summer males live separate from the maternal groups and live singly or in small groups usually carrying 2 to 3 animals. They congregate female herds late autumn and winter.

During the rut season, males become active and follow the female groups particularly the oestrous females. Being polygynous, dominant males enjoy mating with agreed females, rutting period (usually from the last week of November to 15 December) continues for about 15-20 days. Gestation period lasts 155–170 days, youngs are born usually single or twins at the end of May or in early June (Roberts, 1997).

Himalayan ibex is well armed with the senses of sighting, smelling and hearing. Inhabiting in the northern latitudes at high elevations the ibex displays a seasonal fluctuation in breeding period which may differ with the habitat quality (locality) and resource of fresh food for mothers in late spring or early summer.

1.2.6. Population Abundance

Populations of Himalayan ibex occurring in Pakistan are generally small in view of the fragmented habitat and the green forage hidden in the haggard waste of rock and snow, and partly to persistent persecution by meat hunters and also because of the other features of biogeographic region. In 1970, Dr. George B. Schaller, a Zoologist of New York Zoological Society started survey work on the distribution patterns of Ungulates throughout the

mountainous regions of Pakistan. Working in Northern Areas (presently Known as Gilgit-Baltistan) of the Karakorum Range, Schaller (1976B) documented that in the valleys around Kilik Pass in Hunza, a local military unit shot at least 60 ibex in the winter of 1972-73 while he observed only 59 Himalayan ibex which is a low density rate carrying only about 0.4 animals km². In Chitral, around the Dorah Pass he encountered only 10 animals in 50 km² area in a week search, the area was once famous for ibex. However, in the privately protected reserve 'Besti' part of Chitral he observed 72 ibex from 40 km² and near Baltoro glacier along the north facing mountains between 30 km stretch he came across 49 animals. In contrast, Heptner et al. (1966) encountered 600 ibex in 100 sq. km. area distributing with a high density rate of 6 animals per sq. km area in the eastern Pamir range.

The total population figures of Himalayan ibex received from different sources are expected to be ranging between 10,000-12,000 animals throughout its range in Pakistan; 2573 ibex are distributed in NWFP (NWFP Wildlife Department, 1994), 8560 in the Wildlife parks, game reserves and sanctuaries of Gilgit-Baltistan (IUCN, 1996). Earlier reported data given by the then DFO, Gilgit from the same parks, game reserves and sanctuaries was only 3167 ibex during the census of 1994. These figures are not confirmed by the scientific authorities and communities working at present in their respective areas. In northern Pakistan, Hess (1986) surveyed 164 km² area along the Barpu Glacier and estimated a total population consisted of 250 Himalayan ibex occurring with a highest density rate 1.2-1.6 animals' km². Most of the other areas of species distribution have small densities. In Shinghai Valley, he estimates low densities as >0.1 to >0.3 animals/km² in 176 km² surveyed area which gives a total figure of 35-50 individuals. Wegge (1988) estimated above 2000 ibex occurring in the Khunjerab National Park with the density of 1.0 animals/km². Qayyum (1985) estimated a total population of Himalayan ibex 375 individuals occurring in Azad Jammu and Kashmir.

1.3. Study Area

The present study includes the area of upper Neelum Valley district Neelum - spreading over almost whole of mountainous areas covering some 3621 km² area which falls in Azad Jammu and Kashmir (AJ&K). The Azad state of Jammu and Kashmir is situated in the north-eastern part of Pakistan coordinating between 33° and 36° latitude and covers an area of 13,297 km² (Akhtar, 1991a). Neelum valley is surrounded by Gilgit Baltistan in the north-east Indian State of Jammu and Kashmir in the south, and Khyber Pukhtunkhwa in the west, and district Muzaffarabad in the south-west.

1.3.1 Access to the Neelum Valley

From Muzaffarabad, headquarter of the state of Azad Jammu & Kashmir towards north along the roaring Neelum River would require at least 6 hours travelling by a 4x4 jeep to reach at Kel (the centre of the valley). The road condition was not good due to the earthquake of October 2005. The journey was full of jolts on a muddy track during winter but full of joy in view of the azure waters of the river Neelum and beautiful scenic valleys. Sometimes the snow blocked the serpentine track for many days. Army takes care of the road in any case of snow falling and/or land sliding.

1.3.2. Climate

The climate of the valley varies greatly due to the altitudinal variation and its rugged topography. In the south towards Muzaffarabad the climate is typically monsoonal, though the upper Neelum is little affected but it receives heavy snowfall in winter.

2. Material and Methods

Population census of wild ungulates like all wildlife inhabiting rugged mountain terrain involved difficulties. Different methods are used in estimating ungulate populations. It is difficult to say which one is the best because each one could be useful if applied according to the suitability of the area (Pollock and Kendall, 1987). Mark-resight methods have been used frequently to estimate population of mountain sheep in USA (Furlow et al, 1981; Leslie and Douglas, 1979 and 1986). This method involves first capturing of animals and then to release after marking. This method was not possible to use due to our limitations. The methods available for conducting a population survey of caprins have each with its positive and negative aspects that the total counts are always difficult due to species high adaptation with rugged precipitous mountain cliffs, and the species camouflaging coloration and shy nature, and their detection of human presence from a great distance either by their sharp sight or scent ability (Roberts, 1997; Johnson, 1997a).

The situation in Neelum valley is since more difficult because of rugged terrain which provides best hidings in the overlapping ridges. Census in such areas is most adequate to use a fixed-wing aircraft or

helicopter. The helicopter survey allows for aerial views into remote areas as Neelum valley. But the present study area does not allow using these modern methods because it is located with the western border of India and due to its sensitive political situation, it does not allow privately flying over except by the military of Pakistan. Therefore, it was the only possible option to make a count by foot. Systematic transects provide best opportunity in encountering of ungulates but it could also experience difficulty in the areas like Neelum valley mountains due to its topographic situation (Johnson, 1997a).

Transect method is useful in flat areas where observer can walk on its predetermined line, thus the most suitable and reliable method identified was fixed-points counts in such areas as Neelum valley mountains which can easily be located on the maps (Johnson, 1997a), such counting can be done relatively easy by using fixed points as they have minimum error as designed (Johnson, 1997a). Therefore, we took the advantage of two methods; the fixed points counts and transects counts anywhere needed according to the situation and topographic features of the area.

Survey party: in the Upper Neelum Valley

The purpose of this study was to determine the status, distribution abundance and population structure of Himalayan ibex *Capra ibex sibirica* in relation to sustainable harvesting through trophy hunting. Three surveys were conducted in the upper Neelum valley, the area included in 'Pakistan Mountain Areas Conservancy' (PMAC) Project. It was primarily hoped that the maximum information could be collected to estimate the population size of the species. Short surveys were undertaken between 22-27 November 2008, 14-24 November 2009 and 04-17 June 2009 which could explore only 40% area of the total distributional range of the species. November is considered to be the rut season for species. This time period is usually selected because the animals congregate in large groups, therefore, they are easy to count as a whole as they have maximum exposure to encounters (Schaller, 1997).

The age of rams was determined by the horn-ring method; females were difficult to be aged with that technique, they were identified by the size of their body and colour (Giest, 1966). It was assumed that data collected by the group of observers was more consistent because each group included local men. The locals had the first hand knowledge and expertise in locating and identifying the animals of all levels such as age groups and sex difference.

3. Observations

All possible efforts were used to spot out the target species, the Himalayan ibex *Capra ibex sibirica* in the study area. During the field work we also have recorded some other important mammals occurring in the range of target species

3.1. Ecological Characteristics of the Species Habitat

The upper parts of the Valley are characterized by sever winters lasting over more than six months with temperatures dropping to well below the freezing point. The potential habitat area of the Himalayan ibex is the surrounding mountains between Pine Kel and upper Domail – Shounther valley. Mountains are of course among the most spectacular environment in the world. Precipitous cliffs and jagged ridges on both sides of the river Neelum soar upto snowcapped peaks beyond the reach of any creature but the most adventurous, the Himalayan ibex. Each mountain and its aspects have its own particular ecology and its own special assemblage of plants and animals.

The area falls in the western Himalayan highlands where woods are almost like cool temperate forests which grow above 2000m from the sea level (Negi, 1990). The fauna of the valley includes the elements of both Palaearctic and Oriental region. The animal species that manage to exist in the region are of great interest well adapted to the harsh extreme environmental condition. Besides the target species some other important species of mammals are known to occur in the same range of caprinae which include musk deer *Moschus chrysogaster,* snow leopard *Uncia uncia*, black bear *ursus thibetanus*, brown bear *ursus arctos*, alpine weasel *Mustela*

altaica, stoat or ermine *Mustela erminea* - identified by its foot tracks on the snow at upper Bela – Shounther valley.

Three important forest indicator species called arboreal mammals; red Himalayan giant flying squirrel *Petaurista petaurista albiventer*, small grey Kashmir flying squirrel *Eoglaucomys fimbriatus* and yellow-throated marten *Martes flavigula* were seen during the night survey at Arang Kel in the mixed broad leave and coniferous forest at 2550m altitude. These are nocturnal mammals. Marten is a carnivore and potential predator of the other two sciurid sympatric arboreal species. Another, nocturnal arboreal carnivore, the Himalayan palm civet *Paguma larvata* was also observed occurring in the old forest areas. These arboreal members are primitively confined to the moist-temperate environment with the exception of small Kashmir flying squirrel *Eoglaucomys fimbriatus* which has a wide-ranged distribution in the country and extends to the dry-temperate environment while Himalayan palm civet ranges down to subtropical chirpine *Pinus roxburgii* forests (Shafiue, 2003 & Shafique et al., 2006).

Two rodent species were also recorded and identified as Himalayan wood mouse *Apodemus rusiges* and house mouse *Mus musculus* in the same environment. Ambassador of wetlands, the Himalayan otter *Lutra lutra kutub* showed its presence in the clear waters of the river Neelum. Kashmir red fox, *Vulpes vulpes griffithi* which occurs throughout the mountain regions of Pakistan was commonly observed everywhere in Kashmir. Unique floristic features of this environment include a large number of mixed coniferous and broad leave tree species with rich ground cover of shrubs and herbs.

The most important tree species found in this assemblage include conifers; the Himalayan Silver Fir *Abies pindrow*, Himalayan Spruce *Picea smithiana*, Yew *Taxus wallichiana*, and broad leave include Maple *Acer caesium*, Horse Chestnut *Aesculus indica*, Walnut *Juglans regia*, Himalayan Birdcherry *Prunus cornuta*, Ash *Fraxinus spp.* and Large-leaved Elm *Ulmus wallichiana*. The Large-leaved Elm and yew *Taxus wallichium* have been declared threatened throughout their range in Himalayas (IUCN).

Floristic characteristics in the range of Himalayan ibex above 3000m represent the environment of alpine and sub-alpine cold desert which inhabits the important plant species known as Birch *Betula utilis*, Junipers (Sanober) *Juniperus excelsa* and *Juniperus communis*. Willow *Salix flabellaris*, and Rhododendron *Rhododendron spp* also intersperse in this range. Junipers occupy top ridges and middle slopes with association of willow in moist depressions and nullahs. The shrub cover dominates by *Artemisea spp* and its associated shrubs. Above 3600 meters the tree line gives way to the climbers which emerge on to wide open alpine meadows with small herbs like *Waldheimia glabra*, *Saussurea simpsoniana*, *Delphinium cashmiriana* and tiny colourful tundra plants and lichens giving way eventually to bare rock and snow, of course, this is the home of Himalayan ibex *Capra ibex sibirica*.

Snow-capped habitat in Upper Lunda Narrh

The area is home to some majestic birds which include the Lammergeier, Himalayan Griffon, Golden Eagle, Himalayan Snow cock and a host of Rose finch.

We conducted three field surveys for Himalayan ibex at seven locations of Upper Neelum Valley.

During the first survey in November 2008, Himalayan ibex was sighted at four locations in small groups. A single male (trophy-sized) was located from a distance about 2000m resting at a flat rock right above the Shounther lake at about 4000m altitude. Behind that we were unable to focus and sight any of his group members. It was difficult focusing from a great distance when you are not equipped with long range and high power lenses. Light was not too good due to heavy clouds which disabled our tools to focus the area behind the resting ibex. Why this male ibex stayed so long (11:00AM to 3:30) at the same spot?

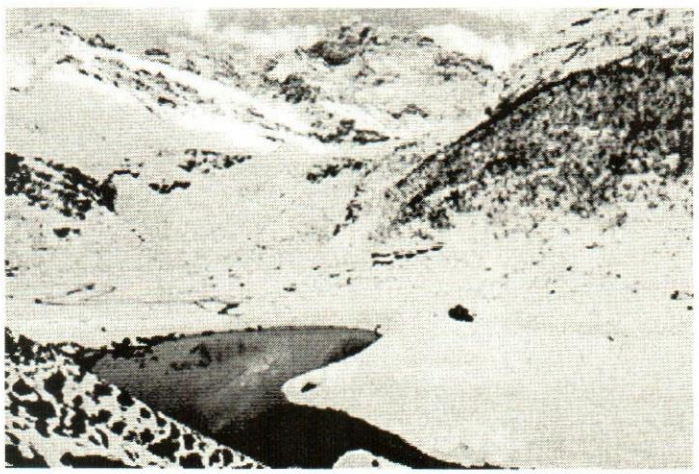
Table 1: Observations on the Himalayan Ibex in the upper Neelum valley Azad Jammu & Kashmir

Sr.#	Location	Nov-2008	Jun-2009	Nov-2009	Total	Average
1	Lunda Narrh	7		12	19	9.5
2	Shounter Nala	1	1	1	3	1
3	Mori Nala		4	4	8	4
4	Patlian Pani		2	4	6	3
5	Neeli Barraf		2	2	4	2
6	Rahwala Narrh	8	7	9	24	7
7	Nareel Nala	8	5	2	15	5
	Total	24	21	34	79	26.3

We could not resolve this clue, only we could assume either the animal stuck up there in deep snow or it was watching and caring for the other members of its group. Another two small groups were seen in Lunda Narr which consisted of 5 males and 2 females. In the Nareel Nullah, we encountered 8 individuals in 3 km long track classified as 5 males and 3 females. At Rahwala Narrh we also observed 8 ibex comprising 3 males and 5 females, and identified 2 trophies sized while one was about 2 years old.

As a follow up during June 2009, although we were able to locate animals in several of the areas identified as supporting ibex but these areas supported very small, scattered populations of animals with large distances (Table I). We made sightings with the records of 1 male ibex at Shounter, a group of 4 animals at Mori Nala including 2 males and 2 females, 2 individuals sighted each from Patlian Pani and Neeli Barraf which included 1 male and 3 females whereas 7 animals were encountered grouped in two small flocks at Rahwala Narrh which included 2 males and 5 females. Southern slopes of Nareel Nala inhabited a group of 5 animals including 2 males and 3 females.

During November 2009, we revisited the site, and a total of 34 ibex were sighted in 8 groups from all the seven valleys of the study area. In this toll 16 were males including 2 trophies sized, and 18 females with different age-groups. Most of the animals were seen



Habitat area behind the Shounter Lake

in small groups carrying 2-6 animals while 2 were seen alone.

Observations of the initial survey validated the number of animals encountered in the follow up surveys assumed that there were no such larger populations occurred in this southernmost range of the species.

4. Results and Discussion

We conducted three surveys in succession from November 2008 to November 2009 to gather data on Himalayan ibex. During the three surveys 24, 21 and 34 ibex were recorded from the same area. These are potential grazing grounds for both the livestock and wild herbivores - the critical habitat areas of ibex to

cover up between cracked-rocks and associated arid pastures to provide food requirements. Virtually the glacial streams are main source of water which flow from the mountain tops and feed the main river of the Neelum Valley, and the wild species which harbor in this spectacular range. Upper Neelum is a major tributary of the Neelum Valley, and local villagers and pastoralists have traditional rights over its high mountain pastures. The people keep several types of livestock including horses, donkeys, goats, sheep and cattle which graze the alpine pastures in summer.

A total number of a taxon present in its whole range or in a large area is impossible to encounter every individual, hence to resolve this matter samples of some sort are designated from the population. Workers have developed many techniques according to the environmental conditions. Some techniques estimate the population directly while others measure by using index. We could not explore the whole area therefore the total population is determined by using index. The figures gained during this study were not as much as they needed for the purpose of this study. The actual collected data for the Himalayan ibex which consisted of only 24, 21 and 36 ibex for the respective surveys was inadequate to assess the accurate population present in the whole distributional range and also it is insufficient to model population structure, trend, population density and growth rate. These are really poor results obtained from such a big mountain track stretching over about 150 km² which covers only 40% of the entire range. In length, the track runs nearly 35-40 km in east-west direction embodying full features of the habitat.

We did not sight enough ibexes as they were sighted in Northern Areas in the north of present study area despite repeated searching in dissimilar seasons in such a region that largely supported an ideal habitat. On average we sighted about only 26 ibex from the surveyed area which represented only 0.17 animals distributed (per) km² area while the species has been estimated with greater density of 0.4 - 1.6 animals (per) km² dispersed in its northern range. The total calculated population of the Himalayan ibex for the whole range in upper Neelum Valley was estimated 67 ibex at most conservative level. Male female ratio was almost identical while the yearling ratio was low which indicated the week growth rate for such populations occurring in the southern range as compared to northern range. Mature males of class III and IV were more numerous than younger classes, and there were only (a) few yearlings. These results suggest low reproduction rates and or high lamb mortality in previous years. To resolve this complication more survey work is required which would test the genuine factors involved in declining populations and degraded population structure of the species.

Of course, during our whole field work the unusual severe weather conditions prevailed in the Valley that may have impact (bias) in encountering, and perhaps the species displacing to northern ranges due to a 50 years record of heavy snow-fall in the Valley (study area) during the winter of 2008-2009.

Himalayan ibex is widely distributed over northern Pakistan, but is only locally abundant in the northern part of its range.

The overall picture of the Himalayan ibex concludes that it has been extinguished from most of its range including most of its localities where ibex herds were seen at least 20 years ago. It was informed that 20 years ago the population size was around 400, and it declined to 200 at the turn of last century, and in the time being only 67 ibex are left in the area.

The animal is clearly rarer in the southern than in the northern part (Hess, 1986). The reasons for this may be elevations in the south are generally lower, there are higher densities of humans using alpine pastures, and there are smaller distances between villages. The Khyber Pukhtunkhwa Forest Department conducted population census on Himalian ibex in 1992 and estimated 2,545 animals for the whole range in the province (NWFP Wildlife Department 1994), in Azad Jammu & Kashmir a total of 375 ibex were estimated by Qayyum (1985). Usman et al. (2007) conducted surveys during 2004 and 2005 in upper Neelum Valley and encountered the total population of ibex 122 occurring in its whole range of upper Neelum valley.

They are also said to be leaving to north in summer and coming back in winter, which is in concordance with the supposed migration pathway between upper Neelum Valley and Northern Areas (Gilgit-Baltistan). Evidence indicates that these small ibex herds appear to move and shift frequently, possibly due to a combination of weather, availability of food and water, and human and livestock disturbance. Given the high level of human activity in this eco-region the number of guns available, the active hunting culture, and the most complete lack of law enforcement

measures, these few remaining small herds of ibex are in extreme danger. It must be cited that due to the last few years' peace in the Valley [Line of Control (LoC)] mountains have become accessible to hunters which led to increased indiscriminate hunting that resulted in rapid decline of the species.

There are a number of predators which occur in the area. As a result of these threats, some populations might have declined, especially in areas with dense human populations. The main predator of the Himalayan ibex is the snow leopard (*U. uncia*), and successfully hunts Himalayan ibex. Other predators include Himalayan lynx (*Felix lynx*) and both, black and brown bear (*Ursus thibetanus laniger* and *Ursus arctos*). Himalayan lynx is a resourceful hunter which is believed to be capable of hunting young ibex and markhor. Some of the Himalayan ibex population specially the young ones are indeed preyed on by the bears.

5. Limiting Factors

Unfortunately, both poaching and overgrazing are prevalent throughout most of the areas. The major threat to species since centuries has been the indiscriminate hunting which led to the species degradation, driving towards reducing populations. The animal provides a valuable source of food; they are utilized for wool, skins, horns and clothing. Himalayan ibex is most hunted for sport and by illegal hunters in the Valley. Poaching also occurs in some areas by military personnel, road maintenance workers and others, especially in areas accessible by vehicle (Schaller et al., 1987).

The populations may fall much below the level of sufficient abundance under the influence of other components of environment which includes draught, avalanches, disease and habitat destruction limiting food resource. Mutual competition definitely occurs when the members of the same species use a resource of limited supply and its use by the species decreases the fitness of females and youngs, stronger would get the benefit (Shafique, 2004 & Shafique et al., 2006).

In addition, seasonal and migratory pastoralism is commonly practiced in several parts of northern Pakistan and Kashmir. It is particularly important as a source of revenue in the case of the high altitude ranges of the Himalaya. Many herding communities continue a long-standing tradition of moving up to alpine pastures for the summer and descending to lower reaches in the winter. Livestock utilize various grazing resources across altitudinal gradients and thus often come into contact with wild animals. Original habitat of the species may be decreasing with the intervention of livestock, sheep and goat in the wild pastures (and) may have a negative impact on the wild populations of ibex through parasitic disease transmission and competition for food.

6. Status in the Present Site

Present status of the species is uncertain, because there never ever have been taken systematic surveys to know the total population present in the upper Neelum Valley (AJK).

7. Conservation through Trophy Hunting

The Emperor Asoka of India in 252BC passed an act of conservation for the protection of animals, fish and forests (Johns, et al., 1981). This may be the earliest documented record of the deliberate establishment of what we today call protected areas, but the practice of setting aside exclusive hunting reserves is much older and the tradition has been continued in many widely different cultures to the present day.

King William-I of England in 1084AD ordered the preparation of the Domesday Book - an inventory of all the lands, forests, fishing areas, agricultural areas, hunting preserves and productive resources of his kingdom as the basis for making rational plans for the country's conservation and management. The modern concept of conservation – the wise maintenance and utilization of the earth's resources – is no more than the combination of these two ancient principles: the need to plan resource management on the basis of accurate inventory; and the need to take protective measures to ensure that resources do not become exhausted.

In Pakistan, Community-based trophy hunting programmes (CTHP) were introduced because it was recognized that only the communities' willingness could effectively preserve wildlife and related habitats. For that, they needed positive incentives, such as community benefits (Shackleton, 2001). The total fee paid to the communities is 80% of the total revenue from trophy hunting and this fee must be invested in a Village Conservation Fund (VCF) for conservation and community benefits. The government gets 20% for administration and management expenses (Arshad, 2001).

Today, Pakistan is one of the leading countries concerned with the conservation of this wild group - caprins through trophy hunting program - an

advanced technical hunting. These animals big game like ibex, markhor and urial are of great interest for the local and foreign hunters due to their striking spiral and huge horns. In Pakistan, trophy hunting program initially has been introduced successfully in Torghar Hills (Torghar Conservancy), Balochistan - a privately protected area inhabits large populations of Suleiman markhor and Afghan urial which once had lost their major populations in response to indiscriminate hunting (Shafiue, 2006). In Gilgit-Baltistan (Northern Areas) many communities are involved in conservation of ibex and markhor, and are availing benefits of community-based trophy hunting programme.

7.1. Minimum Criterion of Trophy-Hunting

The following guidelines are generally applied as a rule to introduce trophy harvesting programme.

7.1.2 CITES International Requirement

Estimation of trophy hunting must cover quantitative aspects, such as stock size and reproductive rates. It necessarily involves measuring possible negative effects on the population and social structure as well as genetic variability within each species and trophy-hunting management.

- individuals are removed on the basis of an adaptive wildlife management plan that is changeable at any time; benefits are directed to local conservation and local communities are agreed preventing any planned agriculture, settlement and illegal hunting in the target area.

- increasing populations are exposed free to natural predators.

- local communities receive a major amount from the trophy-hunting.

7.1.3 Local Requirements

Torghar Conservancy of Balochistan – Pakistan has set a leading example and considered regulating a best Programme of community-based sustainable use of caprins through trophy-hunting all over the world (Shackleton, 1997, Johnson, 1997b), where dwindling populations are increasing rapidly, benefits are shared by the local communities and the project has created lot of jobs for the poor people of local communities (Shafique, 2006).

In Northern Pakistan, communities have developed conservation plans for trophy hunting programme. Criteria implemented there includes

- Collect information of various aspects on all huntable species as baseline study, population size, minimum population size that must sustain population viability, elimination of all illegal hunting.

- Identification of annual quotas from the existing populations, use of the acquired amount from trophy-hunt, self-sustaining programmes, watch and ward etc.

- Conservation initiatives should greatly be in the interest of the target species, particularly habitat improvement and complete control on hunting and poaching, assessment of the populations, estimation techniques and agreements to external monitoring.

8. Suggestions

Viewing the importance of this programme, author would like to suggest further surveys to be undertaken to know the abundance and the potential habitat areas which would help inception of trophy-hunting programme.

Ecological studies of the species, Himalayan ibex *Capra ibex sibirica* is most important to be carried out with the larger conception of the surrounding 'habitat' taking into account all the factors of soil, rock, climate, water catchments and vegetation. In order to understand the ecology of the key species, the study of the habitat is the foundation of all ecological work and wildlife ecology is the basis of wildlife conservation and management (Kawamichi, 1997; & Shafique, 2003 & 2004). Ecological studies on caprins are lacking in the country particularly the species inhabiting Neelum valley in AJK, it is time that such studies should be undertaken.

Government agencies have a very limited capacity to control rural people's use of wild resources – especially when they need these resources to meet their subsistence requirements. The problem will become more acute with increasing human population if mechanisms are not provided for rural people to acquire the technical skills to manage wild resources. An alternative approach is needed that involves rural people in the solution rather than considering them the cause.

"Allocation of trophy hunting quota at this stage will equally be detrimental for the surveillance of species populations and the equilibrium of ecosystem because still we do not know the areas supporting larger populations. Therefore authors would suggest further systematic surveys to be undertaken to meet the criterion of trophy hunting programme".

9. Protection of Viable Populations and Sustainable Harvesting

Genetic research and its implementation to conservation have made such progress over the recent years that ignorance will lead to the decline of the species (cit. in Buechner, 1960); adequacy of genetic processes in wild populations is important tool in conservation and viability (Soule 1987, Hebert 1991). Variation in genetic processes will affect the evolutionary potential of the species when population stay declined at low numbers for long periods. Today many populations are in such condition that they have reached to the degree of extinction. Declined at this degree of the populations should be quickly to a level of several hundred animals that could meet the degree of viability. The populations of Suleiman markhor and Afghan urial have turned from the same situation in Torghar Hills which now have got their lost status re-establishing their numbers in thousands (shafique, 2006).

An increasing population can be identified if the percentage of young population is higher and corresponding to low percentage of older individuals. Adequate techniques and reliable trends in capturing data are vital for the determination of available quota of trophy animals. The allocation of quotas has been suggested based on actual counts of trophy animals in a population (Virk, 1999a); this trend is adequate because of the probability of double counting by the methods used during the surveys in Northern Areas of Pakistan (Shackleton, 1997), the methods suggested by Habibi (1997) are not consistent especially for threatened species such as markhor and ibex, they provide only rough estimates and need to be revised (Shackleton, 1997). Confident levels are high and trends are meaningful in the situation of Torghar Hills evaluated by Johnson (1997a): rapidly increasing numbers of both the populations have proved from the previous three surveys carried out between 1994 and 2000 by the foreign professional wildlife biologists and, individual sincere efforts of STEP towards conservation and management of Suleiman markhor and Afghan urial through community-based trophy hunting undoubtedly a great success (Shackleton, 1997).

Limited trophy hunting has been practiced in Pakistan since 1990 in Balochistan, Khyber-Pukhtoonkhwa, and Gilgit-Baltistan as a management tool for the conservation of Suleiman markhor (*Capra falconeri jerdoni*), Afghan urial (*Ovis vignei cycloceros*), Punjab Urial (*Ovis vignei punjabiensis*), Sindh ibex (*Capra aegagrus blythi*), flare-horned markhor (*Capra falconeri falconeri*) and Himalayan ibex (*Capra ibex sibirica*). Recognizing the significance and success of this program in Gilgit-Baltistan and Torghar Conservancy in Balochistan, many communities in the country as well as Asian Central States and its extensions to Zimbabwe and South Africa have instigated the same mechanism to protect their endangered or threatened species of ungulates.

For instance, the population of Transcaspian urial (*O. v. arkal*) contained only about 1000 animals in 1990, the trophy hunting of this urial introduced in Kazakhstan. Within three years (1990-1992), 47 animals were allocated for harvesting. Initially it was hunted excessively but later it restricted only to 10 individuals per year (Fedosenko 1998a, Weinberg 1998). As the over-harvesting observed negative impacts on the populations the number of trophy-hunts immediately decreased to maintain viability in natural populations.

At the beginning of this programme in Uzbekistan, two individuals of the each species of Transcaspian urial (*O. v. arkal*) and Bukhara urial (*O. v. bocharensis*) were allowed for trophy hunt. Following these hunts Turkmenistan allocated four individuals of Afghan urial (*O. v. cycloceros*) and some numbers of Transcaspian urial (*O. v. arkal*) for harvesting at most conservative level (Weinberg 1997). Iran is also offering Transcaspian urial (*O. v. arkal*) for trophy hunt (Hofer 1999 in. lit.). In Gilgit-Baltistan, many communities have introduced this programme successfully. An effective conservation system includes: sustainable use and on incentive system that promote local management and awareness to emphasize the importance in conservation and management (Shackleton, 1997).

Community-based trophy hunting has been used as a tool to raise money for the protection and management. An adequate quota allocated will support to growing populations steadily (Johnson, 1997b). For instance, Torghar Environmental Society of Pakistan (STEP) has met the basic requirements of the community based-trophy hunt in Torghar Conservancy. Efforts of STEP have brought the

dwindling populations from fewer to greater numbers and the benefits are clear both in the form of creating jobs for local communities and in favour of the two species of caprins through a limited trophy hunt and complete ban on illegal hunt. Such populations occurring in greater number in Torghar Hills are able to sustain with an annual trophy hunt of males equivalent 1-2 percent of the total population size without any negative impact on the population (Harris, 1993).

In developing countries wildlife conservation activities are often limited by financial constraints. Further, to prioritize the needs of local people during development and implementation of conservation policies and programmes are lacking (Lewis et al, 1990). This results in a rapid loss of wildlife particularly large herbivores and carnivores along with their habitats (Mallon, 1991). The majority of the world's biological species and largest surviving supplies of natural resources are found in developing countries (Bowers, 1997) where many plant and animal species have been lost due to poaching and habitat destruction (Haule et al., 2002). Similar kind of causes has contributed to extinction of at least 178 wildlife species since 16th century (Butle and Horan, 2003).

10. Conclusion

A population of a particular species is likely to go extinct if it is below a particular minimum viable size. This would need to be done under field conditions, and would require long-term counts on numerous populations of different initial group sizes. If we wish to take active steps to prevent the extinction of a species, we need to know what the minimum viable size of a population is. Here, we can refer Torghar Conservancy where decreasing populations of Suleiman markhor dropped below 200 animals, the minimum viable populations have got their lost status growing upto thousands when taken into account of community-based sustainable use through trophy harvest.

Since various authorities have encountered group size of the target species smallest to largest, thus it may be given an average group size 15-20 individuals consisting of all categories (sex, age) during the breeding season. In the present case (Neelum valley), if there are about 10 spatially isolated populations, the total size of the population should be above 150 animals as minimum viable size in the entire range of study area for the inception of sustainable use of the species through trophy hunting.

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12. References

Akhtar, N. 1991a. Azad Jammu and Kashmir Fisheries profile, feasibilities for trout culture and an overall sectoral development perspective. Report for Project PAK/88/048, FAO, Rome. 75pp.

Arshad, M. 2001. Community-based Trophy Hunting Programme in Northern Pakistan. WWF-Pakistan. 46pp.

Baillie and Groombridge. 1996. IUCN Endangered Species Red List of the world.

Blumestein, D. T. 1992B. Summer Diets of Tibetan Red Foxes, Khunjerab National Park, Pakistan. JBNHS.

Blumestein, D. T. 1994. New Records of Mustela from

Khunjerab National Park, Pakistan. JBNHS, in press (one page).

Bowers, J. 1997. Sustainability and Environmental Economics: An Alternative Text Addison Wesley Longman, England.

Buechner, H. K. 1960. The bighorn sheep in the United States, its past, present, and future. Wildllife Monograph No. 4, 58 pp.

Butle, E. H., & Horan, R. D. 2003. Habitat conservation, wildlife extraction and agriculture expansion. Journal of Environmental Economics and Management. 45: 109-127.

Caughley, G. 1977. Analysis of vertebrate populations. John Wiley and Sons, New York. 234 pp.

Corbet, G. B. and Hill, J. E. 1991. A world list of mammalian species, 3rd edit: British Museum (Nat. Hist.), London. 243 pp.

Corbet, G. B., and Hill, J. E. 1992. The Mammals of The Indomalayan Region: a systematic review. Natural History Museum Publications, Oxford University Press, Oxford, United Kingdom, 481 pp.

Fedosenko, A. K. 1998a. Status of the arkar and urial populations in CIS countries and the effect of trophy hunting. Traffic Europe Report, unpublished

Fedosenko, A. K and Blank, D. A. 2001. *Capra sibirica*, Mammalian Species. 675:1-13.

Frisina, M. R., Campbell, D and Lajia C. 2000. Enhancing conservation of caprinae using geographic areas to define trophy hypes. Presentation at the IUCN Caprinae Specialist Group's Workshop on Taxonomy and Conservation. May, 2000. Ankara, Turkey. Unpublished.

Furlow, R. C., Haderlie, C. M. and Berge Van Den, R. 1981. Estimating a bighorn sheep population by mark-resight capture. Desert Bighorn Council Trans. 25: 31-33.

Giest, V. 1966. Validity of horn segment counts in aging bighorn sheep. Journal of wildlife Management. 30 (3): 634-635.

Groombridge. B. 1988. Baluchistan Province, Pakistan: a preliminary environmental profile. IUCN Conservation Monitoring Centre Cambridge, UK. Unpublished report. 104 pp.

Habibi, K. 1997. Status of markhor (*Capra falconeri kashmiriensis*) in Chitral Gol National Park and Tushi Game Reserve. Unpublished Notes.

Harris, R. B. 1993. Wildlife conservation in Yeniugou, Qinghai China: Executive summary. Unpublished Ph.D. Dissertation. University of Montana, Missoula, MT. 10 pp.

Haule, K. S., Johnsen, F. H. & Maganga, S. L. S. 2002. Striving for sustainable wildlife management the case of Kilombero Game Controlled Area. Tanzania. Journal of Environmental Management. 66: 31-42.

Hebert, D. 1991. Appendix 4: Theoretical considerations in determining proper ESA listing for argali. Pages 120-121 in M. Lillywhite, ed. Status review, critical evaluation, and recommendations on proposed threatened status for (*Ovis ammon*) prepared by Domestic Technology International, Evergreen, CO for Safari Club International. 123 pp.

Heptner, V. G., Nasimovich, A. A. and Bannikov A. G. 1961. Mammals of the Soviet Union. Vol. 1, Ungulates. Moscow: Academy of Sciences.

Hess, R. 1986. "Number of Flare-horned Markhor *Capra falconeri* and Siberian Ibex, *Capra ibex sibirica* in the areas of the Chitral Gol, the Shingall Nallah and the Barpu Glacier in summer 1985 and winter 1985/86." Report submitted: National Council for Conservation of Wildlife, Islamabad.

Hess, R., Bollmann, K., Rasool, G., Chaudhry, A. A., Virk, A. T. and Ahmad, A. 1997. Pakistan. pp. 239-260, in: D. M. Shackleton (ed. and compiler) and IUCN Caprinae Specialist group, Wild Sheep and Goats, and their Relatives: Status Survey and Conservation Action Plan for Caprinae. IUCN, Gland, Switzerland and Cambridge, U.K.

Hofer, D. 1999. Traffic Europe, in litt. to U. Grimm, 19.01.1999.

IUCN. 1996. Ibex conservation plan, Khyber Valley, District Gilgit, IUCN. Gilgit. 15pp.

John Mackinnon, K., Child, G. and Thorsell, J. 1986. Managing Protected Areas in the Tropics. IUCN Gland Switzerland. 295 pp.

Johns, B. 1981. The effects of selective logging on

the social structure of resident primates. Malaysian Applied Biology. 10(2):221-226.

Johnson, K. A. 1997a. Status of Suleiman markhor (*Capra falconeri jerdoni*) and Afghan urial (*Ovis orientals cycloceros*), populations in the Torghar Hills, Balochistan Province, Pakistan. In: Mufti, A.M., Woods, C.A. and Hassan, S.A. (eds): Biodiversity of Pakistan. Florida Museum of Natural History, Gainesville. pp. 469-483.

Johnson, K. A. 1997b. Trophy hunting as a conservation tool for Caprinae in Pakistan. In: Freese, C.H. (ed): Harvesting wild species: Implications for biodiversity conservation. Pages 393-423. the Johns Hopkins University Press, Baltimore, Maryland.

Kawamichi, T. 1997. The age of sexual maturity in Japanese giant flying squirrel, *Petaurista leucogenys*. Mammal Study, 22: 81-87.

Koller, G. 1972. 'Gran Paradiso's Half Century' Animals, vol. 14, No. 3, pp 12-31.

Leslie, D. M. and Douglas, C. L. 1979. Desert bighorn sheep of River Mountains. Nevada. Wildl. Monog. 66: 1-56.

Leslie, D. M. and Douglas, C. L. 1986. Modeling demographics of bighorn sheep: currant abilities and missing links. Trans. North Am. Wildl. Natur. Res. Conf. 51:62-73.

Lewis, D. Kaweche, G. B. and Mwenya, A. 1990. Wildlife conservation outside protected areas: Lessons from an experiment in Zambia . Conservation Biology.Vol. (4):171-180.

Mallon, D. P. 1991. "Status and Conservation of Large Mammals in Ladakh." Biological Conservation 56: 101–119.

Mallon, D. P., Bold, A., Dulamtseren, S., Reading, R. P. and Amgalanbaator, S. 1997. Mongolia. pp 193-2001 in wild sheep and goats and their relatives: Status surveyand conservation action planfor Caprinae (D. M. Shackleton ed.) international Union for the conservationof Nature, Gland, Switzerland.

Negi, S. S. 1990. Himalayan Forests and Forestry. Indus Publishing Co. Tagore Garden, New Delhi – 110027. 304 pp.

NWFP. Wildlife Department 1994. Distribution and status of wildlife in NWFP. Unpublished report, NWFP Wildlife Department, Peshawar. 53pp.

Pallas, P. S. 1766. Miscellanea zoologica, quibus novae imprimis atque obscurae animalium species describunter. Spicilegia Zoologica 2:1–224.

Pallas, P. S. 1776. Alpium sibiricarum. Spicilegia Zoologica, quibus novae imprimis et obscurae animalium species iconibus, descriptionibus atque commentariis illustrantur 11:31–57.

Pollock, K. H. and Kendall, W. L. 1987. Visibility bias in aerial survey: A review of estimation procedures. Journal Wildlife Management. 51: 502- 510.

Qayyum, S. A. 1985. Wildlife in Azad Jammu and Kashmir. Wildlife Wing, Forest Dept., Govt. of Azad Jammu & Kashmir, Muzaffarabad. 53 pp.

Reading, R. and Shank, C. 2008. *Capra sibirica*, IUCN Endangered Species Red List, 2008.

Rasool, G. 2001. Report on Trophy Hunting in Northern Areas. A consultancy assignment submitted to WWF-Pakistan. 14 pp.

Roberts, T. J. 1977. The Mammals of Pakistan. Ernest Benn, London. 1977. 374pp.

Roberts, T. J. 1997. The Mammals of Pakistan. Oxford University Press, Walton Street, New York. Revised Edition, 525pp.

Schaller, G. B. 1976B. Mountain Mammals in Pakistan, Oryx. Journal of the Fauna Preservation Society. Vol. 13 (4), pp. 351-356.

Schaller, G. B. 1977. Mountain Monarchs. The University Press, Chicago: USA.

Schaller, G. B, Li Hong, Lu Hua, Ren Junrang, Qiu Mingjiang and Wang Haibin. 1987. Status of Large Mammals in the Taxkorgan Reserve, Xinjiang, China. Biological Conservation 42: 53-71.

Schaller, G. B. 1998. Wildlife of the Tibetan Steppe. The University Press of Chicago, USA.

Shackleton, D. M. 1997. Why Caprinae? Conservation Priorities and Options. General Conservation Actions and Implementation. In: SHACKLETON, D. M. (ed.) and the IUCN/SSC Caprinae Specialist Group: Wild Sheep and Goats

and their Relatives. Status Survey and Conservation Action Plan for Caprinae. Chapter 2, 11 and 12. IUCN, Gland, Switzerland and Cambridge, UK.

Shackleton, D. M. 2001. A review of the community-based trophy hunting programs in Pakistan. Prepared for the Mountain Area Conservancy Project with the collaboration of IUCN-Pakistan, NCCW, MoELGRD. 59 pp.

Shafique, C. M. 2003. Some Aspects of Bio-Ecology of Ayubia National Park, District Abbotabad, NWFP. Published Ph.D. Thesis, submitted in University of Karachi. 438pp.

Shafique, C. M. 2004. Ecology of Flying Squirrels of Ayubia National Park, NWFP – Pakistan. Report submitted to WWF-Pakistan, Lahore. 71 pp.

Shafique, C. M. 2006. Status of Suleiman markhor (*Capra falconeri jerdoni*) and Afghan urial (*Ovis vignei cycloceros*) with relation to community-based trophy hunting in Torghar Conservancy, Balochistan Province, Pakistan. Report for SUSG Central Asia and UNDP. 16 pp.

Shafique, C. M., Barkati, S., Oshida, T. and Ando, M. 2006. Comparision of diets between two sympatric flying squirrel species in Northern Pakitan. Journal. of Mammalogy, American Society of Mammalogists. Vol. 87(4):784-789.

Soule, M. 1987. Viable Populations for Conservation. Cambridge University Press, Cambridge, U.K. 189 pp.

Stockley, C. H. 1936. Stalking in the Himalayas and Northern India, Herbert Jenkins, London. 254 pp.

Usman, A., Ahmad, K.B., Awan, M. S., Ashraf, S., Bashar, M. and Awan, M. N. 2007. Distribution and population estimation of Himalayan Ibex (*Capra ibex sibirica*) in upper Neelum valley, District Neelum, Azad Kashmir. Pak. J. Biol. Sci. 10(18): 3150-3153.

Virk, A. T. 1999a. Integrating Wildlife Conservation with Community-based Development in Northern Areas, Pakistan. Unpublished Ph.D. Thesis, University of Montana, Missoula, Montana. 237 pp.

Wegge, P. 1988. Assessment of Khunjerab National Park and Environs, Pakistan. Unpublished report, IUCN, Gland, Switzerland.

Weinberg, P. I., Fedosenko, A. K., Arabuli, A. B., Myslenkov, A., Romashin, A. V., Voloshina, I. and Zheleznov, N. 1997. The Commonwealth of Independent States (former USSR). In: Shackleton, D. M. (ed.) and the IUCN/SSC Caprinae Specialist group: Wild Sheep and Goats and their Relatives. Status Survey and Conservation Action Plan for Caprinae. Chapter, 7.2 IUCN, Gland, Switzerland and Cambridge, UK.

Weinberg, P. I. 1998. in litt. To U. Grimm, 10.12.1998.

Wilson, Don E. and Reeder D. M. (eds). 1993. Mammal Species of the World: A taxonomic and Geographic Reference, Second Edition. Smithsonian Institution Press, Washington D.C. 1312 pp.

Wilson, Don E. and Reeder, D. M. (eds). 2005. Mammal Species of the World: A taxonomic and Geographic Reference, (3rd ed.). Baltimore: Johns Hopkins University Press, 2 vols. 2142 pp.

Sustainable harvesting model for cranes in the Kurram Valley, Khyber Pakhtunkhwa Province, Pakistan

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Abstract
The Kurram valley of Pakistan serves as a migration route to the two crane species namely demoiselle and Eurasian. In recent past the numbers of migratory cranes were estimated to be in thousands along this route, however in year 2001 the migration of cranes has been rarely observed. According to the research conducted hunting is concluded as the major reason for the drastic reduction in the number of migratory cranes in Kurram valley. In this paper a simple deterministic model has been constructed, adapted from Vortex population Viability Analysis used by Miller et al. (1972) in order to estimate extinction probability of Eurasian and demoiselle cranes in the Kurram valley. Data of sandhill crane is taken as an alternate for Eurasian and demoiselle cranes as they share similar population parameters and biological characteristics. The model proposed here is processed in Microsoft Excel while assuming surviving population each year as a base population for next year subjected to 10% of hunting level. The goal of this model was to identify scenarios that resulted in extinction rates of less than 10% over 100 years based on minimum acceptable extinction risk for the "vulnerable" category in the Red list of the World Conservation Union.

Key words: Pakistan, Kurram, Zhob, Bannu, Lakki, Khan, cranes, viability analysis

1. Introduction

Geographically, the Kurram Valley of Pakistan extends over the districts of Lakki and Bannu and the Federally Administered Tribal Areas of the Kurram and North Waziristan Agencies. The Kurram Valley stretches between Dara Tang in the Lakki district to Koh-e-Sufaid in the North West, where it borders Afghanistan. The watershed area of Kurram consists of arid, semi-arid plains and foothills, ranging from 300m to 4761m altitude and part of it extends beyond the international border into Afghanistan. The watershed is defined by the Kurram River and its tributaries, which include Kashu and Gambila (Tochi) Rivers. This River lies on a major migration route for cranes, primarily the Eurasian crane *Grus grus* and demoiselle crane *Anthropoides virgo*, and recently extinct Siberian crane *Grus leucogeranus* (Scott, 1989). A little is known about the ecology, distribution, migration patterns, period of migration and population status of these cranes in Pakistan. Based on love for traditional trapping of cranes the Khyber Pakhtunkhwa Wildlife Department promulgated special crane rules in 1984 (records on file of the wildlife department).

Demoiselle and Eurasian cranes hold a relatively stable population throughout Pakistan. However, the impact of over hunting on the demoiselle and Eurasian crane populations migrating through the Kurram valley have resulted in their depletion from the area. According to the research based on the discussions in 2001 around 20 cranes including both species were trapped in the Kurram valley in comparison to 100 in 1995. This reflects the sharp decline in population of these cranes which is estimated to be 20,000 to 25,000 in early 1980's (Ahmad and Jan, 1995).

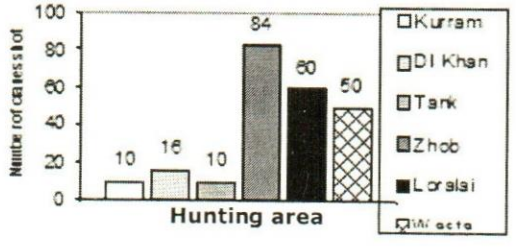
In order to ensure the long term survival of Pakistan's crane species on the migratory route of Kurram valley, prediction of the possible future trends in crane population in response to different hunting level is necessary. Population viability model have now been widely used to assess such long term trends of target population and to predict the probability of survival of species threatened with extinction (cf. Beissinger and McCullough 2002 and Morris, 2002). One of the most sophisticated and successful population viability models now in use, the Vortex Population Viability Analysis model (Lacey et al. 1995 and Lacey, 2002) was developed by the Conservation Breeding Specialist Group (CBSG). This model has already been used successfully by the CBSG to assess the population viability of several species of cranes: the whooping

crane *Grus americana* (Mirande et al., 1996), the Mississippi sandhill crane *Grus canadensis pulla* (Seal and Hereford, 1992), the eastern sarus crane *Grus antigone sharpii* (CBSG, 1997), the wattled crane *Bugeranus carunculatus* (McCann et al., 2000) and the blue crane *Anthropoides paradiseus* (McCann et al., 2002). The model uses a series of parameters whose values can be adjusted to fit specific populations and situations of special interest or concern.

The model then predicts the possible long-term impacts on a species from a population of concern resulting from different levels of threats and/or different management options. This allows conservation specialist and wildlife managers to distinguish among alternatives and thus to guide to design conservation strategies.

In this paper a simple, deterministic model has been constructed which has been adapted from population viability model for sandhill cranes *Grus canadensis* used by Miller (1972) to assess the

Figure 1: Crane (demoiselle and Eurasian) shot for food in the NWFP and Balochistan Provinces (spring 2001)



impact of hunting pressure on these cranes in North America (Miller et al. 1972).

The model proposed here is more appropriate for small population, and assesses the impact of the currently estimated 10% trapping rate against a reduced rate of 5% and 2.5%.

2. Material and Methods

2.1. Structure of Model

This introductory crane population viability model consists of the following parameters:

A_1 = an initial spring population level from which to start the simulation (for cranes in Pakistan this population consists of those adults and sub-adults who have survived the non-breeding season and migration);

A = number of adults and sub adults in the spring

B = proportion of spring population who are adults and, therefore, capable of breeding;

C = number of years to maturity (= adult)

D = proportion of adults that breed,

E = number of young fledged per pair

F = mortality of chicks from fledging to next spring

G = mortality per year of adults and sub adults

H = proportion taken by hunting each year

The following are the basic equations used in the simplest form of the model:

J = number of breeding pairs = (B*D)/2

K = number of fledglings = J*E = (B*D)/2 * E

L = number of fledglings that survive to the spring = K*(1-F)*(1-H)

M = number of adults that survive to the spring = A_1*B*(1-G)*(1-H)

N = number of sub adults that survive to the spring = A_1*(1-B)*(1-G)*(1-H)

A_2 = population in year 2 = L + M + N

O_1 = number of cranes taken by hunters at end of year 1 = (K*(1-F) + A_1*(1-G))*H

In an extended version of the model using age classes, the following conventions were used:

$N1_2$ = sub adult 1 year old = L

$N2_2$ = sub adult 2 years old = $N1_1$*(1-G)*(1-H)

$N3_2$ = sub adult 3 years old = $N2_1$*(1-G)*(1-H)

And, if one is assuming three years as a sub adult, then the number of adults at the end of the year would include existing adults that survived and the 3rd year sub adults who became adults: $M_2 = M_1 + N3_1$*(1-G)*(1-H). In a similar manner, we extended the model to five years classes of sub adults.

2.2. Values Used for the Parameters in the Model

For the purpose of modeling, the demoiselle and Eurasian crane populations, migrating through the Kurram Valley were combined into a single population. Concrete data are not available from the field for either the demoiselle crane or the Eurasian crane. Therefore, the preliminary estimates in this model are based on data for sandhill cranes (Miller, 1972), and whooping cranes (Mirande et al., 1996). Data for Sandhill crane species has been chosen in this study since this species has population size similar to the demoiselle and Eurasian cranes which are also similar to those species in biological characters such as feeding strategies and the estimates

available are reliable. Having similar habits and habitats the Sandhill cranes may also be subjected to limiting factors similar for the demoiselle and Eurasian cranes. However, the whooping crane data were used where the estimates for certain parameters were considered more reliable for this highly monitored species.

The following values were used to construct the model:

Population Size
The initial size of the combined population of demoiselle and Eurasian cranes in the Kurram Valley was estimated at 20,000 based on the work of Ashiq Ahmad and Steve Landfried and others (Ahmad et al., 1993; Ahmad and Jan, 1995 and Roberts and Landfried, 1987).

Age Structure
The proportion of breeding age adults to subadults was estimated at 60:40 percent based on reliable data collected for whooping cranes (Mirande et al., 1996) and for sandhill cranes (Miller, 1972).

Breeding Pairs
It was estimated that 79% of adult birds breed in a given year based on reliable estimates for whooping cranes (Mirande et al., 1996). This number was then divided by 2 to estimate the number of breeding pairs.

Recruitment
The probability of 0.6 fledglings per breeding pair was based on data for sandhill cranes which show that 60% of the breeding pairs successfully produce a live chick each year (Miller 1972).

2.3. Data Interpretation

Natural Mortality
Based on reliable data for the well-monitored population of whooping cranes (Mirande et al., 1996), it is estimated that 26% of the chicks produced die during the first year of life. Mortality for all age classes of subadults and adults is estimated at 7.3% per year. Both estimates are based on reliable data for the well-monitored population of whooping cranes (Mirande et al., 1996). The mortality rates Miller (1972) used in the sandhill crane simulation model are 0.3 for juveniles and 0.06 for adult birds. To err on the conservative side, the higher rates of mortality for each species/age class were applied: 0.3 for the mortality of fledglings in their first year of age and 0.073 for the annual mortality for both adults and subadults.

Hunting Mortality
According to Roberts and Landfried (1987) and Ahmad et al., (1993) hunters trapped 10% of the crane population migrating through the Kurram Valley in early 1980's. This study validates this figure. I also modeled 5% and 2.5% hunting rates to assess the impact on population size and probability of extinction.

Using the equations described above with the values for the key parameters as discussed above, the following procedures were applied:

- The model was started with a base population of 20,000, corresponding to the estimate for the crane population in the Kurram Valley in 1980.
- Starting with a spring population, annual recruitment was calculated as indicated.
- Annual mortality for each age class was then applied in the absence of hunting.
- Mortality resulting from different rates of losses from hunting, estimated at 10%, 5%, and 2.5% were then applied.
- The remaining number of cranes in each age class then was entered as the base population for the next year.
- This simple iterative simulation was then run 100 times to simulate 100 years.

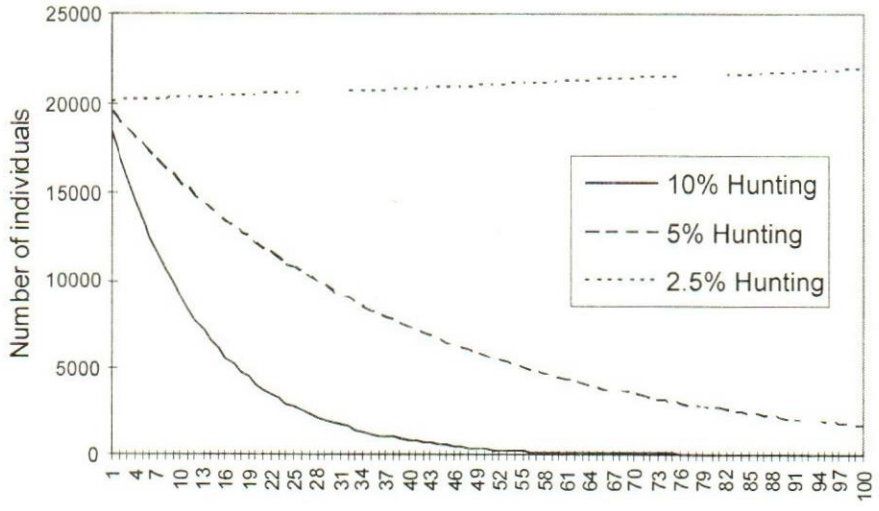
The goal of this modeling was to identify scenarios that resulted in extinction rates of less than 10% over 100 years based on minimum acceptable extinction risk for the "vulnerable" category in the Red List of the World Conservation Union (IUCN, 1994 in Besissinger and McCullough, 2002).

3. Results

The model shows the following results when hunting mortality of 10%, 5% and 2.5% are used:

- **10% Hunting Mortality:** The simple model that is constructed here shows that the base population of Kurram Valley estimated for 1980 would continue to decline precipitously and be extinct in 100 years with a hunting rate of 10% of the

Figure 23: Expected trends in the crane population in response to different rates of loss to hunting



population. The model estimates that in 2001, only 3504 cranes would survive in the population, which is close to the 2,953 cranes (2,087 demoiselle cranes + 866 Eurasian cranes) counted in spring 2001 in the Kurram Valley.

- **5% Hunting Mortality:** Shows a decline with an estimated 11,513 cranes surviving until the year 2001 and only 1,625 surviving by the year 100.
- **2.5% Hunting Mortality:** At this very small rate of loss, the population remains relatively stable with a slight rise over 100 years reaching an estimated 21,943, less than a 10 percent increase.

4. Discussion

This model contradicts the claim of crane hunters that the decline in crane populations occurred only due to the cranes changing their migration routes as a result of war in Afghanistan and not hunting. Current levels of crane hunting in the Kurram Valley have likely contributed to the steep decline of the demoiselle and Eurasian crane populations and are clearly not sustainable. If these current levels of hunting continue, it is likely that these crane populations will reach critically low levels within less than ten years.

The following actions are recommended for long term sustainable crane population:-

- Prepare and implement a recovery plan for the crane populations of the Kurram Valley incorporating a fixed sustainable annual hunting quota. Hunting permits for the Kurram Valley population should be based on available surplus for hunting. The current model suggests that only a hunting rate of less than 3% may be sustainable. This would allow an annual take of only 75 cranes of the nearly 3,000 demoiselle and Eurasian cranes in the population. This is in sharp contrast to the harvest of 374 cranes (demoiselle and Eurasian) from the crane population of the Kurram Valley in spring of 2001. This illustrates the urgent need to dramatically reduce crane hunting in these areas immediately, or there will be no cranes and no hunting in the near future.
- Study and apply more sophisticated population viability models including the Vortex Population Viability model.
- Conduct sensitivity analysis, especially mortality of breeding age adults, to identify key

parameters.

- Collect data on these key parameters in wild populations of demoiselle and Eurasian cranes to allow more accurate assessments and predictions from the model with these species and population specific values.

- Consider impact of additive mortality in other parts of the flyway.

- Design and implement a comprehensive study over the cranes' entire ranges, including their breeding grounds in Russia and Central Asia, and, wintering grounds in Pakistan and India.

- Refine and implement conservation plans as offered in chapter 4 of this thesis to provide the opportunity to the cranes to rebuild their populations and for future generations of hunters to continue their tradition of hunting over years to come.

5. References

Ahmad, A. and Jan, A. 1995. Cranes in Pakistan. *Crane Research and Protection in Europe:* 337-352.

Ahmad, A., Farooque, A. and Ghalib, A. 1993. *The Cranes of Pakistan.* WWF-Pakistan. 39 pp.

Beissinger, S. R. and McCullough, D. (eds.) 2002. *Population Viability Analysis*. The University of Chicago Press, Chicago. 577 pp.

CBSG 1997. Eastern sarus crane (Grus antigone sharpii) population and habitat viability assessment. CBSG, Thailand.

Lacy, R. C. 2002. Vortex Population Viability Analysis Software. www.vortex9.org/vortex.html

Lacy, R. C., Hughes, K. A. and Miller, P. S. 1995. VORTEX—Version 7 User's Manual. IUCN/SSC Conservation Breeding Specialist Group, Apple Valley, Minnesota.

McCann, K. (eds.). 2000. Population and habitat viability assessment for the wattled crane (*Bugeranus carunculatus*) in South Africa. CBSG, South Africa.

McCann, K., Byers, K. A., Miller, P. and Friedman, Y. (eds.). 2002. Population and habitat viability assessment for the blue crane (*Anthropoides paradiseus*): Final Report. CBSG, South Africa.

Miller, R. S. 1972. *A Simulation Model for the Management of Sandhill Cranes*. Yale University: School of Forestry and Environmental Studies, Bulletin No. 80. 49pp.

Mirande, C., Cannon, R. J. and Jhon, R. 1996. Computer Simulations of Possible Futures for two Flocks of Whooping Cranes. Proceedings of the Seventh North American Crane Workshop.

Morris, W. F. and Doak, D. F. 2002. *Quantitative Conservation Biology: Theory and Practice of Population Viability Analysis.* Sinauer Associates, Sunderland, Mass.

Roberts, T. J. and Landfried, S. E. 1987. Hunting pressure on cranes migrating through Pakistan. Pp.139-145. In: G.W. Archibald and R.F. Pasquier (eds.), Proceedings of the 1983 International Crane Workshop, Bharatpur, India, and International Crane Foundation, Baraboo, Wisconsin.

Seal, U. S. and Hereford, S. (eds.). 1992. Mississippi sandhill crane (*Grus canadensis pulla)* population viability assessment workshop. IUCN/SSC Conservation Breeding Specialist Group, Apple Valley, Minnesota.

Scott, D. 1989. *The Directory of Asian Wetlands.* IUCN, Gland, Switzerland.

Temporal fluctuations in populations of birds at Lower Sindh , Pakistan

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Abstract
This paper provides the findings on the total numbers of birds visiting along the sea coast, creeks and lakes of Lower Sindh, Pakistan. Overall, 121 species of birds belonging to 12 orders and 34 families were recorded during the surveys carried out from 2006-2011. The study exposes that the population trends of birds have been changed in comparison with the previous studies mainly due to change in water conditions and food availability.

Key words: food scarcity, water regime, population trend, birds, wetlands

Introduction

Pakistan has 1040 km long coastline, stretching from Sir Creek in the southeast near Indian border to Jiwani in the west near Iranian border. The major portion of the coastline i.e. 770 km long stretch falls in Balochistan, while the rest of 270 km lies in Sindh. In relation to fishing operations, the coastline of Pakistan can be divided into two regions; the Sindh coast and the Balochistan coast. The area offers good opportunities for artisanal, coastal, offshore and deep sea fishing (Majid 1988). Fishing being an important economic activity in coastal areas of Pakistan, particularly on Balochistan coast contributes substantial earning. Export of fish and fishing products have yielded a sum of Rs. 8.8 billion in 2002. According to the census report of 2001, the population of the coastal areas of Pakistan is nearly 1.5 million of which 90.5% lives in the rural areas. The population growth in the coastal areas is much higher (3.33% per year) as compared to non coastal areas (IUCN, 2005). The birds utilize coastal areas as feeding, breeding, wintering and roosting grounds (Hasan, 1994, 1996 & 2005 and Hasan and Brohi, 2009).

Lower Sindh including Sindh Coast

The Sindh coastal region is located between the Indian borders along the Sir creek in the east to the Hub River in the west. The Indus River pours into the Arabian Sea in the southeast of Karachi creating Indus Delta. The Indus Delta is the most prominent feature of the Sindh Coast and covers an area of about 600,000 hectares and is characterized by 17 major creeks and innumerable minor creeks, mudflats and mangrove thickets. The Indus Delta supports wetlands rich in nature and culture and also harbours the largest cover of arid climate mangroves in the world. About 70 km area of Sindh coast stretching from Khudi Creek to Cape Montz, falls within Karachi. Scenic and famous marine turtle beaches like Paradise point, Hawks Bay, Western Backwaters and Sandspit are special features of this coastline.

Material and Methods

Direct count is one of the most widely used methods for determining species diversity and abundance. It is useful in open areas. In the open areas, targeted birds are easy to observe, identify and count. In order to estimate bird species diversity, surveys were undertaken in Lower Sindh near the coast during the winter months to record migratory and resident species. This method was applied by taking randomly selected points within the area of wetland and recording number of each species. During the survey, birds were identified in the field and reconfirmed with the help of field guides. Counting the number of birds precisely in the field was made possible with the use of binoculars and spotting scope.

Results and Discussion

During 2006-11, eleven wetlands of Lower Sindh were surveyed and 121 bird species comprising of 12 orders and 34 families were recorded (Table 2). The highest numbers of birds were observed from Nurri lagoon where the numbers were consistently high in comparison with other wetlands. Here the numbers were around forty thousand every year of the study except 2010-11, when more than fifty thousand birds were recorded. The least number recorded were from Jabbo where only 122 birds were observed. The data of 2009-10 when compared with that of 2010-2011, it showed that the number of birds increased during 2010-11 mainly due to improved water condition after flood (Table 1). The number of birds at Haleji was recorded less than 10,000 every year except 2006-7. The reason might be scarcity of food and changed water conditions of

the wetland. During 2002, the bird numbers at Haleji were recorded as 24,812 (Javed, 2002) which were near to the numbers of 2006-7 of the present study. After that period there was a sharp decline in the number of birds.

The wetlands of Nurri, Kurr, Haleji and Kinjhar were surveyed throughout the period of the study excepct 2008-9. The highest species richness was recorded at Nurri in 2007-8 where more than 60 species of birds were recorded including its adjoining areas. The least bird diversity was observed from Kinjhar during study period. The species richness at Haleji was most consistent throughout (Figure1), while it was higher due to better water condition in the Nurri wetland (Figure 1). Ghalib et al. (1999) have reported 113 species of birds of tidal link and adjoining areas of Nurri Lake while the present study reveals only 62 species of birds at the Lake and adjoining areas. The intensity of migratory birds was low. This difference was, probably, explained by a relatively short inundated area of the Lake and the overall change in the habitat. Birds of lakes and floodplain habitats depend heavily on the depth of water and the duration of flood. An associated shortage of food and nesting habitats for ground and shrub nesting birds might have caused changes in their distribution in the area. Breeding density decreased locally, and visiting birds' diversity and density also decreased. Ghalib et al. (1999) recorded high density rate of visiting birds at Nurri Lake but during the past decade change in water regime has greatly caused decline in the bird species populations. The area of Nurri was the most important site for Greater and Lesser Flamingos. Such high populations of flamingos have not been seen elsewhere in Pakistan.

Major world breeding colony of greater flamingos and lesser flamingos is located at Pachham Island in the centre of Great Rann of Kutch in Gujarat, India (Ali, 1945). The Island is not far from these areas. A small population of greater flamingos used to breed near the out fall of Ahmad Rajo canal near Golarchi in the 70's (Karim, 1985) but during the present study breeding evidences were not seen due to change in water regime and disturbance in the area. The Haleji wetland shows sharp decline in species richness. During 2001, 49 species of birds were recorded from Haleji (Javed, 2002) but during the present search we recorded only 30 species. The reasons might be the same as shortage of food and shelter at the wetland.

Table 1: Number of birds observed from eleven wetlands of Lower Sindh from 2006 to 2011

Wetland	2006-7	2007-8	2008-9	2009-10	2010-11
Nurri	38,361	46,259		43,918	53,433
Kurr	17,549	8820		2268	
Haleji	22,187	1120		8933	3919
Kinjhar	554	400		245	1870
Keti Bundar	3765	3440			
Mirpur Sakro	3262	3600			
Jabbo				122	7097
Hadero				245	965
Korangi/Phitti creeks				4000	5326
Karachi West Coast			4955		

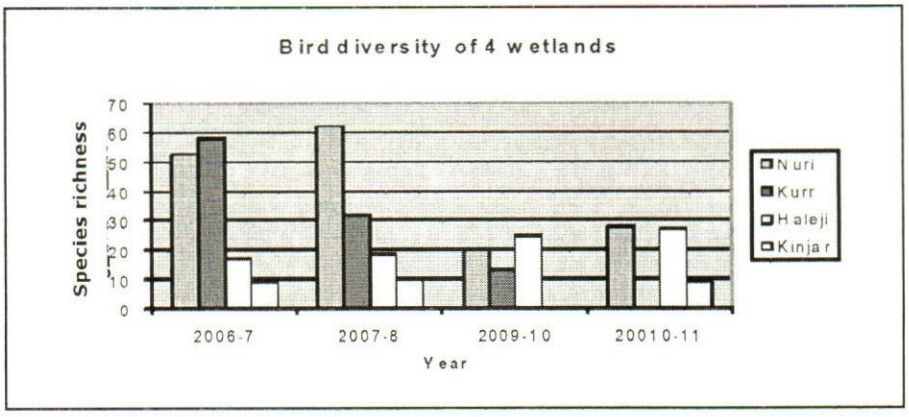

Figure 1: Bird diversity of four wetlands of Thatta and Badin districts

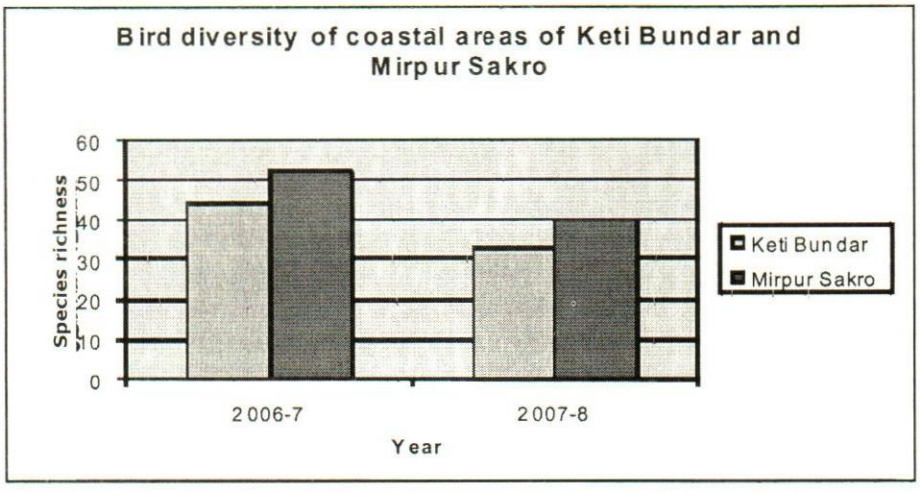

Figure 2: comparative species richness of two localities of Sindh coast

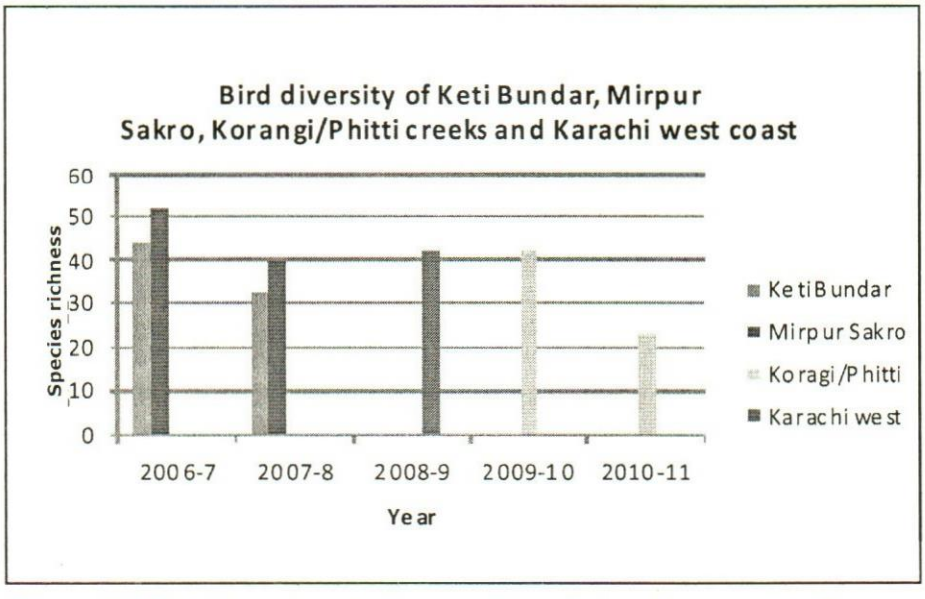

Figure 3: Bird diversity of all coastal localities of Lower Sindh coast

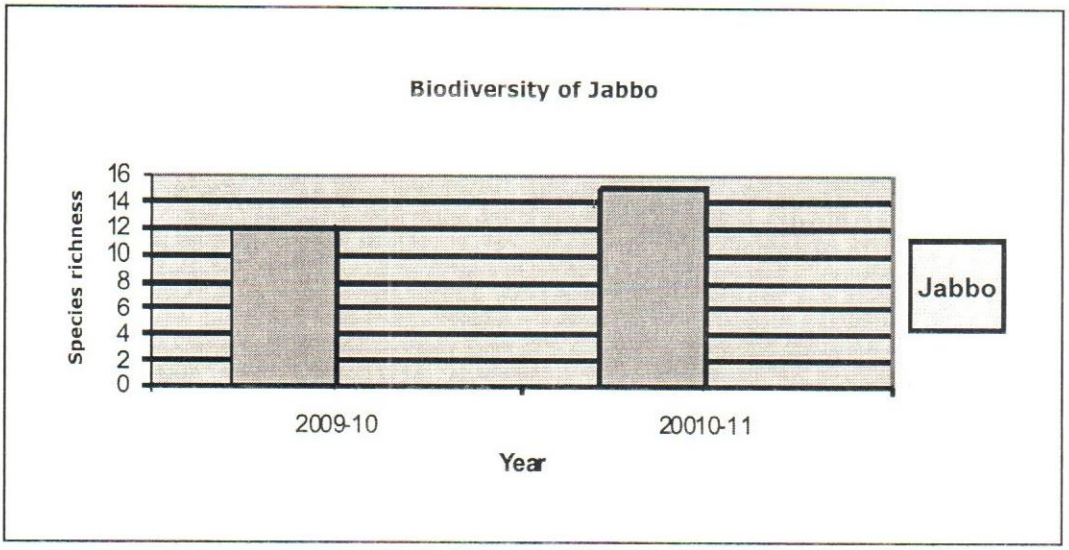

Figure 4: Avifaunal diversity at Jabbo of two consecutive years

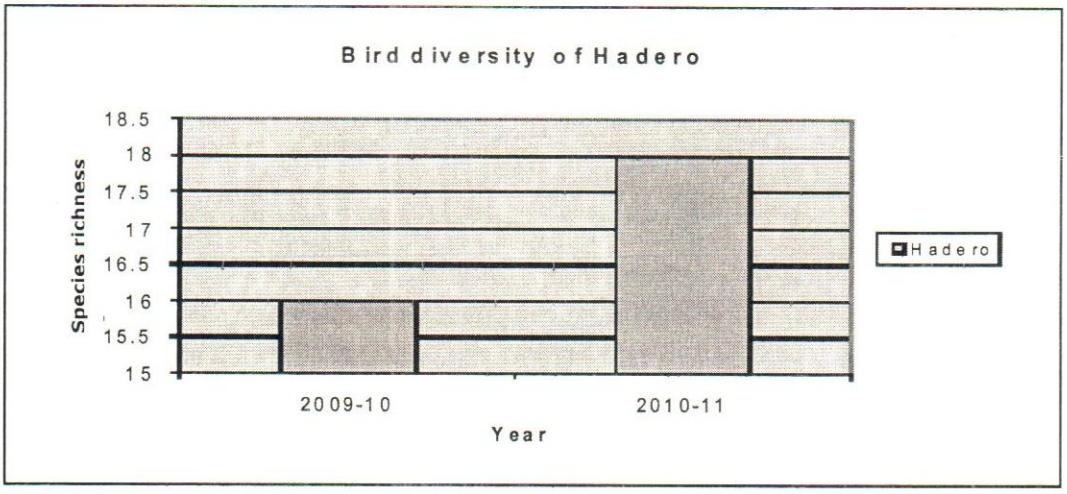

Figure 5: Bird diversity at Hadero of two consecutive years

The birds of Keti Bundar and Mirpur Sakro were studied during the periods 2006-7 and 2007-8. During 2006-7 at Mirpur Sakro we recorded more than 50 species of birds while during the period 2007-8 populations showed a significant decline dropping to 40 species. Similar situation was recorded at Keti Bundar during the period 2007-2008 (Figure 2).

Bird diversity of all the coastal sites surveyed during the study period showed that the species richness of all the four sites was more or less consistent during 2006-10 except during 2010-11 where more than 20 species of birds were recorded from Korangi/Phitti creeks (Figure 3).

Species richness at Jabbo wetland for the two consecutive years was very low mainly due to extreme pollution from the Karo-Gangro outfall drain (Figure 4).

Bird diversity of Hadero was extremely low during 2009-10 and 2010-11 mainly due to poor food conditions for the birds (Figure 5).

Table 2: List of birds recorded from Lower Sindh, Pakistan

S#	Common Name	Scientific Name	Status
1.	Order:***Podicipediformes*** Family:**Podicipedidae**		
2.	Little grebe	*Tachybaptus ruficollis*	R/common
3.	Black-necked grebe	*Podiceps nigricollis*	WV/Scarce
4.	Great crested grebe	*Podiceps cristatus*	WV/Scarce
5.	Order***:Pelecaniformes*** Family:**Pelecanidae**		
6.	White pelican	*Pelecanus onocrotalus*	WV/common
7.	Dalmatian pelican	*Pelecanus crispus*	WV/rare
8.	Family:**Phalacrocoracidae**		
9.	Large cormorant	*Phalacrocorax carbo*	WV/common
10.	Little cormorant	*Halietor niger*	R/frequent
11.	Order:***Ciconiiformes*** Family:**Ardeidae**		
12.	Grey heron	*Ardea cinerea*	WV/common
13.	Indian pond heron	*Ardeola grayii*	R/common
14.	Large egret	*Egretta alba*	WV/common
15.	Little egret	*E. garzetta*	R/common
16.	Indian reef heron	*E. gularis*	R/common
17.	Family:**Threskiornithidae**		
18.	White spoonbill	*Platalea leucorodia*	WV/frequent
19.	Order***:Phoenicopteriformes*** Family:**Phoenicopteridae**		
20.	Greater flamingo	*Phoenicopterus ruber*	WV/common
21.	Lesser flamingo	*P. minor*	WV/rare
22.	Order:***Anseriformes*** Family: **Anatidae**		
23.	Common Shelduck	*Tadorna tadorna*	WV/common
24.	Common teal	*Anas crecca crecca*	WV/common
25.	Mallard	*Anas Platyrhynchos*	WV/common
26.	Nothern pintal	*Anas acuta*	WV/common
27.	Gadwall	*Anas strepera*	WV/common
28.	Wigeon	*Anas penelope*	WV/common
29.	Garganey or blue-winged teal	*A. querquedula*	PM/common
30.	Common shoveller	*A. clypeata*	WV/common
31.	European pochard	*Aythya ferina*	WV/common
32.	Tufted duck	*Aythya fuligula*	WV/frequent
33.	Order:***Accipitriformes*** Family:**Accipitridae**		
34.	Black pariah kite	*Milvus migrans*	R/common
35.	Black shouldered kite	*Elanus caeruleus*	R/common
36.	Brahminy kite	*Haliaster indus*	R/common
37.	Long-legged Buzzard	*Buteo rufinus*	WV/common
38.	Goshawk	*Accipiter gentilis*	WV/frequent
39.	Tawny eagle	*A. rapax*	R/frequent
40.	Steppe Eagle	*Aquila nipalensis*	WV/frequent
41.	Greater spotted eagle	*A. clanga*	WV/frequent
42.	White-backed vulture	*Gyps bengalensis*	R/rare
43.	Egyptian vulture	*Neophron percnopterus*	R/common

134.	Pied Wheatear	*O. picata*	WV/scarce
135.	Desert wheatear	*Oenanthe deserti*	WV/common
136.	Hooded wheatear	*O. monacha*	R/common
137.	Family: **Timaliidae**		
138.	Common babbler	*Turdoides caudatus*	R/common
139.	Family: **Sylviidae**		
140.	Graceful Prina	*Prina gracilis*	R/common
141.	Desert warbler	*Sylvia nana*	WV/common
142.	Lesser whitethroat	*Sylvia curruca*	WV/common
143.	Blyth's reed warbler	*Acrocephalus dumetorum*	WV/frequent
144.	Chiffchaff	*Phylloscopus collybita*	WV/common
145.	Family: **Nectariniidae**		
146.	Puple sunbird	*Nectarinia asiatica*	R/common
147.	Family: **Ploceidae**		
148.	House sparrow	*Passer domesticus*	R/common
149.	Indian baya weaver	*Ploceus philippinus*	R/common
150.	Family: **Sturnidae**		
151.	Indian common myna	*Acridotheres tristis*	R/common
152.	Family: **Dicruridae**		
152.	Black drongo	*Dicrurus macrocercus*	R/common
153.	Family: **Corvidae**		
154.	House Crow	*Corvus splendens*	R/common

Abbreviations used:
R-resident
WV-Winter visitor
WV/R-Partly winter visitor/partly resident
PM- Passage migrant
R/WV-Partly resident/partly winter visitor
M/PM-Migratory/passage migrant
WV/r- Rare winter visitor
SBV/WV/PM-Summer breeding visitor/passage migrant
SV-Summer visitor
SBV/PM-Summer breeding visitor/passage migrant

References

Ali, S. 1945. *The Birds of Kutch.* Oxford University Press.

Ghalib, S. A., Hasnain, S. A. and Razzak, A. 1999. *Avifauna of tidal link, Badin* (eds Kazmi, Q. B. and Kazmi, A.) *Aquatic biodiversity of Pakistan. Marine Reference Collection and Resource Centre, and Department of Zoology,* University of Karachi. 55-62.

Hasan, A. 1994. The birds of Sindh mangroves. *Rec. Zool. Sur. of Pak. XII: 98-105.*

Hasan, A. 1996. Biodiversity of bird fauna in mangrove areas of Sindh. In: (Kazmi, Q. B. ed.) *Proceedings of Coastal aquaculture.* UNESCO, Marine Reference Collection and Resource Centre, University of Karachi, 21–26.

Hasan, A. 2005. Seasonal Avi-fauna Diversity of Korangi-Phitti Mangrove Swamps, Indus Delta, Pakistan. *Proceedings of the National Workshop on Biodiversity,* Ministry of Environment, Government of Pakistan. 60–67.

Hasan, A. and Brohi, M. A. 2009. Some observations on Karachi west coast. Rec. Zool. Surv. Pakistan. 19: 66-68.

IUCN 2005. Preliminary Compendium of Coastal and Marine Protected Areas in Pakistan. Sindh Programme Office, IUCN – The World Conservation Union. 44pp.

Javed, H. I. 2002. Report on the waterbird census 2002 on the wetlands of Sindh and NWFP, Rec. Zool. Sur. Pakistan. 14:19-26.

Karim, S. I. 1985. Breeding evidence of flamingos *Phoenicopterus roseus* in mudflats beyond Golarchi district Badin, Sindh. Rec. Zool, Sur. Pakistan. 10:21

Majid, A. 1988. Marine Fisheries in Pakistan. In: (Thompson, M. F., Tirmizi, M. N. eds.) *Proceedings of Marine Sciences of Arabian Sea.* American Institute of Biological Sciences, Washington, D. C. pp. 247–254.

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Assessment of threats to different parakeet species in the provinces of the Punjab and Sindh, Pakistan

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Abstract
The present study was conducted to assess the threats to parakeet species in both the provinces of Sindh and Punjab. The common threats noted were poaching, habitat loss, pet business, crop pest, export and smuggling to neighboring countries. All these factors have adversely affected the parakeet population in the wild. The prices of Alexandrine and Rose-ringed parakeets and their chicks are substantially higher in the market as compared to the field price. The paper also suggests measures for the conservation of parakeets particularly the Rose-ringed and Alexandrine parakeets.

Key words: Parakeets, threats, conservation, Punjab, Sindh, smuggling

Introduction

Parakeets comprise of 372 species in 86 genera that make up the order Psittaciformes. The order is subdivided into three families: the Psittacidae ('true' parrots), the Cacatuidae (cockatoos) and the Strigopidae (New Zealand parrots) (Christidis, 2008).

Many parrot species are in decline, and several are extinct. Of the 350 or so living species, 130 are listed as near threatened or worse by the IUCN (http://www.iucnredlist.org). There are several reasons for the decline of so many species, the principal threats being habitat loss and degradation, hunting and, for certain species, the wild-bird trade. Parrots are persecuted because, in some areas, they are (or have been) hunted for food and feathers, and as agricultural pests. For a time, Argentina offered a bounty on Monk Parakeets (an agricultural pest), resulting in hundreds of thousands of birds being killed, though apparently this did not greatly affect the overall population (Campbell, 2000). A study conducted in late 1990s on the International Trade of Parrots listed by CITES found that 1.2 million parrots were exported between 1991 and 1996 with the majority of the birds coming from Neotropics. In India there is a ban on the bird trade but it can not be enforced, every year 50,000 Parakeet chicks are collected and exported (Rosemary, 2003).

Parrots are popular as pets due to their sociable and affectionate nature, intelligence, bright colors, and ability to imitate human voices. The domesticated Budgerigar, a small parrot, is the most popular of all pet bird species. In 1992 the newspaper "USA Today" published that there were 11 million pet birds in the United States alone (Ward, 1992) many of them parrots. Europeans kept birds matching the description of the Rose-ringed Parakeet (or called the ring-necked parrot), documented particularly in a first century account by Pliny and Elder (Christidis, 2008) as they have been prized for thousands of years for their beauty and ability to talk.

The popularity of parrots as pets has led to a thriving and often illegal trade of birds because of which some species are now threatened with extinction. A combination of trapping of wild birds and damage to parrot habitats makes survival difficult or even impossible for some species of parrots. Import of wild caught parrots into the US and Europe is illegal. The trade continues unabated in some countries. A report published in January 2007 presents a clear picture of the wild-caught parrot trade in Mexico (http://www.defenders.org/programs).

In Pakistan all the Provincial wildlife departments provide special license to hunters for trapping common birds including Parakeets. The National Council for Conservation of Wildlife (NCCW) regulated the trade of wild fauna in the country and issued license to exporters for exporting the Parakeets from the country. According to documents of NCCW annually a quota of 25,000 parakeets especially of Rose-ringed Parakeets were awarded to bird dealers in the country to export bird till 2007. In 2008 the NCCW imposed ban on the export of Parakeets especially of Rose-ringed Parakeet on the assumption that parakeet population was decreasing throughout the country.

Considered as common bird in Pakistan all the

species of Parakeets are ruthlessly hunted and exported from the country. The Parakeets are captured mainly by nets and other practices. The young birds especially the chicks are much valued in market and are removed from nests by using iron rod. Many of the chicks die due to mishandling of the hunters.

Four species of parakeets have been reported from Pakistan (Robert, 1991) which are Blossom-headed parakeet (*Psittacula cyanocephala*), Rose-ringed parakeet (*Psittacula krameri*), Slaty-headed Parakeet (*Psittacula himalayana*) and Alexandrine or Large Indian Parakeet (*Psittacula eupatria*) . The parakeets are generally considered common crop pest so no studies have been carried out on the threats faced by parakeets in the country and only few studies including feeding behavior of parakeets in Guava, Sunflower and Maize fields and roosting and feeding behavior of Rose-ringed Parakeet in Central Punjab have been carried out (Khan, 2002; Iqbal, 1998; Hussain et al., 1991; Khan & Hussain 1990; Bashir et al., 1981) and consider Rose-ringed parakeet as a common crop pest.

The current study was carried out to assess the threats to Parakeets in Pakistan and suggest some mitigating measures for conservation of all the four species of Parakeets.

Material and Methods

Study Area

For the current study 29 Districts from Sindh and the Punjab Provinces and the Islamabad Capitol Territory were selected. Thirteen Districts i.e., Sialkot, Kasur, Bahawalpur, Rahimyar Khan, Multan, Kahanewal, Faisalabad, Attock, Khushab, Sargodha, Chakwal districts, Lahore and Murree Foothills were studied in the Punjab province, and fifteen districts i.e., Sanghar, Badin, Hyderabed, Larkana, Mirpur Khas, Sukkar, Thatta, Tando Allahyar, Khairpur, Ghotki, Nawabshah, Shikarpur, Noushehro Feroz, Matyari and Tando Muhammad Khan were studied in Sindh province.

Methods

The field surveys were undertaken in 29 districts from Sindh and the Punjab provinces by the technical staff of the Punjab and Sindh Wildlife Departments. The staff of Zoological Survey of Pakistan also accompanied the survey team in some districts. Before the surveys the ZSP staff held meetings with staff of the provincial department staff to finalize the study sites, survey team composition and methodology for survey. The surveys were carried out from end April till mid-May, 2011. Survey Performa was used which contained different questions regarding the status of Parakeets in the area, habitat preference, hunting techniques, number, age group and sexes of parakeets caught in a season, business, high demand species, threats and conservation suggestions by local communities. ZSP staff also collected information about prices, inflow of parakeets to and outflow from birds markets within the country as well as out of the country by visiting birds markets in Karachi and Rawalpindi.

Threats to Parakeets

The data was organized and fallowing threats to Parakeets were found.

Export

Due to worldwide export demand, parakeets are continued to be trapped and exported. No research has been carried out to evaluate the parakeet trade and its sustainability. Keeping in view the export demand for parakeets the Government of Pakistan annually granted export quota of about 25,000 parakeets through National Council for Conservation of Wildlife (NCCW) until 2008. Mass level trade in Parakeets brought a sharp decline in the Parakeet population in the country. Keeping this fact in view the NCCW imposed ban on Parakeet export. A media article (Dawn 26 July, 2010) highlighted the issue that ban on parakeet export was imposed without any population census in the country. But the present study revealed that the population of Parakeets, especially of the Rose-ringed Parakeets, is declining in the country. The quotas which were allocated earlier for export were not based on sustainable harvesting of the current Parakeet population. Despite the ban thousands of Parakeets are still smuggled from Pakistan to other countries including Arab countries via Iran.

Illegal Hunting

Poaching chicks for the lucrative pet trade is one of the biggest reasons for the parrots' decline. According to local hunters, common people and market surveys it was observed that thousands of Parakeets are annually captured and exported. After visiting the Empress Market of Karachi, which is the largest bird selling Market of Pakistan, it surfaced that the Parakeet catch has decreased during the last

decade. A decade ago 50,000 to 70,000 Parakeets were annually brought for sale from different parts of the country and now only 10,000 to 14,000 birds reach here for sale (Baloch et al., 2011). During the current survey the annual catch of parakeets especially of Rose-ringed parakeet ranged from 200 to 3000 birds and each hunter trapped 30 to 200 birds throughout the year in each district of the Punjab. In Sindh 30 to 300 birds were captured per hunter and birds captured from each district throughout the year ranges from 250 to 2000.

People who are involved in hunting are mostly professionals but some agricultural labourers are also involved part time in parakeet hunting. The Rose-ringed Parakeet was the most captured species in both the provinces. These birds are locally sold to middlemen or in local markets. The adult Rose-ringed is sold for Rs. 100/- to Rs. 540/- and adult Alexandrine Parakeet is sold for Rs. 2000/- to Rs. 5000/-. The chicks of both the species are costlier due to their quick learning capacity. The chick of Alexandrine parakeet is sold from Rs. 3500/- to Rs. 6000/- and the chick of Rose-ringed is sold from Rs. 500/- to Rs. 1000/-.

Habitat Loss

Habitat loss was also found to be one of the most threatening factors for decline in Parakeet populations. Almost all the four species of Parakeets make their nests or occupy the nests of other bird species in the old tree holes. Due to deforestation throughout the country old trees are ruthlessly cut down for wood, timber and other purposes. Thus the roosting and nesting sites of Parakeets are shrinking day by day which may have negatively affected its population.

Pet

The Parakeets are famous pet birds and it is the main reason for their export. The young birds are most favorite for this purpose because they are easily trained to mimic the voice of human or any thing else. The young birds are taken away from nest by hunters and are primarily fed with boiled pulses to grow. The adult birds are captured by putting net around a tree in the roosting or nesting site. This practice is carried out in evening time when the birds return back to their roosting sites.

According to market surveys in Rawalpindi the Alexandrine chick is sold for Rupees 8000/ bird, while the chick of Rose-ringed is sold for Rs. 1500/- to Rs. 2000/- depending on its sex. The adult of Alexandrine is sold for Rs. 12000/- to Rs. 16000/-. The male Rose-ringed is sold for Rs. 1000/- and the female for Rs. 500/-.

Considered as Crop Pest

In 1976 Bashir (1981; as cited in Robbert's 1991), had noted 80% loss in Sunflower crop by parakeets in Rahim Yar Khan.

In Pakistan some studies have been carried out on its predation upon crops (Khan et. al., 2006) which suggest that Parakeets mostly the Rose-ringed Parakeet cause considerable damage to crops like maize, sunflower, oil seed crops like mustard and canola, apart from a variety of orchards like guava farms and berries *Ziziphus jujuba*. This makes the Parakeets anti farmer. The farmers use to cut down the old trees in the vicinity of their fields and thus reduce their roosting and nesting sites which may also affect its population.

Recommendations

- No census has ever been conducted for parakeet population in Pakistan. Country level census for Parakeets should be executed to determine population status of all the species of parakeets including study of habitat.
- Export and other illegal smuggling of parakeets should be strictly monitored and ban on export of parakeets may not be lifted till the population shows an increasing trend.
- Local level community organizations may be formed with alternate livelihood options to protect avifauna including parakeets.
- Provincial Wildlife staff may be facilitated to enforce the wildlife laws to minimize illegal hunting of birds including parakeets.
- The provincial wildlife departments may refrain from issuing license to all and sundry for catching common birds especially the Parakeets.
- Stricter control and monitoring on bird trade within Pakistan and export to other countries may be observed.

References

Baloch, S. A. Sattar, A. and Soomro, M. A. 2011. status and distribution of parakeets in Sindh 16pp

Bashir, E. A., Siddiqui A. S. and Mian., I. 1981. Investigation of some aspects related to the Rose-ringed Parakeet damage control in sunflower in Pakistan. FAO/PAK/71/554. 10*pp*.

Campbell, T. S. 2000. "The Monk Parakeet" (http:/ / invasions. bio.utk.edu/ invaders/ monk. html). The Institute for Biological Invasions.

Christidis, L. and Boles, W. E. 2008. Systematics and Taxonomy of Australian Birds. Canberra: CSIRO Publishing. 200pp. ISBN 9780643065116.

Daily Dawn, 26.07.2010, Export banned without parrot survey by Faiza Ilyas

http://www.iucnredlist.org

http://www.defenders.org/programs_and_policy/international_conservation/mexico_program/stopping_the_illegal_parrot_trade.php/ (date accessed November 2011).

Hussain I., Munir, S., Ahmed, S. and Khan, A. A. 1991. Bird pest damage to Guava Fruits. Pak. J. Agri. Sci., Vol:28, No.1 Illustrations: Submitted by the Management Authority of Switzerland.

Iqbal, M. T. 1998. Roosts and roosting habits of the rose-ringed parakeet in Central Punjab, *M. Phil. Thesis*, P: 92. Department of Zoology and Fisheries, University of Agriculture, Faisalabad.

Khan, A. A. and Hussain, I. 1990. parakeet *psitachlla krameri,* damage to standing maiz crop in Pakistan. Sarhad J. Agri. 6(2):185-191.

Khan, H. A., Anwar, N. and Parveen, S. 2006. Abundance of Rose-ringed Parakeet (*Psittacula krameri*) and House Sparrow (*Passer domesticus*) on Guava and Sunflower Farmlands in an Agro-ecosystem in Faisalabad–Pakistan. Journal of Agriculture & Social Sciences 1813–2235/2006/02–3–125–128.

Khan, H. A. 2002. Foraging, feeding, roosting and nesting behaviour of the rose-ringed parakeet, *Psittacula krameri*, in the cultivations of Central Punjab, Pakistan. *Ph.D. Thesis*, P: 152. Department of Zoology and Fisheries, University of Agriculture, Faisalabad.

Roberts. T. J. 1991. The Birds of Pakistan. Vol (1). Oxford University Press, Karachi, Pakistan. pp275-277.

Rosemary. 2003. The worldwide Trade in Wild-caught Parrots. Proceedings of International Aviculturists Society.

Ward, S. 1992. USA Snapshots: Most Popular Pet (http://pqasb.pqarchiver.com/USA Today (Retrieved 2009-09-06).

A Note on avifauna of Head Maralla, district Sialkot, Punjab, Pakistan

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Abstract:
Considering importance of the wetland avifauna of the wetland and adjacent area was studies during 2010-2012. Eighty Nine species of birds belonging to 14 orders, 34 families and 61 genera were recorded. Of the recorded 89 species 44 species were waterfowl while 45 species were terrestrial. Occurrence of *Ciconia nigra* (Black Stork), *Mycteria leucocephala* (Painted Stork), *Anas poiclorhynchos* (Spotbilled Duck), *Sturnus cantro* (Pied Mayna) and breeding of *Dendrocygna javanica* (Lesser Whistland Teal) is important.

Key words: Avifauna, Head Maralla, wetlands, water bodies

Introduction

Head Maralla is one of the most important wetlands of the country because it supports a diversity of fish, amphibians, reptiles, birds and mammals. The site is well known to inhabit some extremely rare species of birds. Occurrence of *Ciconia nigra* (Black Stork), *Mycteria leucocephala* (Painted Stork), *Anas poiclorhynchos* (Spotbilled Duck), *Sturnus cantro* (Pied Myna) etc. and breeding of *Dendrocygna javanica* (Lesser Whistling Teal) were most important records at the Wetland. In the past, it has been one of the largest wetlands of Punjab harbouring highest concentration of waterfowl during midwinter.

Head Maralla is located at 32°45 N, 74°31 E and 25 Km north of Sialkot. The wetland consists of a reservoir on the Chanab River, constructed for irrigation purpose and surrounded by agriculture lands. The embankments extend out into the reservoir and hold back shallow lagoons as the water level in main river channel falls. The depth of water in the lagoons varies from 0.2-5.0m.

The aquatic vegetation in the wetland consist of *Carex fedia, Hydrilla verticillata, Nelumbo nucifera, Nymphaea lotus, Phragmites harka, Potamogeton crispus, P. pectinatus, Typha angustata, Vallisneria spiralis and Zannichellia palustris*. The natural vegetation of the adjacent plain is tropical thorn forest with mainly with species as *Capparis decidua Prosopis cineraria, Tamarix aphylla, Ziziphus mauritiana, Z. nummularia, Eleusine compressa, Erianthus spp, Dalbergia sissioo* and *Acacia nilotica* etc.

A number of workers have contributed in the studies on Avifauna of the country and referred the occurrence and abundance of water birds at Head Maralla. Roberts (1991, 1992) reported the occurrence of different species of water birds at the site. Van (1987 & 1988), Scot and Rose (1989) and Perennou et al. (1990, 1991 & 1992) compiled the Midwinter waterfowl counts of Asia and referred the midwinter data of the wetlands. Scot (1989) compiled directory of Asian Wetlands and described the biography of the wetlands.

The present paper is based on the studies on the Avifauna of the wetland and adjacent areas during July, 2010 to January, 2012.

Material and Methods

The birds were directly observed, identified and counted with the help of binoculars and spotting scopes. The GPS receiver was also used to record the coordinate of the wetland. For the identification of water birds, different field guides were used. The total population of the birds was determined by direct counts.

Results and Discussion

89 species of birds belonging to 14 orders 34 families and 61 genera were recorded. Of the recorded 89 species 44 species were waterfowl while 45 species were terrestrial.

Commonly found waterfowl species include *Ardeola grayii* (Grey Heron), *Bubulcus ibis* (Cattle Egret), *Egretta alba* (Large Egret), *Egretta garzetta* (Little Egret), *Egretta intermedia* (Intermediate Egret), *Ardea cineria* (Grey Heron), *Anas penelope* (Wigeon), *Anas strepera* (Gadwal), *Anas crecca* (Common Teal), *Anas platyrhynchos* (Mallard), *Anas acuta* (Pintail), *Anas clypeata* (Shoveller), *Aythya ferina* (Common Pochard) etc.

Abundant and common terrestrial species include *Milvus migrans* (Pariah Kite), *Elanus caeruleus* (Black winged Kite), *Aquilla rapax* (Tawny Eagle), *Francolinus francolinus* (Black Partridge), *Columba livia* (Blue Rock Pigeon), *Streptopelia decaocta* (Indian Ring Dove), *Streptopelia senegalensis* (Little Brown Dove), *Centropus sinensis* (Common Crow

Pheasant), *Merops orientalis* (Small Green Bee eater), *Turdoides caudatus* (Common Babbler), *Turdoides striatus* (Jungle Babbler), *Dicrurus macrocercus* (Black Drango), *Corvus splendense* (House Crow), *Acridotheris tristis* (Indian Myna), *Acridotheris ginginiatus* (Bank Myna), *Passer domesticus* (House Sparrow) etc.

Ciconia nigra (Black Stork) is an extremely rare species of Storks occasionally found at the wetlands of the country. Biddulph (1981) recorded flocks in Gilgit main valley in each February, March and April and Scully (1887) noted a flock of over 100 in autumn in Gilgit. Roberts (1991) describes that on 13 February 1969 at day break 68 black storks were counted at Lal Sohanra Lake including only 3 Juveniles.

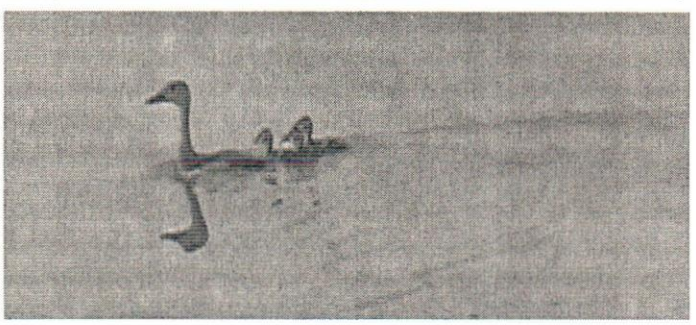
Anser indicus (Barheaded Goose) is a rare winter visitor Anatid species which is found with small population on the margin of rivers mainly Indus. According to Roberts (1991) a flock of varying size enters on the head pond and seepage lakes around Taunsa Barrage near Dera Ghazi Khan.

Tadorna ferruginea (Ruddy Shellduck) is another rare winter migrant and occurs with small population on some of the wetlands of the country. A few birds of the species were also seen on the wetlands.

Roberts (1991) states that *Dendrocygna javanica* (Lesser Whistling Teal) is generally a summer or monsoon visitor to the region from India. In Punjab it is a regular breading visitor at Tounsa Barrage which has been referred by Scot (1989). During present studies breading of the species has also been recorded at Head Maralla. A female with three chicks was seen in July 2010.

Hydrophasianas chirurgus (Pheasant tailed Jacana) is also mainly a summer breading visitor which was seen with good numbers.

Anas poiclorhynchos (Spot-billed Duck) is one of the species resident in the region but is occasionally found at the wetlands of the Punjab. The species was recorded at the site during midwinter 2012.



Lesser whistling Teal with three chicks

In the terrestrial species of bird's occurrence of *Sturnus cantro* (Pied Starling) is notable. According to Roberts (1992) the species is extremely rare and was not recorded in Pakistan before 1965 untill Z.B. Mirza found a small party of 15 birds. The species was found sparsely spread in the area in different visits. Two nesting pairs were also found in July, 2010.

References

Biddulph, J. 1881. The Birds of Gilgit; Stray Feathers. Vol. 9, pp 301-66.

Perennou, C., Rose, P. and Poole, C. 1990. Asian Waterfowl Census, 1990. International Waterfowl and Wetland Research Bureau, Slimbridge, England.

Perennou, C. and Mundkhur, T. 1991. Asian and Australian Waterfowl Census, 1991. International Waterfowl and Wetland Research Bureau, Slimbridge, England.

Perennou, C. and Mundkhur, T. 1992. Asian and Australian Waterfowl Census, 1992. International Waterfowl and Wetland Research Bureau, Slimbridge, England.

Roberts, T. J. 1991. The Birds of Pakistan. Volume 1 (Non Passeriformes), Oxford University Press Karachi.

Roberts, T. J. 1992. The Birds of Pakistan, Volume, 2 (Passeriformes), Oxford University Press, Karachi.

Scott, D. A. and Rose, P. M. 1989. Asian Waterfowl Census, 1989. International Waterfowl and Wetlands Research Bureau, Slimbridge, England.

Scott, D. A. 1989. A Directory of Asian Wetlands. IUCN, Gland, Switzerland and Cambridge, UK.

Scully, J. 1887. Contribution to the Ornithology of Gilgit; Stray Feathers, Vol. 10. No. I, pp 88-146.

Van. der. Van J. 1987. Asian Waterfowl, 1987. International Waterfowl and Wetlands Research Bureau, Slimbridge, England.

Van. der. Van J. 1988. Asian Waterfowl, 1988. International Waterfowl and Wetlands Research Bureau, Slimbridge, England.

Checklist of Birds of Head Maralla

Order/Family	Scientific Name	Common Name
Order Podicipediformes		
Family Podicipedidae	*Tachybaptus rufficollis*	Little Grebe
Order Pelecaniformes		
Family Phalacrocoracidae	*Phalacrocorax carbo*	Great Cormorant
	Phalacrocorax fuscicollis	Indian Cormorant
Order Ciconiformes		
Family Ardeidae	*Ixobrychus sinensis*	Little Bittern
	Nycticorax nycticorax	Night Heron
	Ardeola grayii	Indian Pond Heron
	Bubulcus ibis	Cattle Heron
	Egretta alba	Large Egret
	Egretta garzetta	Little Egret
	Egretta intermediate	Intermediate Egret
	Ardea cinerea	Grey Heron
	Ardea purpurea	Purple Heron
	Ciconia nigra	Black Stork
	Mycteria leucococephala	Painted Stork
Family Threskiornithidae	*Platalea leucorodia*	Spoonbill
Order Anseriformes		
Family Anatidae	*Dendrocygna javanca*	Lesser whistling Teal
	Anser indicus	Bar-headed goose
	Tadorna ferruginea	Ruddy shell Duck
	Anas penelope	Wigeon
	Anas strepera	Gadwall
	Anas crecca	Common Teal
	Anas platyrhynchos	Mallard
	Anas poecilorhynchos	Spot-billed Duck
	Anas acuta	Pintail
	Anas clypeata	Shoveler
	Aythya ferina	Common Pochard
Order Accipitriformes		
Family Accipitridae	*Milvus migrans*	Black Kite
	Elanus caeruleus	Black-winged Kite
	Circus auriginosus	Marsh Harrier
	Aquila rapax	Tawny Eagle
	Hieraaetus fasciatus	Bonells Eagle
Order Galliformes		
Family Phasianidae	*Francolinus francolinus*	Black Partridge
Order Gruiformes		
Family Rallidae	*Porzana parva*	Little Crake
	Porphyrio porphyrio	Purple Swamphen
	Gallinula chloropus	Indian moorhen
Order Charadriiformes		
Family Recurbirostridae	*Himantopus himantopus*	Black-winged Stilt
Family Charadriidae	*Charadrius dubius*	Little Ringed Plover
	Charadrius alexandrinus	Kentish Plover
	Hoplopterus indicus	Red-wattled lapwing
Family Calidridinae	*Calidris minuta*	Little Stint
Sub Family Tringinae	*Tringa totanus*	Common Redshank
	Tringa nebularia	Common Greenshank
	Tringa ochropus	Green Sandpiper
	Tringa glareola	Wood Sandpiper
	Actitis hypoleucos	Common Sandpiper
Family Sturnidae	*Sterna aurantia*	River Tern

Order Columbiformes		
Family Columbidae	*Columba livia*	Blue Rock Pigeon
	Streptopelia decaocto	Indian Ring Dove
	Streptopelia senegalensis	Little Brown Dove
Order Psittaciformes		
Family Psittacidae	*Psittacula krameri*	Rose-ringed Parakeet
Order Cuculiformes		
Family Cuculidae	*Centropus sinensis*	Common Crow Pheasant
Order Strigiformes		
Family Strigidae	*Athene brama*	Spotted Owlet
Order Coraciiformes		
Family Alcedinidae	*Halcyon smyrnensis*	White-throated Kingfisher
	Alcedo atthis	Small Blue Kingfisher
	Ceryle rudis	Pied Kingfisher
Family Meropidae	*Merops orientalis*	Small Green Bee-eater
	Merops superciliosus	Blue-cheeked Bee-eater
Order Piciformes		
Family Picidae	*Dinopium benghalense*	Lesser Golden-backed Woodpecker
Order Passeriformes		
Family Alaudidae	*Galerida cristata*	Crested Lark
	Alauda gulgula	Small or Lesser Skylark
Family Hirundinidae	*Riparia paludicola*	Indian Sand Martin
Family Motacilidae	*Motacilla flava*	Yellow Wagtail
	Motacilla citreola	Yellow Headed Wagtail
	Motacilla alba	White Wagtail
	Motacilla maderaspatensis	Pied Wagtail
Family Pycnonotidae	*Pycnonotus leucogenys*	White-cheeked Bulbul
	Pycnonotus cafer	Red-vented Bulbul
Family Turdidae	*Saxicola torquata*	Common Stone Chat
	Saxicola caprata	Pied Bush-chat
Family Sylviidae	*Cisticola juncidis*	Streaked Fantail Warbler
	Prinia gracilis	Streaked Wren Warbler
	Prinia burnesii	Long-tailed Prinia
	Orthotomus sutorius	Common Tailorbird
Family Rhipiduridae	*Rhipidura aureola*	White-browed fantail Flycatcher
Family Timalidae	*Turdoides caudatus*	Common Babbler
	Turdoides striatus	Jungle Babbler
Family Laniidae	*Lanius vittatus*	Bay-backed Shrike
	Lanius minor	Lesser Grey Shrike
Family Dicruridae	*Dicrurus macrocerus*	Black Drongo
Family Corvidae	*Dendrocitta vagabunda*	Tree Pie
	Corvus splendens	House Crow
Family Sturnidae	*Sturnus contra*	Asian Pied Starling
	Acridotheres tristis	Indian Myna
	Acridotheres ginginianus	Bank Myna
Family Passeridae	*Passer domesticus*	House Sparrow
	Passer pyrrhonotus	Sind Jungle Sparrow
Family Ploceidae	*Ploceus philippinus*	Baya Weaver or Indian Baya
	Ploceus manyar	Streaked Weaver Bird

Indian Mackerel (*Rastrelliger kanagurta*) from Pakistan-II. population dynamics

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Abstract
Study of the population parameters of Indian mackerel (*Rastrelliger kanagurta*) indicates asymptotic growth (L_∞) and growth coefficient (K) to be 32.55cm and 0.46 $year^{-1}$ respectively. Natural mortality (M) estimate was 1.02 whereas total mortality (Z) was 2.04 and fishing mortality (F) was 1.03. The exploitation ratio (E) was calculated to be 0.5 and E_{max} was 1.0 indicating that stocks of Indian mackerel are not over-exploited. Annual steady biomass was estimated to be 185,645mt. Present production is estimated to be about 40,000mt, however bulk of the biomass consists of small sized specimens whereas stocks of large sized specimens seem to be over-exploited.

Keywords: Indian mackerel, growth, mortality, parameters, exploitation ratio, biomass

Introduction

Indian mackerel (*Rastrelliger kanagurta*) contribute substantially to the fish production and export in Pakistan. It is estimated that about 30,000 to 40,000mt. of this small pelagic fish is landed in Pakistan (Anonymous, 2011). Various aspects of its biology and fisheries have already been given by Moazzam et al. (2005), however, its population parameters and dynamics of its fisheries from Pakistan are not reported so far. In India, various aspects of its population and fisheries dynamics have been studied by Abdussamad et al. (2006, 2010), Devaraj et al. (1994), Luther (1973, 1995), Noble *et al.* (1992), Sivadasi et al. (2006), Udupa and Bhat (1984) and Yohannan (1979, 1982). Present paper is second of the series on the studies on Indian mackerel from Pakistan and deals with various aspects pertaining to its population dynamics.

Material and Methods

Sampling of Indian mackerel was started in April 2004 from Karachi Fish Harbour and data pertaining to length frequency distribution was recorded at least three times in a week. Data for landings of Indian mackerel was obtained from Anonymous (2011). The length frequency data of Indian mackerel was analyzed using ELEFAN I routine of FiSAT software (Gayanilo *et al.*, 1996). Estimation of asymptotic length (L_∞) and growth coefficient (K) were made using von Bertallanfy Growth Function & Length Frequencies and Powell-Wetherall method. Estimation of other population parameters including age and growth, mortality rates, recruitment patterns, probability of capture, virtual population analysis (VPA), yield per recruit, biomass per recruit and isopleth analysis was made using FiSAT software (Gayanilo et al., 1996). Growth parameters including L_∞ and K were obtained from Gulland and Holt plot (Gulland and Holt, 1959). Total mortality (Z) was estimated by length converted catch curve method of Pauly (1984) whereas natural mortality coefficient (M) was obtained using formula of Pauly (1980). Temperature was taken as 26°C. Fishing mortality (F) coefficient was calculated using formula (E= F/Z and U= F/Z (1-e -Z) proposed by Gulland (1983). Probability of capture, yield per recruit and biomass per recruit were determined by backward extrapolating of length converted catch curve while keeping the L_c constant. Using different exploitation ratios and different size at the first capture values of Y/R were plotted to generate the isopleth diagram. The yield was determined using the Knife edge selection method from the equation of Beverton and Holt (1957).

Results and Discussion

The length-weight relationship of Indian mackerel from Pakistan coast given in Moazzam *et al.* (2005) indicates a = 0.00544 and b = 3,207 with r = 0.931 which is used in the present study.

Asymptotic Length (L_∞) and Growth Coefficient (K)

The minimum and maximum total lengths of Indian mackerel from Pakistan varied between 7.0cm and 31.0cm. The value of asymptotic length (L_∞) and the growth parameter (K) estimated by the ELEFAN I through von Bertallanfy Growth Function Plot and

Length Frequencies using FiSAT software were found to be 32.55 and 0.460 cm, respectively (Fig. 1). Employing Gulland-Holt method L_∞ was 32.55 and K was 1.481 year^{-1} respectively (Fig. 2). The values obtained by Faben's method (Lα = 32.55cm and K = 0.460) were used to describe the annual growth. The growth performance index (ø) of Indian mackerel was computed as 2.443.

In the present investigation, the methods employed to get the growth parameters yielded asymptotic length (L_∞) in the close range of 31.00 and 47.00cm and the growth coefficients 'K' differed between 0.4 and 10.00. Therefore, results obtained through von Bertallanfy Growth Function (i.e. L_∞ = 32.55 and K = 0.46 year^{-1}) were used in all progressive calculations using FiSAT software.

A comparison of the growth parameters of Indian mackerel from various parts of the Indo-Pacific area is made which reveals that the high value of L_∞ i.e., 40 and 42cm were computed in Egypt by Sanders et al. (1984) and Rafail (1972) respectively (Table - 1). Lowest value of L_∞ was reported by Torres and Pauly (1991) from South Africa. Similarly highest value of growth coefficient (K) i.e., 0.80 was reported from Philippines by Guanco (1991) whereas lowest value (0.23) was reported from Egypt by Sanders et al. (1984).

Mehanna (2001) observed that males have a higher K-value than females which was possibly because males approach their asymptotic length relatively faster than females. Although in the present study an attempt was made to determine growth parameters of male and female separately but no significant difference in the results was obtained. Therefore, pooled data was used for further calculation.

Mortality and Exploitation Rate

During the present study, the instantaneous rate of total mortality coefficient (Z) for Indian mackerel estimated by length converted catch method were 2.04 year (Fig. 3). The instantaneous natural mortality (M) estimated by Pauly's empirical formula method was 1.02 year^{-1}. Fishing mortality Z-M was calculated as 1.03 year^{-1}. The exploitation ratio (E) computed was 0.50. Mehanna (2001), computed total mortality (Z) around 1.12 year for male and 1.005 for female, natural mortality (M) as 0.261 for male and 0.251 for female whereas fishing mortality was calculated as 0.859 for males and 0.754 for female in Indian mackerel from Gulf of Suez, Egypt. Abdussamad et al. (2010) computed average total mortality (Z) as 7.86, natural mortality (M) as 2.52 and fishing mortality (F) as 5.34 from Tuticorin Coast, India. During the present study total, natural and fishing mortalities were observed to be higher than those reported for Gulf of Suez. However, as compared to India, these values are much smaller.

Abdussamad et al. (2010) observed that along Tuticorin Coast, India, the exploitation rate fluctuated between 0.582 and 0.787 and E_{max} was 0.865, which is larger than the exploitation rate and attributed that the stock of Indian mackerel remain under-exploited. During the present study, E was observed as 0.5 and E_{max} as 1.0 which tends to indicate that Indian mackerel resources are also under-exploited and there seems ample scope for expansion of its fishery.

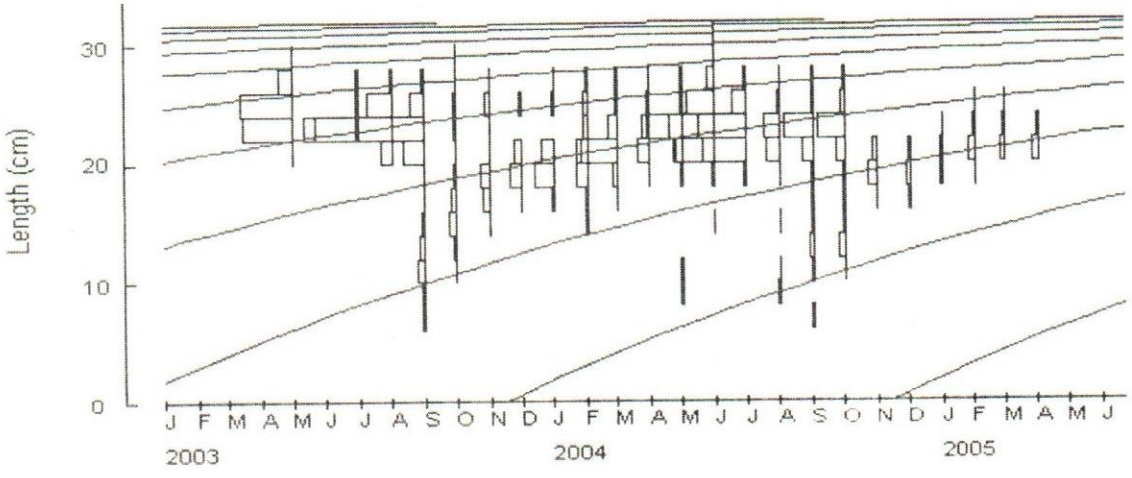

Fig 1: von Bertallanfy Growth Function Plot for Indian mackerel

Table 1. Growth parameters of Indian mackerel (*Rastrelliger kanagurta*) from different part of the indo-Pacific Areas

Area/Country	Asymptotic Length (L_∞)	Growth Coefficient (K)	Reference
India	31.6	0.60	Seshappa (1958)
India	39.0	0.74	Luther (1973)
India	31.6	0.60	Banerji & Krishnan (1973)
India	31.3	0.64	Pauly (1978)
India	33.28	1.634	Abdussamad *et al.* (2010)
Egypt	42.0	0.29	Rafail (1972)
Egypt	40.0	0.23	Sanders *et al.* (1984)
Egypt (Gulf of Suez)	32.15	0.57	Mehanna (2001)
Seychelles	31.7	0.64	LaBlache *et al.* (1988)
South Africa	30.3	0.72	Torres and Pauly (1991)
Philippines	38.0	0.80	Guanco (1991)
Yemen	32.3*	0.67	Edwards and Shaher (1991)
Pakistan	32.55	0.46	Present Study

*Fork Length

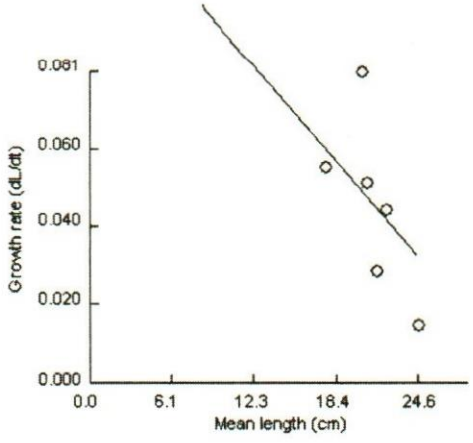

Fig 2: Gulland-Holt plot for Indian mackerel

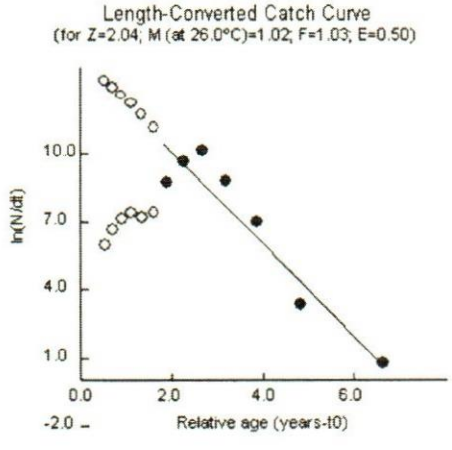

Fig 3: Estimation of 'Z' by length converted catch curve method for Indian mackerel

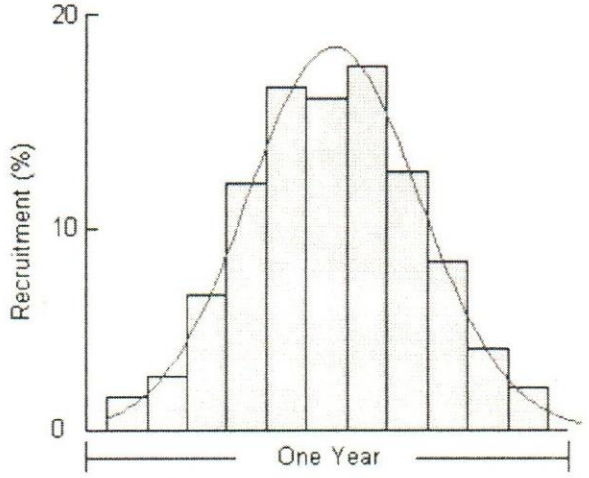

Fig 4: Recruitment pattern of Indian mackerel

Unimodal recruitment pattern was found in the present investigation (Fig. 4) with peak recruitment pulse between May-August. This is in conformity with the spawning pattern observed by Moazzam et al. (2005). Major gonadal activity was found between May and October forming a unimodal reproduction pattern which conforms with the recruitment pattern. Abdussamad et al. (2010) observed similar unimodal recruitment pattern from Tuticorin Coast, India. They also observed mature and spent specimens throughout the year indicating round the year spawning with peak spawning and recruitment during January and April. In Pakistan, although spawning was also observed to be continuous throughout the year but peaks of spawning was observed to be between May to October and that of recruitment between May to August.

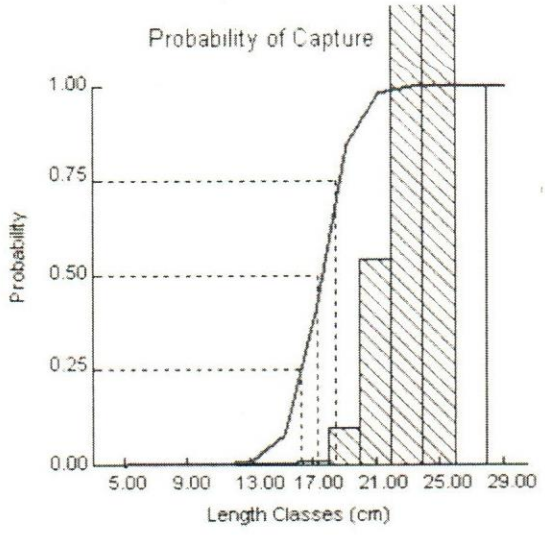

Fig 5: Probability of Capture analysis of Indian mackerel

Probability of Capture

The selection of probability of capture (Fig. 5) indicates that the estimated length sizes for 25% (L_{25}), 50% (L_{50}) and 75% (L_{75}) probabilities of capture would be 16.32cm, 17.38cm and 18.44cm indicating high catching probability of the smaller sized specimens in the gillnet fisheries of Indian mackerel in Pakistan.

Virtual Population Analysis

Length structured population analysis reveals that the maximum fishing mortality occurs in the length between 19.0cm to 27.0cm with a maximum value in the lengths of 27.0cm (Fig.6). The total steady state biomass was found to be 185,646mts. The total population, catch (in number), fishing mortality and steady-state biomass (mts.) per length class is presented in the Table 2.

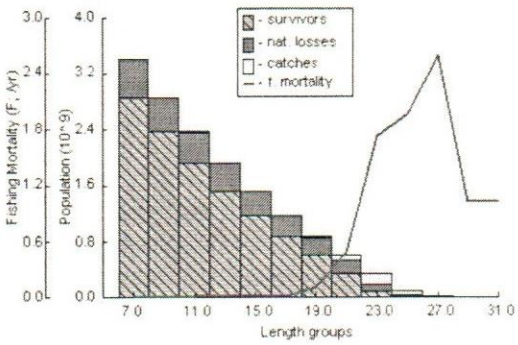

Fig 6: Length structure virtual population analysis of Indian mackerel

thos

Further estimate of number of fish in the sea, including e lost due to natural causes and those caught and their fishing mortality is represented in Fig. 6. The number of fish recruited to the fishery in the size class of 7.0cm was 3.4 billion, their fishing mortality being meager 0.0017, with biomass (standing stock) of 3,045mts. However, from the size group of 19.0 to 27cm onwards, the mean fishing mortality was 1.3804 which is higher than fishing mortality of 1.03. Total biomass was estimated to be 185,646mts whereas average annual landing of Indian mackerel in Pakistan was estimated to be about 40,000 mts (Anonymous, 2011) indicating that fishing is being done below the available stock level. It is noticeable that bulk of the biomass consists of small sized specimens whereas stocks of large sized specimens are relatively in

smaller concentrations. It is, however, noteworthy that smaller size group 7.0 to 17.0cm dominates in the biomass, which are not commercially exploited whereas bulk of the catch which consist of sizes larger than 19.0cm are targeted and harvested. The biomass of this size range is highest (101,023 mts) and not yet exploited to their maximum sustainable limit.

The magnitude of coefficient of total mortality in heavily exploited fish population is largely influenced by the extent of fishing intensity. Recent use of small mesh size (less than 5.0cm) is now leading to catch of small sized specimens, which may seriously affect population and biomass of high sized groups, thus affecting the Indian mackerel fisheries.

Relative Yield-per-recruit and Biomass-per-recruit

It is seen that the relative yield per recruit peaks at exploitation ratio (E_{max}) of 1.0 as the exploitation rate increases beyond this value, relative yield per recruit decreases. The yield isopleth diagram suggested that viable fishing is possible when exploitation is kept at E= 1.0 and L_c/L_∞ = 0.8 (Fig. 7).

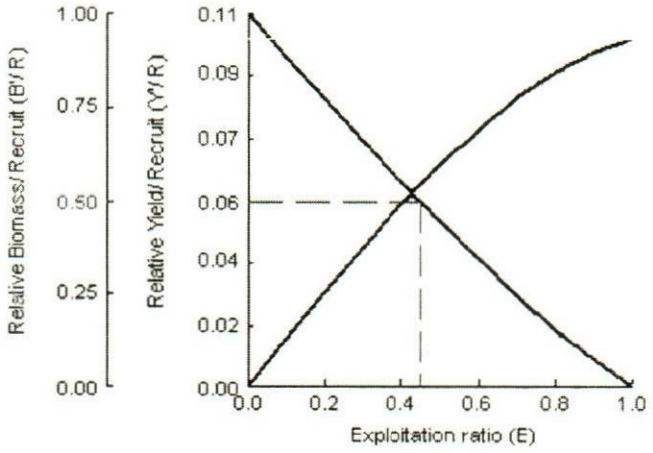

Fig 7: Relative yield-per-recruit and biomass- per-recruit for Indian mackerel

The exploitation level which will result in a reduction of the unexploited biomass by 50% was equaled 0.447. The results indicated that the present levels of E are lower than those which give the maximum (Y/R).

Table 2. Total population, Catch (in number), fishing mortality and Study state biomass (mt) per length class

Mid-Length (cm)	Catch (in numbers)	Population (N)	Fishing mortality (F)	Steady-state Biomass (m. tons)
7.0	900000.00	3408122880.00	0.0017	3044.99
9.0	1900000.00	2863980800.00	0.0039	6112.94
11.0	3400000.00	2370397184.00	0.0079	10381.57
13.0	5000000.00	1926164352.00	0.0131	15677.96
15.0	4500000.00	1530482432.00	0.0134	21649.77
17.0	6200000.00	1184452480.00	0.0216	27753.84
19.0	28100000.00	884842048.00	0.1180	32808.27
21.0	84900000.00	613759552.00	0.4800	33557.11
23.0	157100000.00	348458592.00	1.7345	22996.22
25.0	53600000.00	98973688.00	1.9655	9043.66
27.0	11900000.00	17556678.00	2.6039	1939.26
29.0	500001.00	995147.63	1.0300	679.93
31.0	0.00	0.00	1.0300	0.00
			TOTAL	**185,646**

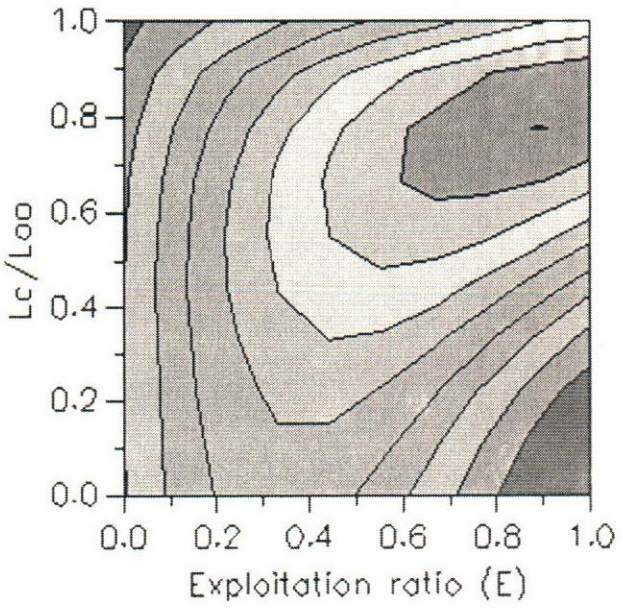

Fig 8: Relative Yield/Recruit Analysis (Knife-edge Selection)

Under present conditions of fishing, the maximum sustainable yield (MSY) can be achieved with an exploitation rate of 1.0. With present exploitation ratio of 0.50, the model suggests that the exploitation of Indian mackerel is below the maximum sustainable yield. This model also suggests that there is still scope for increasing the fishing effort. The decision to increase fishing needs careful analysis of other factors including concentration of fishing in some selected areas and capacity of processing and market availability of enhanced products.

The results of population dynamics of Indian mackerel are based on data collected during 2003 and 2004. The fishing scenario for Indian mackerel has substantially been changed since then including increase in fishing fleet, use of small mesh and continuous exploitation almost along the entire coast of Pakistan. The need for carrying out population dynamic studies of Indian mackerel from various parts along the coast of Pakistan is warranted. There is also need to relate these population parameters with environmental factors which may help in understanding the production phenomenon and fisheries of Indian mackerel more comprehensively.

References

Abdussamad, E. M., Kasim, H. M. and Achayya, P. 2006. Fishery and population characteristics of Indian mackerel, *Rastrelliger kanagurta* (Cuvier) at Kakinada. Indian Jour. Fish., 53: 77-83.

Abdussamad, E. M., Pillai, N. G. K., Kasim, H. M., Mohamed, O. M. M. J. H. and Jeyabalan, K. 2010. Fishery, biology and population characteristics of the Indian mackerel, *Rastrelliger kanagurta* (Cuvier) exploited along the Tuticorin coast Indian Jour. Fish., 57: 17-21.

Anonymous, 2011. Handbook of Fisheries Statistics of Pakistan. Vol. 20. Marine Fisheries Department, Government of Pakistan, Karachi.

Banerji, S. K. and Krishnan, T. S. 1973. Acceleration of assessment of fish populations and comparative studies of similar taxonomic groups. In : Proceedings of the Symposium on Living Resources of the Seas around India. Spec. Publ., Centr. Mar. Biol. Res. Inst., Cochin, India. Pp. 158-175.

Beverton, R. J. H. and Holt, S. J. 1957. On the dynamics of exploited fish populations, MAFF Fish. London, Inv. Ser II, 19: 533p.

Devaraj, M., Fernandez, I. and Kamat S. S. 1994. Dynamics of the exploited Indian mackerel, *Rastrelliger kanagurta* stock along the south-west coast of India. Jour. Mar. Biol. Ass. India, 36: 110-151.

Edwards, R. R. C. and Shaher, S. 1991. The biometrics of marine fishes from the Gulf of Aden, Fishbyte, 9: 27-29.

Gayanilo, F. C., Jr., Sparre, P. and Pauly, D. 1996. Food Agriculture Organization, International Centre for Living Aquatic Resource Management. Stock assessment tools (Fish Stock Assessment Tools). A computer software package (Ver-1.1, September, 1995) series manual. FAO computerized information series (Fisheries), 8:1-126.

Guanco, M. R. 1991. Growth and mortality of Indian mackerel, *Rastrelliger kanagurta* (Scombridae) in the Visayas Sea, Central Philippines, Fishbyte, 9: 13-15.

Gulland, J. A. 1983. Fish Stock assessment: a manual of basic methods, FAO, Wiley.

Gulland, J. A. and Holt, S. J. 1959: Estimation of growth parameters for data at unequal time intervals. J. Cons. Inter. Explo. Mer. CIEM., 25: 47-49.

LaBlache, G., Augier de Moussac G. and Jivan Shah, N. 1988. Summary of description of the artisanal fisheries and resources for the Seychelles. In: M. J. Sanders, P. Sparre and S.C. Venema (eds.), Proceedings of the workshop on the assessment of the fishery resources in the Southwest Indian Ocean, FAO/UNDP: RAF/79/065/WP/41/88/E. Pp. 116-141.

Luther, G. 1973. Observations on the biology and the fishery of the Indian mackerel, *Rastrelliger kanagurta* (Cuvier, 1816) from Andaman Islands, Indian Jour. Fish., 20: 425-447.

Luther, G. 1995. Fishery and resource characteristics of mackerel of Visakhapatnam coast. Mar. Fish. Infor. Serv., 138: 1-5.

Mehanna, S. F. 2001. Population dynamics and fisheries management of the Indian mackerel *Rastrelliger kanagurta* in the Gulf of Suez, Egypt, Jour. KAU. Mar. Sci. 12: 217-229.

Moazzam, M., Osmany, H. B. and Zohra, K. 2005. Indian Mackerel (*Rastrelliger kanagurta*) from Pakistan-I. Some aspects of biology and fisheries. Rec. Zool. Surv. Pakistan 16: 58-75.

Noble, A., Gopakumar, G., Pillai, N. G. K., Kulkarni, G. M., Kurup, K. N., Ruben, S., Sivadasi, M. and Yohannan, T. M. 1992. Assessment of mackerel stock along the Indian Coast. Indian Jour. Fish., 39: 119-124

Pauly, D. 1978. A preliminary compilation of fish length growth parameters, Berichte des Instituts fur Meereskunde an der Christian-Albrechts Universtat Kiel, 55: 200.

Pauly, D. 1980. On the inter-relationships between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks. Jour. Cons. CIEM., 39: 175-192.

Pauly, D. 1984. Length converted catch curves, a powerful tool for fisheries research in the tropics (Part II), International Center for Living Aquatic Resource Management. Fishbyte, 2: 17-19.

Rafail, S. Z. 1972. Studies of Red Sea fisheries by light and purse-seine near Al-Ghardaqa. Bull. Inst. Ocean. Fish (Cairo), 2: 25-49.

Sanders, M. J., Kedidi, S. M. and Hegazy, M. R. 1984. Stock assessment for the Indian mackerel, *Rastrelliger kanagurta* caught by purse-seine from the Gulf of Suez and more Southern Red Sea waters, Project for the Development of Fisheries in the areas of the Red Sea and Gulf of Aden, FAO / UNDP RAB / 83/ 003 / 03. Cairo.

Seshappa, G. 1958. Occurrence of growth cheeks in the scales of Indian mackerel, *Rastrelliger kanagurta* (Cuvier). Curr. Sci., 27: 262-263.

Sivadasi, M., Radhakrishnan P. N., Nair Balasubramanian, K. K. and Bhaskaran M. M. 2006. Length weight relationship, relative condition, size at first maturity and sex ratio of Indian mackerel *Rastrelliger kanagurta* from Calicut. Jour. Mar. Biol. Ass. India, 48: 274 – 277.

Torres, F. Jr. and Pauly, D. 1991. Tabular data on marine fishes from Southern Africa, part II: Growth parameters, Fishbyte, 9: 37-38.

Udupa, K. S. and Bhat, C. H. K. 1984. Age and growth equation of the Indian mackerel from the purse seine catches off Karnataka coast. Indian Jour. Fish., 31: 61-67.

Yohannan, T. M. 1979. The growth pattern of Indian mackerel. Indian Jour. Fish., 26: 207-216.

Yohannan, T. M. 1982. Population dynamics of Indian mackerel based on data from Mangalore during 1967-1975. Indian Jour. Fish., 29: 50-62.

Feasibility study of fish and shrimp smoking in the mid-coastal zone of Bangladesh

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Abstract
A study was conducted to evaluate the feasibility of fish and shrimp smoking in the mid-coastal zone of Bangladesh specially in Noakhali district. The fisheries resources, meteorological condition, geographical location and other natural resources of these regions are favorable for fish and shrimp smoking but smoking is not practiced. Moreover, a considerable amount of fish, shrimp and crab become spoiled due to lack of proper storage facilities and logistic support. This problem becomes bigger during fishing season. Data were collected on availability and abundance of different fish and shrimp, tree species and on meteorological condition. The geographical location of this region was also observed. Data were collected from different fishermen, fishing boat owners, fish traders and also from weather office as well as from District Fisheries Officer (DFO) and Upazilla Fisheries Officer (UFO). It was found that total production of fish in Noakhali district is 60,079mt., 20,800mt is harvested from coastal and marine water. Hilsa contributes 34.2% of total marine production. Total shrimp and prawn production is 592mt. Total forest area of Noakhali district is 182,186ha. During 1990-2009 the average temperature of Noakhali ranged from 25.2°C to 27.10°C. Again, the average minimum monthly precipitation was found highest in June (800mm) and lowest in December (0.5mm). The findings of the present study consider smoking feasible in the mid-coastal zone of Bangladesh.

Keywords: Fish, shrimp, smoking, meteorological condition, geographical location, feasibility

Introduction

Bangladesh is called a country of thousand rivers from the time immemorial. It also possesses a vast part of seawater in the south and south eastern region. Large quantity of fishes and shrimps are caught from these sources which plays vital role in the economy of this agro-based developing country.

The people of Bangladesh are habituated and prefer to take fish and shrimp in fresh condition. However, it is difficult to supply the fish and shrimp in fresh condition to the consumers throughout the year. Moreover, the peak of fish and small shrimp catch in Bangladesh is seasonal. During catching season the catch is much higher than the consumers need. The bulk catch is difficult to transport to distant districts and city markets quickly. So, these resources need to be stored and transported carefully and safely in good, acceptable condition.

Due to high population growth there remains a gap between supply and demand of fish and fisheries products in Bangladesh. Narrowing the gap not only requires increasing production but also improvement in all aspects of marketing and distribution system (ICLARM, 1991). For this, the harvested fish and fisheries products should be processed properly to reduce the gap between supply and demand. The most important contributing factors of post harvest losses are probably rough handling, improper and delayed icing, longer exposure to high temperature, contamination and lack of knowledge on sanitation and personal hygiene.

Fish smoking is a method of preservation effected by a combination of drying and deposition of naturally produced chemicals resulting from thermal breakdown of wood. Where the primary reason for smoking fish had been to preserve it, it is now mainly done to impart a pleasant mild smoky flavour. Many companies now produce kilns based on this proven technology of laminar air-flow through the product. The increasing use of micro-processors has added another quality factor that insures consistency and adaptability in processing any smoked seafood product for varying demands in any marketplace (differing salt levels, moisture content requirements, etc.) (Krasemann, 2001). Currently smoking is gaining considerable

popularity. The traditional smoked varieties like haddock, cod and kippers appeal to a new demand for 'old-fashioned' food, particularly as processing is now being done without chemicals or other additives. Smoking of under-utilized species such as dogfish (Shiau and Chai, 1985) and shark fillets (Davis, 1986) is becoming an area of interest. Prepared and flavored mackerel, pates and roulades are now being added to this list (Anonymous, 1987).

During rainy season small shrimps are preserved through smoking as no other alternative method is available then in Bangladesh (Hoq et al., 2006). Materials needed for smoking are also available in different parts of the country. So, for the betterment of our nation and for the economic development of the country smoking should be practiced in all potential areas. Mid coastal region of Bangladesh, i.e. Noakhali and its adjacent areas posses all the resources needed for smoking. For these reasons the present study was conducted to achieve the objectives of 1) finding different species of fish and shrimp which are suitable for smoking, 2) searching different species of trees which are useful as fuel, 3) examining the meteorological characteristics (temperature, humidity, rainfall) of the research area and 4) assessing the public interest about smoked products.

Material and methods

Site selection

Some area of mid cost (some portion of Noakhali Sadar Upazila, Hatiya, Nijhum Dwip etc.) are selected for research. The main cause lying behind this is that, in this region huge amount of fish and shrimp is harvested in different seasons and these exceed the local demand. In 2008, the overall production was 52,000mt (District Fisheries Office, 2008). Some of these fish and shrimp are sent to other regions of the country but due to lack of infrastructure significant losses occur. Moreover, the area is along the bay and estuary, with hot and sunny weather for most of the year, making the area an ideal place for smoking.

Selection of target group

Fishermen, fishing boat owners, aratdars, fish traders and fry collectors are selected as target groups. All kind of people related to fisheries were selected to authenticate the data. Data were collected from 50 randomly selected individuals of the taget groups.

Data collection methods

Data were collected through questionnaire interviews, focus group discussion (FGD) and finally checked through cross check interviews with key personnel like District Fisheries Officer (DFO) and Upazilla Fisheries Officer (UFO).

Data processing and analyses

Microsoft excel software was used for data analyses and for chart, graph and diagram preparation.

Results

Fisheries resources of Noakhal

a) Physical resources

Noakhali is very rich in physical fisheries resources. Pond, khas pond, shrimp farm, river, canal, flood plain, estuaries etc. are available. All these habitats accommodate different types of fishes in different quantity. Number and area of these habitats are shown in table 1.

Table 1. Physical fisheries resources of Noakhali district

Type	Number	Area (ha)
Pond	92,150	9,989
Shrimp farm	1,370	524
River	8	NS
Canal	150	NS
Khas pond	123	160
Flood plain		30,925

b) Other fisheries resources and infrastructure of Noakhali

The number of other fisheries resources is presented in table 2 below.

Table 2. Infrastructural and other resources of Noakhali district

Type	Nature	Number	Total
Fishermen	Permanent	7,756	
	Temporary	5,973	13,729
Fishing Boat	Mechanized	1,280	
	Non-mechanized	496	1,776
Prawn Hatchery	Government	0	
	Non-Government	2	2
Ice factory			38
Fish market			138

Total fish production of Noakhali

Fish production from different sub-sectors of fisheries in Noakhali is large. The highest amount of production comes from pond. Marine and coastal sectors also contribute much in total production (Table 3).

Table 3. Production from different sub-sectors of fisheries in Noakhali district

Source	Production (mt)
Pond	24,975
Prawn and Shrimp	592
River	7,942
Canal	1,270
Flood plain	4,500
Coastal and marine	20,800
Total	60,079

Availability of raw materials of smoking

a) Different species of fish captured in coastal and marine water of Noakhali

Different types of fishes are found in Noakhali region (Fig. 1). Among these fishes, hilsa (*Tenualosa ilisha*) is the most important. Contribution of hilsa in total marine production is 34.2%. As being a fatty fish, hilsa is a suitable species for smoking. Pangus (*Pangasius pangasius*) is found in coastal water of Noakhali and is also used for smoking. Chewa (*Parapocryptes batoides*) is another important species because it is abundantly available. Some other important species of this region are Koral (*Lates calcarifer*) and Poa (*Pennahia macrophthalmus*).

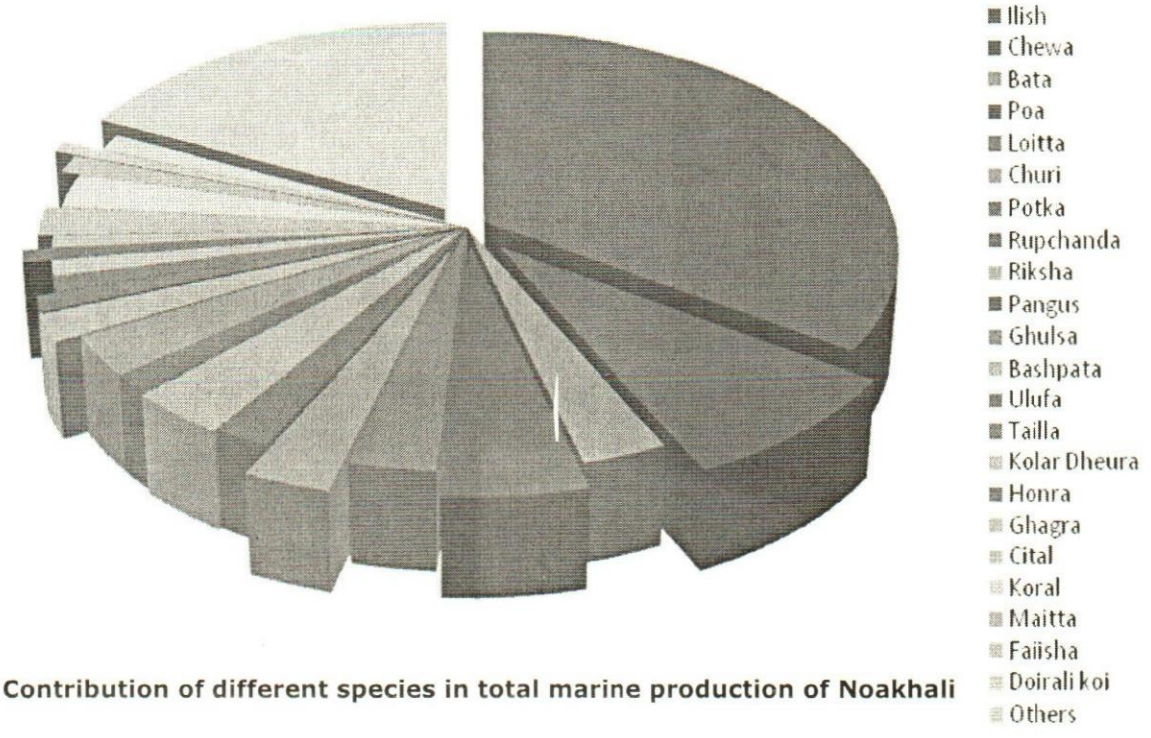

Fig. 1. Contribution of different species in total marine production of Noakhali

b) Different shrimp and prawn species present in coastal region of Noakhali

Different types of shrimps are available in Noakhali (Fig. 2). Production of shrimp and prawn is higher in this region. Giant Tiger Shrimp (*Penaeus monodon*) and Giant River Prawn (*Macrobrachium rosenbergii*) are major contributers in total production. Among the shrimp species Horina (*Metapenaeus monoceros*), Chali (*Metapenaeus brevicornis*) and Chaka (*Penaeus indicus*) are very important because these are widely used for smoking. Some of the shrimp species like Kuruma Shrimp (*Penaeus japonicus*), Brown Shrimp (*Metapenaeus spinulatus*) etc. are also suitable for smoking.

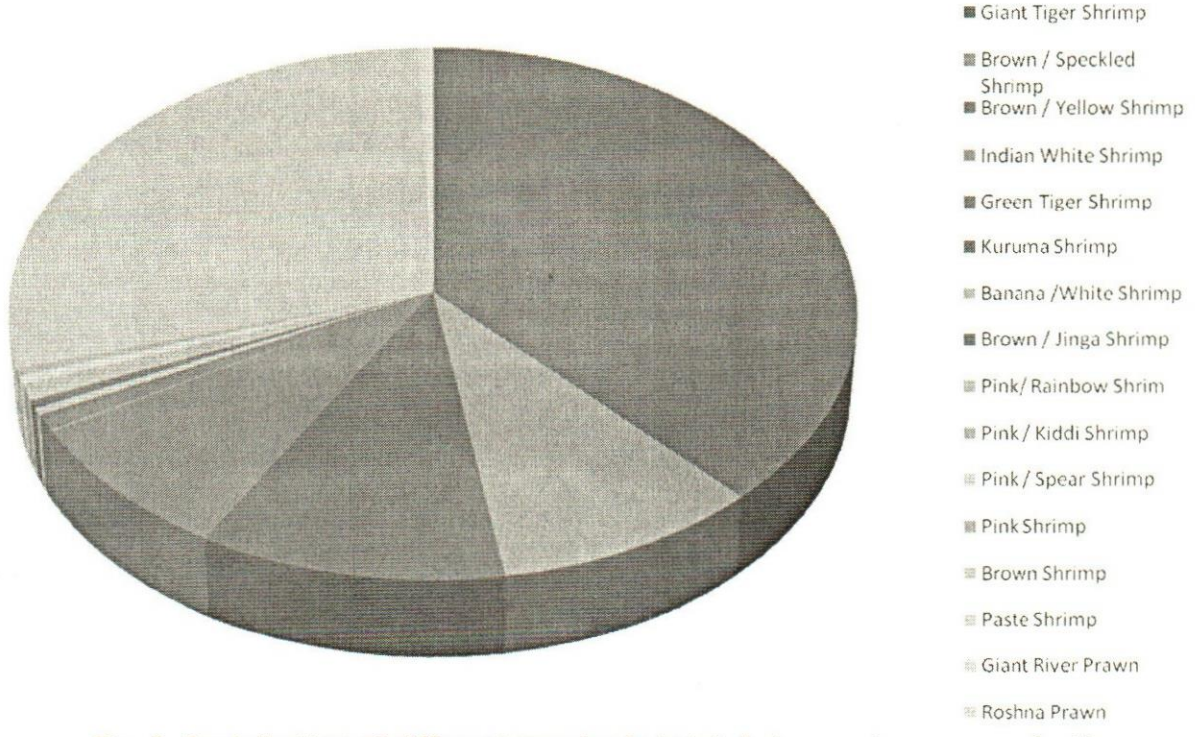

Fig. 2. Contribution of different species in total shrimp and prawn production

(c) Availability and abundance of different trees (wood)

The forest areas of Noakhali coastal forest division comprises of newly accreted chars of the Ganges, Brahmaputra and Meghna estuary and the fringes of the mainland delta, which is 182,186ha (Canonizado, 1999). Landless people as well as some vested group gathered in the area and encroached about 6,045ha forest land and destroyed existing forest resources.

(d) Mangrove plantation area

Different areas of Noakhali district are used for mangrove plantation (Table 4). These are mainly remote areas along with estuaries and bays and situated in southern part of the district.

Table 4. Location and area of mangrove plantation in Noakhali

Location	Age class				Total
	26-30 years	21-25 years	16-20 years	11-15 years	
Char Bagga	239ha	190ha	-	-	429ha
Char Mazid	182ha	1,240ha	-	819ha	2,241ha
Char Laxmi	113ha	180ha	291ha	31ha	615ha
Total					3,285 ha

Meteorological condition of Noakhali

(a) Temperature trend in Noakhali

Temperature, i.e. warm weather is a very important parameter for smoking. Fig. 3 indicates the average annual temperature of Noakhali from 1990 to 2009, ranging from 25.25°C to 27.10°C. This is a high temperature profile.

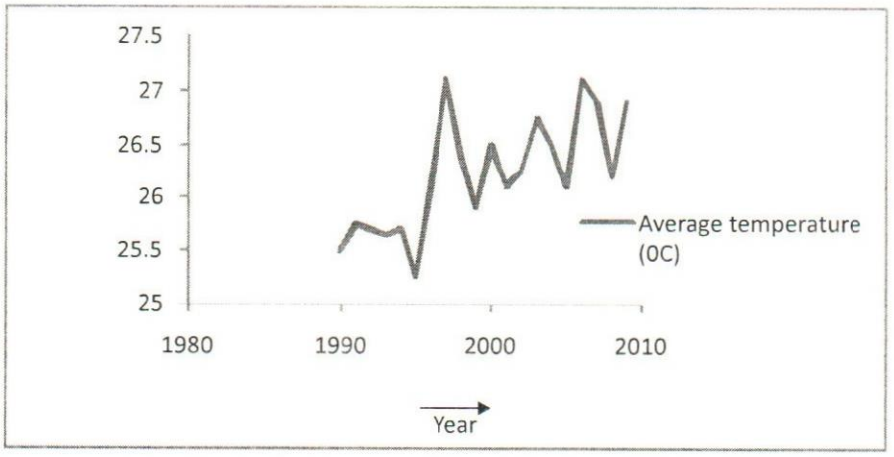

Fig. 3. Average annual temperature of Noakhali.

(b) Monthly minimum precipitation

Precipitation or rainfall is also important for smoking operation. This creates difficulties to smoking operation. Fig. 4 shows monthly minimum precipitation of Noakhali for the years 2000-2009. This indicates heavy rainfall from May to September (310mm-800mm), moderate at March, April, November and December (51mm-100mm) and low from December to March (0.5mm-7mm).

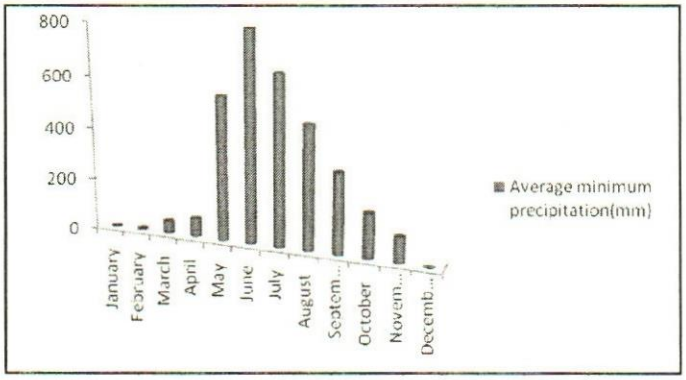

Fig.4. Monthly minimum precipitation of Noakhali of the year 2000-2009.

Public interest

Smoked fisheries products are not popular in this region. Only 10% people know about smoked products. However, after hearing about the technology most of the people became interested and 65% of the interviewee said that they will purchase and eat smoked fisheries products if available in their locality.

Socio-economic status of the target groups

(a) Religious status

Religion plays an important role in the socio-cultural life of people of a given area and can act as a notable constraint or modification in social change. In the study area, 75% of interviewees were Muslims and the remainder (18%) was Hindus, with no Buddhists or Christians. Religious restriction on eating crab might also discourage the Muslims to be involved in catching crabs.

(b) Educational status

Generally the people associated with fishing and fish trading are marginal segment of population and as such had a little or no education, about 55% were found to be educated at the level of class one to two, about 9% at the level of class five to nine, whereas the rest (36%) were completely illiterate.

(c) Family size

In the study area it was observed that 50% of the fishermen and fish traders had above 6-7 members in their family, whereas 30%, 13% and 7% of them had 4-5, above 7 and 2-3 members in their family respectively.

(d) Monthly income

Average income of people of target groups was low. Five per cent of them earn Tk. 3500, 12% earn Tk. 3000, 20% earn Tk. 2500, 35% earn Tk. 2000, 22% earn Tk. 1500 and 6% earn less than Tk. 1500 per month.

Discussion

The Subarnachar upazilla, southern part of Companyganj upazilla and Hatiya upazilla of Noakhali district are most suitable for fish and shrimp smoking because raw material including fish, shrimp and wood are available in this region alogwith favourable meteorological condition for smoking. Again, this region is faces Bay of Bengal in the south and is also bounded by Meghna river estuary in south and west. So, the transportation of goods is easier from this region to all over the country specially to Chittagong, Bhola and Barishal districts.

The average annual temperature of Noakhali ranges from 25.25°C to 27.10°C. Nishat and Haque (2008) conducted a study and found that the average temperature of Noakhali Sadar ranged between 24.50°C and 27°C during 1950-2003. Nishat and Haque (2008) also showed that, monthly maximum temperatures of Noakhali between 1990 and 2004 were; January 25.50°C, February 29°C, March 32.60°C, April 33.50°C, May 32.70°C, June 31.75°C, July 31.20°C, August 32°C, September 32.20°C, October 32°C, November 29.80°C and December 26°C. This also indicates warm weather of Noakhali region. Riches (2010) suggested that hot and sunny day is helpful for proper smoking. Hot weather condition help producers to produce smoked products of better quality. So, this area is suitable for smoking.

It is found that rainfall is heavy from May to September, moderate in March, April, November and December and low from December to March. During rainfall smoking becomes difficult. It is possible to overcome this difficulty by developing proper facilities.

Anonymous (2004) conducted a survey and showed that, any fish can be smoked but species high in fat (oil) such as salmon and trout are recommended

because they absorb smoke faster and have better texture than lean fish which tend to dry and become tough after smoking. Hilsa is a fish with very high fat content and it is available in Noakhali region. Smoked hilsa is very tasty among smoked fishes. Hilsa comprises 34.2% of total marine catch of Noakhali, so it is abundantly available as raw material for smoking. Other different types of fishes are also found in Noakhali region and some of these are underutilized. Smoking could be a tool to ensure proper utilization of those species.

Riches (2010) in his report suggested that, 'Mostly any kind of wood will work, but you might wish to use woods like alder or fruit woods'. He suggested using fruit trees like lemon, apple, apricot, cherry, orange, guava etc. Different kinds of fruit tree species are available in Noakhali region which are useful for smoking. Along with mango, jackfruit, tentul, gab, guava etc. can also be used. Some palm species like coconut, betel nut, khejur etc. will also become useable. Fruit tree species are able to develop special type of flavour in smoked products. Riches (2010) also suggested avoiding some species like cedar, cypress, elm, eucalyptus, pine, fir, redwood, sassafras, spruce and sycamore as these type of species produce unpleasant flavour in the final product. However, for sustainable management it is also necessary to assess the total number or amount of trees.

This study finds that average income of individuals associated with fishing and fish trade is very low. Only 17% individuals earn more than Tk. 3000, earning of 55% individuals ranges between Tk.2000-3000 and 28% individuals earn only Tk. 1500 or less. If smoking practice begins it will provide alternative livelihood for many people and will ensure the proper utilization of resources and will help people to improve their livelihood simultaneously.

Conclusion

Mid-coastal zone of Bangladesh i.e. Noakhali possesses all sorts of fisheries resources needed for smoking. Hilsa, shrimp, crab etc. along with huge amount of forest area are available in the region. Hot and sunny weather is a prime need for smoking and is available, at least, for 6-7 months. Considering these aspects and by managing few other aspects like increasing people awareness, training for producers, proper storage facility, development of marketing facility and logistic support, introduction of modern technologies, arrangement of bank credit or microcredit and improvement of socio-economic condition of the people engaged in fisheries, the region can be established as the most suitable place for fish and shrimp smoking of the country.

References

Anonymous. 1987. Smoked fish. Froz. Chill. Foods. 41(8), 12, 14-15, 18, 20, 23.

Anonymous.2004. http://www.fish4fun.com/smoking_fish.htm, 21-08-10.

Canonizado J. A. 1999. Integrated Forest Management Plan for Noakhali C/A Divisio (1999-2008). p. 321. Forest Resource ManagementProject, TA Component. Mandala Agril. Dev. Corp. Forest Department. Ministry of Environment and Forest, Dhaka.

Davis, P. 1986. Smoked shark and market possibility. Australian fisheries. pp. 41-45.

District Fisheries Office. 2008. Annual District Fisheries Report, Noakhali.

Hoq M., Enamul, M., Zaher, M. S., Alam M. J. 2006. Smoking of shrimp and fish from coastal village of north-west Bangladesh. Bangladesh J. Fish. Res. 10(2): 203-206.

ICLARM. 1991. Socio-economic impacts of fish culture extension programme. Annual program Report, ICLARM, Dhaka.

Krasemann, S. 2001. Smoking Seafood, In Fish Smoking, A Torry Kiln Operator's Handbook, 1963. Torry Research Station, Department of Scientific and Industrial Research, Ministry of Technology, Edinburgh.

Nishat, A. and Haque, R. 2008. Promotion of adaptation to climate change and climate variability: Experiences from Noakhali. IUCN Bangladesh Country Office, Bangladesh.

Riches, D. 2010. Guide to Barbeque and Grilling. New York, U.S.A.

Shiau, C. Y. and Chai, T. 1985. Smoked dogfish processing and its refrigerated storage stability. J. Food Sci. 50: 1348-50.

Distribution and status of freshwater turtles in wetlands of the Punjab and Sindh, Pakistan

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Abstract
The current distribution and status of freshwater turtles in wetlands of Indus River system in the provinces of the Punjab and Sindh, Pakistan are reported. All the eight species of turtles were recorded during the study. It was also observed that freshwater turtles, their eggs and juveniles are collected by some local communities for food and also for international trade. Measures are suggested for conservation and management.

Key words: Freshwater turtles, Status, Distribution, Indus River System, Conservation

Introduction

Order Chelonia of Class Reptilia contains 13 recognized families of tortoises, freshwater and marine turtles (Ernst et al., 2005). Some 350 species of tortoises and freshwater turtles exist on Earth. Among them 24 species are listed as critically endangered, 48 as endangered and 60 as vulnerable by the International Union for the Conservation of Nature and Natural Resources (Gibbons et al., 2000; Halliday and Adler, 2006; IUCN, 2010). Turtles serve as keystone species from which other organisms benefit. Turtles represent major components in their environments and are part of the web of interacting and co-dependent species that constitute healthy ecosystems. Without turtles and tortoises, those ecosystems and the critically important human-welfare eco-services they provide would gradually suffer from the loss of biodiversity and degrade in ways still partially understood (Turtle Conservation Fund, 2002).

The world's living tortoise and turtle species are a remarkable evolutionary success story. Turtles being recognized as indicators of environmental health appeared approximately 220 million years ago in the Permian wetlands and have been able to inhabit marine and freshwater habitats. Some genera are distributed very widely but others are restricted to islands or small continental areas. Turtles and tortoises have evolved a remarkable armored shell that has remained relatively unchanged through evolution. While other vertebrate species have evolved and gone extinct, the basic body form of turtles has remained an obvious testament to their success and their ability to survive millions of years of natural selection (Turtle Conservation Fund, 2002).

Turtles evolved a life strategy characterized by slow growth and late maturity (usually in the order of 10-15 years), longevity (typically living for sixty or more years) and successful reproduction throughout life without senility, relatively modest annual reproductive output (one to over 100 eggs per mature female per year depending on species), very low survivorship of eggs and juveniles but increasingly high average annual survivorship of sub-adults and adults. In short, the key to turtle life history is to reach maturity, live for a long time and produce a modest number of eggs each year so that over a lifetime enough eggs are produced to ensure that a few will successfully hatch and some of these will survive to adulthood (van Dijk, 2010).

Throughout the world turtles are being impacted by a variety of threats which make them one of the most severely threatened vertebrate groups. They are collected, traded and eaten or otherwise used in large numbers. Of all the threats that turtles face recently, the most urgent is uncontrolled and excessive illegal trade for food and traditional medicines in many parts of Asia. Their eggs, juveniles, adults and body parts are exploited indiscriminately with little regard for sustainability (Gibbons et al., 1998; Klemens, 2000). The demand for turtles in China is very strong and threatens the majority of Asian species with extinction in the wild (IUCN Red List of Threatened Species, 2010), a phenomenon known as 'Asian Turtle Crisis' (Van Dijk et al., 2000).

Freshwater Turtles are among the most important groups of the wetlands associated biodiversity. Eight species of freshwater Turtles belonging to two families i.e. Geoemydidae and Trionychidae are found in Pakistan. These include *Chitra indica* (Narrow Headed Soft Shell Turtle), *Goclemys humiltoni* (Spotted Pond Turtle), *Nilssonia* gangeticus (Ganges soft-shell turtle), Nilssonia

(Peacock soft-shell turtle), Lissemys punctata (Indian Flap shell Turtle), Pangshura smithi (Brown Roofed Turtle), Pangshura tecta (Indian saw-backed turtle) and Hardella thurgi (Crown River Turtle). The Ganges soft-shell turtle, Peacock soft-shell turtle, Spotted pond turtle and the Indian roofed turtle are included in Appendix-I; whereas Indian flap-shell turtle, Smith's Turtle and Chirta turtle are included in Appendix-II of the Convention on International Trade in Endangered Species of Fauna and Flora (CITES). Crowned River Turtle is the only non-CITES species (UNEP-WCMC, 2012).

Despite the significance of freshwater turtles no detailed scientific work has been conducted in Pakistan and basic data on occurrence and population distribution of different species is scarce. Current distribution and status of turtles and threats to them are not well established or otherwise generalized information is available about the turtle's species in Pakistan (Noureen, 2007). Minton (1966) published a book entitled "Herpetology of Pakistan" and described the distribution of the reptiles of Pakistan including turtles. Khan and Mirza (1976) presented a key and checklist of Reptiles including distribution of turtles in Pakistan. Ghalib et al. (1981) published checklist of reptiles of Pakistan including their known distribution. Azam et al. (2005) made observations on distribution and abundance of freshwater turtles in river Indus. Akbar et al. (2006) identified eight species of freshwater turtles from the rivers in Punjab. In their study Pangshura smithii (43.62%) was the most abundant species followed by Pangshura tecta (42.06%). Status of Aspideretes gangeticus (6.55%) was common while Geoclemys hamiltonii (1.76%), Nilssonia hurum(3.09%) and Lissemys punctata (1.50%) was recorded as frequent. Hardella thurjii and Chitra indica were rare (0.88% and 0.54% respectively). Noureen (2007) worked on the turtle use by Kail communities as food and also raised the issue of illegal turtle trade.

This research deals with the distribution and status of freshwater turtles in Indus River System in the provinces of the Punjab and Sindh, Pakistan.

Material and Methods

Study Area

The study was carried out in Indus River system in the provinces of the Punjab and Sindh, Pakistan. The Indus River is a major river that originates in Tibet and flows through India and Pakistan. The river runs a course through the Ladakh region of Jammu and Kashmir, Gilgit-Baltistan and flows along the entire length of Pakistan in a southerly direction to merge into the Arabian Sea. The total length of the river is 3,180 km. The Indus River has five main tributaries; the Jhelum, Sutlej, Chenab, Ravi and Beas. These rivers merge with one another to form the Panjnad, which then joins the Indus mainstream. Human habitation is sparse but increases with proximity to the delta. The only large towns are Dera Ismail Khan in the province of Khyber Pakhtunkhwa and Sukkur and Hyderabad in province of Sindh.

The irrigation system, claimed to be the largest in the world, consists of 19 barrages, 12 inter-river link canals and two million kilometers of tertiary watercourses. The Indus River is critical for Pakistan's 160 million people and its watershed is also an area of rich biodiversity, particularly where it opens to the Arabian Sea. The Indus river delta is a highly productive area for freshwater fauna and an important region for water birds.

The study was carried out in and around riverine wetlands of Indus River System including Chashma, Taunsa, Guddu, Sukkar and Kotri Barrages, Sidhnai, Trimmu, Rasool, Maralla, Balloki, Sulemanki, Punjnad and Qadirabad Headworks, Manchar, Drigh, Langh, Hammal, Bakhar, Chotiari and Khinjeer Lakes, Ghazi Ghat, Ravi, Soan and Ling rivers between October 2009 and February 2012.

Survey Methodology: Line transects method was applied for the observation of freshwater turtles on the upstream and downstream of the barrages and associated canals. Transects of 1 kilometer were selected along the canals and both upstream and downstream of the barrages. Study was based mainly on direct observation; enumerations depended on basking and floating turtles. Point count method was used on the sites where no basking sites were present. For the said method a point was selected and Floating and swimming turtles were observed, identified and counted. Drag nets were also used on those sites where lines transect and point count methods were not applicable i.e., large lakes and marshes. Netted animals were identified, counted and released back.

Binoculars were used to identify the species and GPS points of the sites were also noted. Information regarding the general site description, land use patterns and illegal turtle hunting were also collected from the sites.

Results and Discussion

A total of 3,914 turtles of eight species were recorded during the field surveys. *Pangshura smithii* (79.38%) was the most abundant species distributed throughout the study area followed by *Geoclemys hamiltonii* (6.72%) and *Lissemys punctata* (6.10%). These species were commonly encountered during the field surveys. Records for *Aspideretes gangeticus* (4.42%), *K. tecta* (1.76%) and *Chitra indica* (1.15%) were frequent while *A. hurum* (0.38%) and *Hardella thurjii* (0.076%) were rare (Annexure 1).

Distribution and Habitat Preferences of Freshwater Turtles

***Pangshura smithii* (Brown River Turtle)**
Pangshura smithii (Plate 1) is plentiful in streams of Indus Drainage in north at least to Jhelum. There is also a single record from *Rajshahi District in Bangladesh* (Minton, 1966). Recent records come from Northern India, Pakistan, Nepal, and Bangladesh. Ghalib et al. (1976) reported this species from Dadu, Hyderabad, Sanghar, Thatta and Jacobabad Districts from Sindh province and Tunsa Barrage, Multan, Vihari, Sahiwal and Lahore Districts in the Punjab.

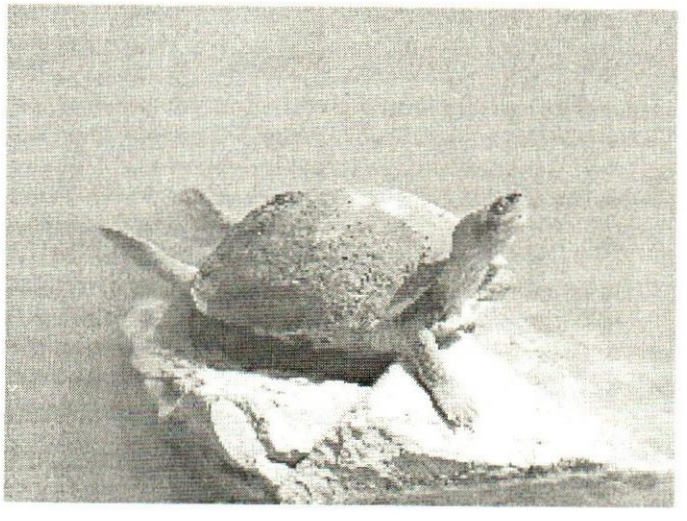

Plate 1: Pangshura smithii

During the current study Pangshura smithii was found widely distributed and most abundant species in the Indus River system. It was recorded from Jinnah, Chashma, Taunsa, Guddu, Sukkar and Kotri Barrages; Sidhnai, Trimmu, Rasool, Maralla, Balloki, Sulemanki, Punjnad and Qadirabad Headworks; Manchar, Drigh, Langh, Hammal, Bakhar, Chotiari and Khinjeer lakes, and Ghazi Ghat, Ravi, Soan and Ling rivers. Its distribution ranges from Upper Punjab to Lower Sindh and lakes where river connections exist.

This turtles is more common in main river bodies and canals with shallow, slow moving water and sandy banks. It is occasionally found in lakes and ponds. This is the only species found in Pakistan having habits of social basking. This species is omnivorous preferring insects. It also eats meat, fish, frogs, fruits etc.

***Pangshura tecta* (Indian roofed turtle)**
According to Ghalib et al. (1976) in Pakistan Pangshura tecta (Plate 2) is mainly confined to Middle Sindh while it has also been reported from Brahamaputra and Gangas rivers in India, Bangladesh and also in the Mahanadi basin. Minton (1966) reported its distribution within 50km radius of Manchar Lake.

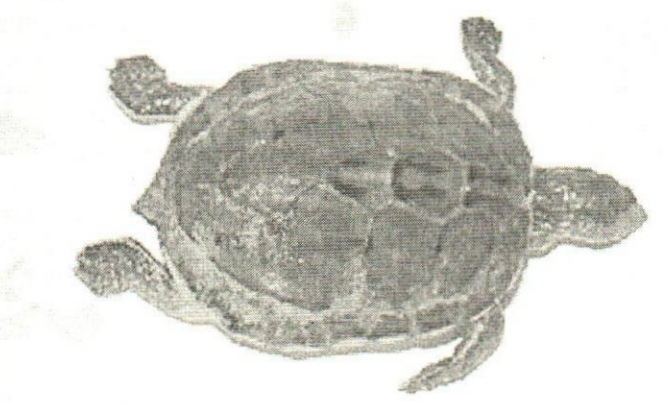

Plate 2: Pangshura tecta

During the present study Pangshura tecta was recorded from Sukkar and Kotri Barrages, Punjnad Headwork and Chotiari Reservoir i.e. ranges in distribution from Central Punjab to Lower Sindh. This is a quiet-water turtle, occurring in quiet streams, canals, oxbows, ponds, and man-made water tanks. A soft bottom and abundant aquatic vegetation are preferred conditions. It loves basking in the early morning sun. Basking helps the turtle to maintain its body temperature as well as for the synthesis of Vitamin D. It is less alert as compared to *K. Smithii* and not so good swimmer. Food comprises mainly of vegetative matter (Minton, 1966).

***Geoclemys hamiltoni* (Spotted Pond turtle)**
Geoclemys hamiltoni (Plate 3) was found widely distributed in Indus River System. Its distribution ranges from Upper Punjab to Lower Sindh and it was very abundantly recorded from Lakes.

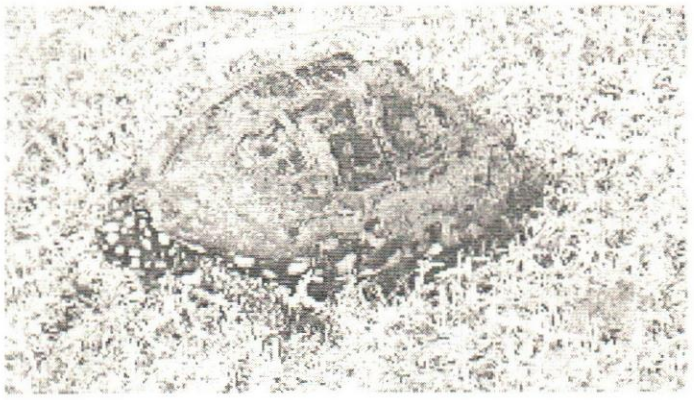

Plate 3: *Geoclemys hamiltoni*

Plate 4: *Hardella thurgii* (Photo credit: Frank Bonin)

During the field visits this species was recorded from Chashma, Taunsa and Guddu Barrages, Punjnad and Sulemanki Headwork, Langh, Hammal, Khinjer and Chotiari Lakes and Ghazi Ghat. Previous Records of *Geoclemys hamiltoni* come from Indus Valley from Jacobabad south to Saidabad and Gangas River in India (Minton, 1966). Ghalib et al. (1976) reported this species from Indus Valley (Dadu, Tharparkar, Hyderabad Districts) and Punjab (Balloki and Qadirabad Headworks and Taunsa Barrage).

In the wild Spotted Pond Turtles are reported to feed primarily on snails. Wild caught turtles from Pakistan voided snail opercula and undigested algae. The alga was believed to have been ingested incidentally (Minton, 1966). *Geoclemys* is known to feed on the snails and dragonfly larvae. The large heads, cusps and ridges in the turtle's mouths are probably adaptations for crushing snails. Their occurrence in quiet waters with abundant aquatic vegetation is probably related to the fact that this vegetation supports extensive snail populations.

***Hardella thurgii* (Brahminy River Turtle)**
Hardella thurgii (Plate 4) is predominantly found in shallow vegetation chocked lakes and ponds. This species is highly aquatic, spending much of their time resting on the bottom. Mainly feed upon plant material. Akber et al. (2005) reported this species from Trimmu Headwork in Punjab while Ghalib et al. (1976) reported it from Taunsa Barrage in Sindh. Minton (1966) reported *Hardella thurgii* from Sukkar Barrage. This species is very restricted in its distribution in Pakistan. During the present study Brahminy River Turtle was recoded only from Kotri Barrage.

***Nilssonia gangeticus* (Gangas Soft shell Turtle):** This species (Plate 5) is known to be highly aquatic, inhabiting the deep turbid rivers but it is frequently seen basking on sandy banks or retiring in shallow waters with its head striking out of water. It is an omnivorous species and the diet comprises a wide range of aquatic vegetation and animal food like fish, mollusks, frogs and crustaceans. It is known to be very prominent scavenger, feeding even on human corpses, and as such the turtle is useful to mankind by its role in cleaning the aquatic ecosystem, acting as a species for 'biological control of pollution'.

According to Minton (1966) this species occurs northwest to Dera Ismail Khan and Montgomery (presently Faisal Abad). This species also inhibits the Gangas River in India. Ghalib et al. (1976) reported its distribution in Sindh (Dadu, Tharparkar and Hyderabad Districts) and Punjab (Balloki Headwork and Taunsa Barrage). This species is widely distributed in Indus River system of Pakistan. It is distributed from Upper Punajb to Upper and Middle Sindh. *Nilssonia gangeticus* was recorded from Chashma, Taunsa, Guddu, Sukkar and Rasool Barrages, Sulemanki, Trimmu, Punjnad and Qadirabad Headworks and Ghazi Ghat during the present surveys.

Plate 5: *Nilssonia gangeticus*

***Nilssonia hurum* (Peacock soft shell turtle)**
Nilssonia hurum (Plate 6) is a species of turtle found in Nepal, India, Bangladesh (in the Brahmaputra and Ganges rivers) and Pakistan. In Pakistan the species is present in Indus river system but is reported to be rare in Pakistan. During the study it was recoded from the River Chenab only i.e., Trimmu and Punjnad Headworks. Khan and Mirza (1976) have also reported it from Lower Sindh.

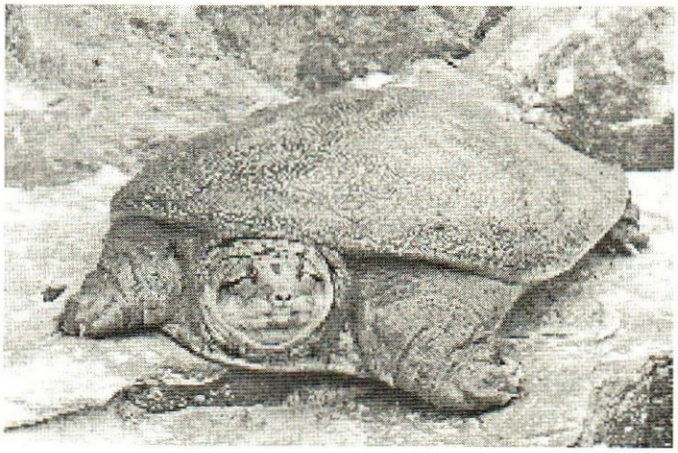

Plate 6: *Nilssonia hurum*

The Indian peacock soft shell turtle utilizes rivers, lakes and ponds from the upper reaches of the rivers to the lowest while apparently avoiding the saline river mouths. Its ability to burrow into the mud may be associated with its ability to inhabit ponds and other lentic environments that may dry up during the dry season. These turtles are frequently found swimming largely in quite, shallow water or basking on the bank. The species is primarily nocturnal and omnivorous; juveniles are observed feeding on mosquito larvae and fish, while adults consume snails, earthworms, prawns, fish, frogs, carrion and vegetation.

***Lissemys punctata* (Indian Flap Shelled Turtle)**
The "Flap-shelled" name stems from the presence of femoral flaps that are located on the plastron. It is Plentiful in shallow muddy lakes and marshes where river connections exist. This species of freshwater turtle (Plat 7) is widely distributed in Pakistan. Its distribution ranges from Upper Punjab to Upper Sindh till Guddu Barrage and Lakes in Sindh. During the study period it was recorded from Chashma, Taunsa, Guddu and Rasool Barrages, Qadirabad and Punjnad Headworks, Drigh, Hammal and Chotiari Lakes and River Soan.

According to Minton (1966) this species occurs southward in the Indus Drainage to delta in Pakistan.

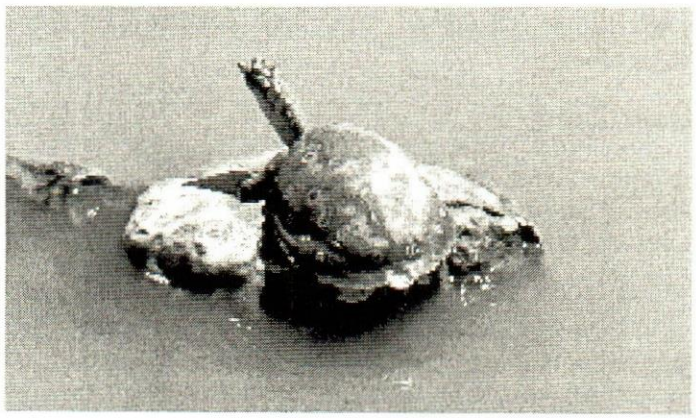

Plate 7: *Lissemys punctata*

He also reported from Gangas River in India and Bangladesh. Ghalib et al. (1976) reported its distribution in Sindh (Dadu, Hyderabad, Sanghar, Sukkar and Thatta Districts) and Punjab (Balloki Headwork and Taunsa Barrage).

***Chitra indica* (Indian Narrow Headed Soft shell Turtle)**
Chitra indica (Plat 8) is mainly confined to sandy sections of the Indus and other large rivers. It is highly aquatic. This species is carnivorous in its feeding habit. It occurs in Sindh near Thatta (Ghalib et al., 1976) and is also known from Sutlaj and Indus Rivers in lower and middle Indus Valley in Pakistan, Ganges River in India and Ratburi River of Thailand (Minton, 1966).

Plate 8: *Chitra indica*

During the current study this species was found widely distributed in Indus River system. Its range extended from Central Punjab to Lower Sindh. During the field surveys it was recorded from Taunsa, Guddu and Sukkar Barrages, and Ghazi

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Freshwater Turtles of Pakistan: Threats to Survival and Conservation Challenges

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Abstract
Current study gives an insight to threats faced by freshwater turtles in their natural habitats and reviews the priority steps for their conservation. Despite being listed in CITES appendices and Provincial Wildlife Acts as protected animals law enforcement seems negligible and turtles are exploited and traded. Collection and trade have also become an important component of the local livelihoods. Moreover habitat destruction, pollution and poisoning of water bodies, death in commercial fishing gear, canal auction and road mortalities have played havoc to these animals. Paucity of nationwide population status and trade data, lack of studies on biology of individual species, lack of capacity of custom and field staff in turtle taxonomy are challenging gaps in freshwater turtle conservation.

Key words: Freshwater turtles, threats, illegal hunting, trade, conservation

Introduction

Order Chelonia of class Reptilia contains 13 recognized families of tortoises, freshwater and marine turtles (Ernst et al., 2005). Among 350 species of tortoises and freshwater turtles, 24 are listed as critically endangered, 48 as endangered and 60 as vulnerable (IUCN, 2010).

Turtles are part of the web of interacting and co-dependent species that constitute healthy ecosystems. While not as visible as birds or ecologically dominant as large mammals or fish, turtles often fulfill important roles in the ecosystem like seed dispersal, vegetation management, control of insect and snail populations and keeping water clean and populations healthy by scavenging dead animals and preying on weak and sick individuals (Turtle Conservation Fund, 2002).

Natural populations of turtles are characterized by a suite of life history characteristics that may predispose these populations to rapid declines in the face of anthropogenic harvest. Among these characters are delayed maturity and high natural levels of nest mortality. Demographic analyses have indicated that the sustainability of harvest is a dubious proposition for numerous species (Congdon et al. 1993, 1994, Heppell 1998, Reed et al., 2002) including turtles.

Turtles throughout the world are being impacted by a variety of threats which make them one of the most severely threatened vertebrate clades. Turtles are being collected, traded, and eaten or otherwise used in large numbers. Of all the threats that turtles face recently, the most urgent is uncontrolled and excessive illegal trade for food and traditional medicines in many parts of Asia. Their eggs, juveniles, adults and body parts are exploited indiscriminately with little regard for sustainability (Gibbons et al., 1998, Klemens, 2000). The demand for turtles in China is very strong and threatens the majority of Asian species with extinction in the wild (IUCN Red List of Threatened Species, 2010), a phenomenon known as 'Asian Turtle Crisis' (van Dijk et al., 2000).

China once had the world's most diverse freshwater turtle fauna but in 1980s over-collection, illegal trade, and habitat destruction increased dramatically, pushing almost all Chinese turtles towards extinction. As a substitute for dwindling native species, freshwater turtles and tortoises are collected from countries further and further away and are imported in huge numbers. Species originate from Bangladesh, Cambodia,

Table 1: IUCN and CITES Status of Freshwater Turtles of Pakistan

Species	IUCN Status	CITES Status
Geoclemys hamiltoni	Vulnerable	Appendix I
Pangshura smithii	Low Risk	Appendix II
Hardella thurjii	Vulnerable	Non CITIES
Pangshura tecta	Vulnerable	Appendix I
Nilsonia gangeticus	Vulnerable	Appendix I
Nilssonia hurum	Vulnerable	Appendix I
Lissemys punctata	Low Risk	Appendix II
Chitra indica	Endangered	Appendix II

China, India, Indonesia, Lao PDR, Malaysia, Myanmar, Nepal, Pakistan, Papua New Guinea, Thailand and Vietnam (Gong et al., 2006).

Turtles are considered to be of particular conservation concern because their life history and habitat requirements of wetlands and terrestrial environment (Congdon et al., 1996; Klemens, 2000). Many turtle and tortoise species depend on high adult survival to offset high egg and juvenile mortality in the wild (Schlaepfer et al., 2005). While it is evident that threatened species and populations of tortoises and freshwater turtles are entitled to conservation actions, their conservation also help them maintain their ecological roles. Overall, turtles are likely to be of net benefit to humans even if not used as protein for consumption, though the significance of turtle-mediated ecosystem benefits remains un-quantified.

Freshwater turtle fauna of Paksitan is represented by eight species belonging to two families i.e. Geoemydidae and Trionychidae. These include *Chitra indica* (Narrow Headed Soft-shell Turtle), *Goclemys humiltoni* (Spotted Pond Turtle), *Nilssonia gangeticus* (Ganges soft-shell turtle), *Nilssonia hurrum* (Peacock soft-shell turtle), *Lissemys punctata* (Indian Flap shell Turtle), *Pangshura smithi* (Brown Roofed Turtle), *Pangshura tecta* (Indian saw-backed turtle) and *Hardella thurgi* (Crown River Turtle).

Despite the significance of freshwater turtles data regarding the threats and status of illegal hunting and export is not available but only generalized information is available. Illegal trade in turtle parts was first reported by Baig (2006) mentioning a group of about 40 persons, camping at Taunsa Barrage and killing *Chitra indica* and *Nilssonia gangeticus* for their body parts. Body parts of hundreds of turtles were lying with them. They used to collect over 200 turtles every week and selling their parts for Rs. 100-200 to buyers from Lahore and Karachi. Noureen (2007) worked on the turtle as food among *Kail* communities and also raised the issue of illegal turtle trade.

In Pakistan, conservation of species is a provincial responsibility. Each of the provinces and capital territory of Islamabad has its own Wildlife Conservation Legislations. A federal ban was imposed in August 1981 on the export of all wild mammals, reptiles and certain birds including their parts, products and derivatives except for limited numbers of authorized hunting trophies.

Freshwater turtles are on the appendices I & II of the CITES which don't allow their international trade. Also, the import and export of wildlife species without a lawful certification is prohibited according to Section 14 of the Punjab Wildlife Protection, Preservation and Management Act, 1974; Section 12 of Sindh Wildlife Protection Ordinance, 1972 and Section 13 of the Khyber Pakhtunkhwa Wildlife Protection, Preservation and Management Act, 1975.

Freshwater turtles were not included in the list of protected animals in all Provincial Wildlife Protection Acts. Khyber Pakhtunkhwa Wildlife Department amended the Wildlife Protection Act, 1975 in August 2007 and included freshwater turtles in the list of protected animals. Following Khyber Pakhtunkhwa (KPK), the Punjab Wildlife Department revised the Punjab Wildlife Protection Act 1974, on November 30th, 2007 and included the Order Chelonia in the list of protected animals (Schedule III).

Current study assesses the threats faced by freshwater turtles and highlights the conservation issues and measures at wetlands of Indus River System in Punjab and Sindh.

Material and Methods

Study Area

The Indus River is a major river that originates in Tibet and flows through India and Pakistan. The river runs a course through the Ladakh region of Jammu and Kashmir, Gilgit-Baltistan and flows along the entire length of Pakistan in a southerly direction to merge into the Arabian Sea. The total length of the river is 3,180 km (World Resource Institute, 2003).

The Indus River has five main tributaries; the Jhelum, Sutlej, Chenab, Ravi and Beas Rivers. These rivers merge with one another to form the Panjnad River, which then joins the Indus mainstream. Human habitation is sparse but increases with proximity to the delta. The only large towns are Dera Ismail Khan (Khyber Pakhtunkhwa), Sukkur and Hyderabad in Sindh Province.

The irrigation system, claimed to be the largest in the world, consists of 19 barrages, 12 inter-river link canals and two million kilometers of tertiary

freshwater turtles i.e. use of poisonous chemicals to maximize the catches. In order to boost their catch, greedy fishermen throw poisonous chemical in the water that immediately kills the fish along with other aquatic life. The dead fish immediately start floating on the surface of water. This practice has adversely affected the freshwater turtle population as it is resulting in high turtle mortality.

The illegal practice of using hazardous chemicals and dynamite blasting to catch fish has still been continued in the outskirts of Islamabad in River Soan and Korang Nallah. This practice is also very common in main rivers. Sukkar Barrage has been the victim of this incident in March 2010 where hundreds of turtles were washed ashore when poison was poured to maximize the fish catch. Guddu Barrage also suffered from such an incident in 2010, when some toxin in Desert Pet Feeder resulting in mass mortality of freshwater turtles.

Priority Steps for Turtle Conservation

According to Turtle Conservation Coalition Report (2011), 25 species of turtles are most likely to become extinct, with a further 40 species at very high risk of extinction. Between 48 to 54% of all 328 of the species considered threatened, turtles and tortoises are at a much higher risk of extinction than many other vertebrates.

Nonetheless, wild turtles continue to be caught and sent to market in large number (as well as to turtle farms, to be used as breeding stock), resulting in a situation described by conservationists as "the Asian turtle crisis". In the words of the biologist George Amato, "the amount and the volume of captured turtles vacuumed up entire species from areas in Southeast Asia", even as biologists still did not know how many distinct turtle species live in the region. About 75% of Asia's 90 tortoise and freshwater turtle species are estimated to have become threatened (Turtle Conservation Coalition, 2011).

Improved enforcement of existing and updated legislation is a key component to conserve freshwater turtles in the country. The ultimate goal "the survival of secure populations of turtle species in their natural habitats" is to be achieved.

Population Status Database and Turtle Biology

The necessity to survey the distribution, monitor the status of turtle species and study their ecology in natural habitat throughout the country is a desired step. Surveys of species coexisting with human in stable agricultural landscapes or man-made water bodies are also useful to identify species with adequate populations and thus of lesser conservation concern.

Nation wide data regarding the population status and ecology of freshwater turtles is an essential component for the species management. As the conservation plans for the species either *in situ* or *ex situ* directly depend upon the field study, conservation programs require knowledge of the species' native distributions, habitats and basic ecology.

State of Legislation and Enforcement

At present, provinces have wildlife laws and legislation that provide protection to freshwater turtle species. In addition, being the signatory to CITES, the provisions should be implemented through national legislation. Overall, the scope and extent of the existing laws is adequate to protect most turtle species.

In contrast, enforcement of existing legislation and regulations is insufficient. The inability of customs officers, wildlife enforcement agency staff and others to identify turtle species with any accuracy is a serious obstruction to effective enforcement. Without being able to identify animals in trade, it is nearly impossible to determine which species are traded legally and which are illegal. This problem is exploited by traders, who intentionally misidentify and make false declarations of the contents of shipments.

Clarification of Legislation Enforcement is hampered by overlapping, competing or undefined responsibilities of different government authorities. Such overlapping authorities may involve species conservation and protected areas management divisions of forestry departments, aquaculture and fisheries departments, veterinary health departments, coastal management authorities and security forces.

Certain authorities may be assigned specific jurisdiction over certain species, while another authority is responsible for its habitat management and yet another authority has exclusive control over trade in the species. In many countries, the specific details may not be spelled out in law, leading to different interpretations of authority. Where such

complications exist, review of national legislation is urgently recommended to clarify the precise duties and responsibilities of various authorities, and procedures should be developed to increase cooperation between these authorities.

Capacity Building

Capacity building is obviously essential if enforcement is to be improved. Providing additional resources such as staff, office and equipment facilities and improved funding for work outside the office are primarily the responsibility of the respective governments. Organizations have an important role in organizing and providing training, preparing and distributing identification materials, and giving other practical assistance.

The existing mechanisms to impose fines and other penalties on individuals, companies and organizations, who breach laws and regulations, should be improved. A proportion of the fines resulting from confiscations and prosecutions should be transferred directly to the budget of the specific enforcement agencies, which would provide a very effective incentive for improved enforcement. If there is a shortage of funds to hire the necessary staff and provide the facilities needed to enforce the legislation and regulations, a tax on the cross-border trade of fauna and flora can be imposed to supplement funding for the enforcement authorities. Enforcement training for the wildlife trade can also be incorporated in general wildlife enforcement programs. The importance of turtle conservation as a priority for enforcement should be emphasized in training programs and general awareness development.

Wildlife Trade Monitoring

There is an urgent need for data on turtle trade. Information is needed on species and volumes of turtles shipped through various sources. Equally important is knowledge of the use of turtle parts and products, the places of manufacture and trade routes. It would probably be most effective if a single organization coordinates the compilation and analysis of the trade data collected.

The paucity of trade data, natural history data and particularly long-term status data makes it difficult to judge the effects of trade on native turtle populations. It is clear, though, that trade is at least a contributing factor in the decline of most species and in many cases it is the main cause (Asian Turtle Trade Working Group, 1999).

Habitat Conservation

Habitat destruction and drainage of wetlands for agricultural purposes and use of pesticides have detrimental effects on the wildlife resources. Constructions in core habitat areas lead to reduction of appropriate nesting and basking sites for the turtles. Agriculture near the river banks is also a common practice leading to the same effect. Good agricultural practices are desired to protect the freshwater fauna in general and turtles in particular.

Fishing Operations, Canal Auction and Pollution

Turtle mortality during the fishing operations is a common phenomenon. Many fishermen also consider the turtle's enemies to fish and kill them. Awareness must be raised among this group of people to conserve the turtle population and it must also legally be made mandatory for the fishermen to safely release the turtle by catch. An overview of mitigation measures and fishing gear modifications that have been developed in different fisheries is highly desirable, as is a mechanism to distribute this knowledge to fishery operators and regulators, and establishment of a communications forum where experiences and ideas can be exchanged and deliberated.

During the canals auction and desiltation, mass mortalities of freshwater turtles occur. Hibernating animals are either killed during the desiltation or shifted to other places where required habitat doesn't exist resulting in death. Measures should be taken to release the turtles into main river bodies during the auction of canals.Strict legal measures should be taken to control the chemical poisoning of water bodies to maximize the fish catch and this practice should be strictly discouraged.

Commercial Farming of Freshwater Turtles

Commercial farming of freshwater turtles for export as food, pet and for religious purposes is well established and represents a large proportion of the regional and global trade in turtles. While farming is an economic activity undertaken for financial gain and is often a closed-cycle production process, it is not without effects on native turtle populations. Farming of species within their native range is likely to create pressure on natural populations as additional founder stock is collected. Farming non-native species carries the inherent risk of escape and to establish as invasive species.

On the positive side, a substantial and reliable

supply of farmed turtles is likely to keep market prices stable and may thus lead to a correspondingly stable maximum price for wild-collected turtles, which will likely be higher than for farmed turtles. In addition, the possibility exist that organized turtle farmers would push for a ban on trade in wild-caught turtles or in worse way it may also lead to a very severe stress on natural turtle population. Close monitoring of trade for farmed turtles can overcome this issue.

Conservation Breeding and Genetic Implications

Given that current levels of trade directly threaten a number of turtle species with extinction in their natural range, it is essential that species recovery programs be formulated. Such programs are likely to involve both *in situ* and *ex situ* conservation breeding efforts. This requires the nationwide data on species status, ecology and genetics. Anthropogenic effects can exacerbate loss of genetic diversity owing to increased habitat fragmentation and diminished population size. Genetic approaches can be used to detect and monitor these effects at various temporal and spatial scales.

Understanding historical and contemporary evolutionary processes, at scales ranging from an individual to an entire landscape, provides valuable knowledge for development of short-term and long-term conservation plans. Conservation priorities can be identified and program success can be monitored using molecular methodologies.

Aspects of turtle biology and mating systems that are exceedingly difficult or impossible to ascertain from field studies can be illuminated using genetic markers. Further, molecular methods are an emerging crime investigation tool for monitoring the turtle trade. Despite these applications and the inherent importance of genetic diversity to long-term viability of turtle populations, there is a general paucity of such genetic studies on freshwater turtles and tortoises (Fitzsimmons and Hart, 2007).

Due to lack of studies, there is a limited repertoire of molecular markers currently available for turtle geneticists (Engstrom et al., 2007). With the ongoing genomic revolution the number of available markers, their information content, and range of applications for chelonian conservation will increase. For example, new genomic approaches offer exciting possibilities to investigate whether variation within specific gene regions can be tied to phenotypic or other traits that are tied to probabilities of survival or reproductive success. Emerging technologies hold great promise to link increasingly assessable modern technology to fundamental problems in turtle biology and conservation. Other technological advancements will enhance efficiency of DNA fingerprinting and enable high through put analyses, such as SNPs (single nucleotide polymorphisms) and microarrays (McGaugh et al., 2007).

Confiscated Turtles

Practical difficulties result from confiscation of live turtles. Necessary facilities and resources to house and care for the animals are also needed. The eventual destiny of such animals should be decided with reference to the IUCN Draft Guidelines on Placement of Confiscated Animals (2002). Confiscated animals may also contribute to conservation breeding programs. It is reasonable to insist that those responsible for illegal or inappropriate shipments will cover the costs of efforts to solve these problems.

Review of CITES Listing

Review of freshwater turtle species status on Appendices I or II of CITES and IUCN Red Data List (2005) is an action to be considered. The justification of review for turtle species in CITES Appendix is based on the criteria of trade shifts in the region. By listing Non-CITES turtles such as *Herdella thurgii* as the case in Pakistan in at least CITES Appendix II, every traded turtle needs to be accompanied by appropriate documentation and it becomes much easier for the authorities of both source and consumer countries to insist on the required documents.

CITES listing of all turtles will not solve the turtle trade problem on its own. It will, however, result in a much more straightforward situation for inspection and enforcement authorities: if you are trading turtles, you would need to show documents. Identification of Appendix-I species in commercial trade is much more likely when every shipment of turtles is documented and inspected.

Community Awareness

Public awareness and education are important tools in any long-term conservation strategy. Culturally and emotionally, unsustainable trade leads to the loss of a group of species from peoples' daily lives, customs and conceptual world, thus leaving a poorer world for their children.

Unlike many other topics that people in our country love to discuss around chai-time, protection of wildlife, and in this case turtles, has never gained popularity. The result of our collective social apathy towards the issue has resulted in significant loss of wildlife, and endangerment of precious species.

Outreach programs need to be developed to highlight the magnitude of the turtle trade and its consequences to the community. In collaboration with media, schools and other institutions popularized campaigns that boost awareness in all sectors of the community are also handful.

Conclusion

Set of serious threats faced by freshwater turtles in the country is resulting in mass level decline in turtle fauna. Illegal hunting in specific is having detrimental effects on already threatened populations. Financially, short-term exploitation of a limited resource with very slow recovery is inappropriate, particularly since local collectors gain very little financial benefit from selling off their resources and compromise their options for sustainable developments like eco-tourism or perhaps wildlife ranching. Ecologically, the role of Asian turtles is almost unknown and it will be close to impossible to ever obtain that knowledge or restore this role once a species has disappeared from the wild. Turtles can serve as a focal point in general conservation awareness programs. Conservation can be presented on television and integrated in global marketing and donor aid programs. Turtles must be portrayed as a conservation priority, as animals with an intrinsic value to share the Earth, not just a commodity to be exploited. Strict law enforcement is the prime step to be taken in order to protect the existing turtle population. Studies on turtle ecology and wildlife trade monitoring are the issues needed to be dealt effectively. Provincial Wildlife Departments, Federal wildlife Conservation Agencies, WWF Pakistan and IUCN can play key role in conservation efforts. Community based conservation programmes and alternative livelihood opportunities are also needed to minimize the pressure on natural turtle population.

References

Aresco, M.J. 2005. Mitigation measures to reduce highway mortality of turtles and other herpetofauna at a north Florida lake. J. Wildl. Manage. 69: 549-560.

Asian Turtle Trade Working Group, 1999. Report from the Workshop held 1–4 December 1999, Phnom Penh, Cambodia, under sponsorship of the World Wildlife Fund, the Wildlife Conservation Society, and TRAFFIC USA.

Baig, K. J., 2005-2006. Environmental Baseline Survey and Monitoring of Taunsa Barrage Emergency Rehabilitation and Modernisation Project: A report submitted to Zoological Science Department, Pakistan Museum of Natural History. pp 22

Carol Browne, 2009. Impacts of urbanisation and metal pollution on freshwater turtles, http://ses.library.usyd.edu.au/handle/2123/4009, accessed on October 16th, 2011

Congdon, J. D., and Gibbons, J. W. 1996. Structure and dynamics of a turtle community over two decades. In: Long-term Studies of Vertebrate Communities.

Congdon, J. D., Dunham, A. E. and Van Loben Sels. R. C. 1993. Delayed sexual maturity and demographics of Blanding's turtles (Emydoidea blandingii): implications for conservation and management of long-lived organisms. Conservation Biology. 7:826-833.

David A. Steen and Lora Smith. 2006. Road surveys for turtles: consideration of possible sampling biases. Herpetological Conservation and Biology 1(1):9-15

Engstrom, T.N., Edwards, T., Osentoski, M.F., and Myers, E.M. 2007. A compendium of pcr primers for mtdna, microsatellite, and other nuclear loci for freshwater turtles and tortoises. Chelonian research monographs no. 4, PP. 124-141.

Fratto, Z. W., Barko, V. A. and Scheibe, J. S., 2008. Development and efficacy of a bycatch reduction device for Wisconsin-type fyke nets deployed in freshwater systems. Chelonian Conservation and Biology 7:205–212.

Forman, R. T. T., Alexander, L. E. 1998. Roads and their major ecological effects. Annual Review of Ecology and Systematics 29, 207–231.

Frid, A. and Dill, L. M. 2002. Human-caused disturbance stimuli as a form of predation risk. Conservation Ecology 6(1): 11

Fitzsimmons, N. N. and Hart, K. M. 2007. Genetic studies of freshwater turtles and tortoises: a review of the past 70 years. Chelonian research monographs no. 4, pp. 15-46.

Ghislaine Guyot & Jean Clobert, 1997. Conservation Measures For A Population Of Hermann's Tortoise Testudo Hermanni In Southern France Bisected By A Major Highway, Biological Conservation, 251-256

Gibbons, J. W., Scott, D. E., Ryan, T. J., Buhlmann, K. A., Tuberville, T. D., Metts, B. S., Greene, J., Mills, T., Leiden, Y., Poppy, S., Heppell and S. S. 1998. Applications of life history theory and population model analysis to turtle conservation. Copeia 1998: 367-375.

Gong S., Jichao, W., Haitao, S., Riheng, S. and Xu Rumei (2006). Illegal trade and conservation requirements of freshwater turtles in Nanmao, Hainan Province, China. Oryx, 40 , pp 331-336

Heppell, S. S. 1998. Application of life-history theory and population model analysis to turtle conservation. Copeia. 1998:367-375.

Hassan, M. S., Raoof, A., Shadid, M. A., Skogerboe, G. V., ur-Rehman, S. and Aslam, M. 1999. Monitoring andevaluation of agro-economic benefits and project impact for Fordwah eastern Sadiqua (South) irrigation and drainage project. Watercourse monitoring and evaluation directorate, WAPDA.

IUCN. 2002. Guidelines for the placement of Confiscated Animals. Prepared by the IUCN/SSC Re-introduction Specialist Group, IUCN, Gland, Switzerland and ERWDA, Abu Dhabi, UAE, 24 pp.

IUCN. 2005. IUCN red list of threatened species. Ver. 2005. 2. http://www.iucnredlist.org/. Accessed 13 December 2009.

IUCN. 2010. IUCN red list of threatened species. Ver. 2010. 1. http://www.iucnredlist.org/. Accessed 21 March 2010.

Khaskheli, J., October 20, 2008. Freshwater turtle endangered by drought http://www.thenews.com.pk/daily_detail.asp?id=142038 accessed on December 16th, 2011

Klemens, M. W. (ed.), 2000. Turtle Conservation, Smithsonian Institution Press, Washington.

Marchand, M. N. and Litvaitis, J. A. 2004: Effects of habitat features and landscape composition on the population structure of a common aquatic turtle in a region undergoing rapid development. Conserv. Biol. 18: 758-767.

McGaugh, S. E., Alacs, E. A., Edwards, S. V., Feldman, R., Georges, A., Sites, J. W. Jr. and Valenzuela, N. 2007. From molecules to organisms: research applications of modern genetic tools for turtle biology and conservation. Chelonian research monographs no. 4, PP. 47-72.

Michele Collet. 2012. 10 Most Endangered Turtles on Earth http://www.environmentalgraffiti.com/news-10-most-endangered-turtles

Noureen, U. 2007. A Preliminary visit to Dera Ismail Khan to assess the status of freshwater turtles of Pakistan (unpublished Report). Pakistan Wetland Programme, Pakistan: 1-23.

Ramsar Convention on Wetlands. 2003. Annotated Ramsar List: Pakistan. Ramsar Convention Secretariat: Gland, Switzerland.

Reed, R. N., Congdon, J. D. and Gibbons, J. W. 2002. The alligator snapping turtle [Macrochelys (Macrochelys) temminckii]: a review of ecology, life history, and conservation, with demographic analyses of the sustainability of take from wild populations, p. 17. Savannah River Ecology Laboratory, Aiken SC.

Schlaepfer, M. A., Hoover, C. and Dodd, C. K. Jr. 2005. Challenges in evaluating the impact of the trade in amphibians and reptiles on wild populations. Bioscience 55(3): 256-264.

Turtle Conservation Coalition (Rhodin, A.G.J., Walde, A.D., Horne, B.D., van Dijk, P.P., Blanck, T. and Hudson, R. Eds.). 2011. Turtles in Trouble: The World's 25+ Most Endangered Tortoises and Freshwater Turtles—2011. Lunenburg, MA: IUCN/SSC Tortoise and Freshwater Turtle Specialist Group, Turtle Conservation Fund, Turtle Survival Alliance, Turtle Conservancy, Chelonian Research Foundation, Conservation International,

Wildlife Conservation Society, and San Diego Zoo Global, 54 pp.

Turtle Conservation Fund. 2002. A Global Action Plan for Conservation of Tortoises and Freshwater Turtles. Strategy and Funding Prospectus 2002–2007. Washington, DC: Conservation International and Chelonian Research Foundation, 30 pp.

van Dijk. 2010. Status of the World's Tortoises and Freshwater Turtles, global conservation strategy, pp1.

van Dijk, Peter Paul, Bryan L. Stuart and Anders G. J. Rhodin (eds). 2000. Asian Turtle Trade: Proceedings of a Workshop on Conservation and Trade of Freshwater Turtles and Tortoises in Asia. Chelonian Research monographs, Number 2. 164 pp.

World Resource Institute. 2003. Watersheds of the World_CD. The World Conservation Union (IUCN), the International Water Management Institute (IWMI), the Ramsar Convention Bureau, and the World Resources Institute (WRI): Washington, DC. http://multimedia.wri.org/watersheds_2003/index.html

WWF. 2005. An Overview of Glaciers, Glacier Retreat and Subsequent Impacts in Nepal, India and China. WWF Nepal Program: Kathmandu,Nepal.

Zuberi B. February 25, 2007. Pakistani Turtles in Danger, http://pakistaniat.com/2007/02/25/pakistani-turtles-in-danger/ accessed on January 6th, 2012

Feeding effect of Rutaceae host plant species on the developmental behaviour of common mormon *papilio polytes* L., female forms *papilio polytes* f *cyrus* and *papilio polytes* f *stichius* (Lepidoptera:papilionidae) in Lower Sindh, Pakistan

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Abstract
The consumption of host plants of family Rutaceae, i.e. Curry leaf and eight different varieties of citrus plants by common mormon *papilio polytes* L. female forms *Papilio polytes* f. *cyrus and Papilio polytes* f. *stichius* and their effects on larval and postlarval development were studied at Tando Mohammad Khan, Lower Sindh during the period February to November 2002. Ingestion of different types of food showed significant effect on growth rate, food utilization and reproductive potential of the pest. It was observed that the growth index value of *P. polytes* f. *cyrus* and *P. polytes* f. *stichius* was highest being 5.333-6 in Curry leaf (*Murraya koenigii*) followed by citrus willow leaf (*Citrus reticulate*) being 4.375-5.161, in Kaghzi lime (*Citrus aurantifolia christm*) 3.636-5.03, in Common jamberi (*Citrus limonia*) being 3.75-3.87 and minimum in orange Washington (*Citrus sinensis*) 3.125 - 3.030, on the bases of (Growth Index Value) the host plant preference, oviposition larval survival, percentage of pupation, adult emergence and survival of adults. The sequence of curry leaf and different citrus varieties are: Curry leaf *Murraya koenigii*, Citrus willow leaf *Citrus reticulate*, Citron *Citrus medica*, Kaghzi lime *Citrus aurantifolia* Christm, Sweet lime *Citrus aurantifolia* Swingle, Common jamberi *Citrus limonia*, Eureka lemon *Citrus limon* and Orange Washington *Citrus sinensis*.

Key Words: *Papilio Polytes* f *cyrus* and *P. polytes* f *stichius*, curry leaf, citrus varieties, developmental behavior

Introduction

Papilio polytes L., is commonly called the common mormon butterfly *Papilio polytes* Linneaus (1758) described the males as black with forewings having white marginal spots and hind wings with a white post dorsal band and a distinct tail. Females are polymorphic exhibiting three distinct forms, of those, the f *Cyrus* only resembles the male whereas f *stichius* having white dorsal patches on hind wings and f *romulus* having red distal patches on hind wings and appears quite different (Srivastava and Ahlawat, 1999; Roberts, 2001). *P. polytes* is distributed almost all over Asia having a number of races (Abreral, 1990). It is a serious pest of curry leaf and citrus plantation in Pakistan (Malik, 1970). *P. polytes* is found commonly throughout Islamabad and Rawalpindi, during April to September (Rafi et al., 1999). This Papilio is found in many countries including Pakistan. It extends in the east to India and China, in the west to Iran and in the south to Adfrica (Duport, 1913). In Pakistan, *Papilio polytes* has three female forms i.e., *Papilio polytes* f *cyrus*, *Papilio polytes* f *stichius* and *Papilio polytes* f *romulus* (Malik, 1970; Roberts, 2001). *Papilio polytes* is the pest of citrus and commonly found in Pakistan, India and China (FAO, 1970; 1972). The *Papilio polytes* is polymorphic and has four morphs forms whereas the male is always monomorphic. These forms are described as f *cyrus,* f *polytes,* f *romulus* and f *theseus*, one form of the female f *cyrus* only resembles the male, pest are foliage feeder and prefer newly leaves of curry leaves and citrus plants, their fifth instars larvae are vigorous foliage feeder and its sever infested plants become very weak (Uesugi, 1991). Pest is commonly found in plains and their caterpillars are foliage feeder and prefer blossoms and young nurseries of curry leaf and citrus plants (Roberts, 2001). The pest is active almost throughout the year and the larvae are vigorous foliage feeders of curry leaf and citrus plants. In case of sever infestation, trees are seriously affected and the young seedlings become completely defoliated. In Pakistan the highest population of *P. Polytes*, female forms *P. polytes* f *cyrus*, *P. polytes* f *stichius* and *P. polytes* f *romulus* is found during and after the monsoon (Ayyar, 1940). It is imperative to know that the food preference of this pest is based on the rate of food intake, indigestibility and efficacy of conversion of ingested food into body biomass. These parameters give an idea about the utilization efficiency of pest species with a view to know the preferential food habits. Margabandhu (1933) while

studying the host plants and host preference of *P. polytes* forms reported that the larvae consumed all the citrus varieties. Waldbauer (1968) described the methods including consumption index, relative growth rate, approximate digestibility and efficiency of conversion of digested food to body biomass. Finke and Scriber (1988) observed influence of host plants play major role in the larval growth of closely related *Papilio* species. Pipatwatanakul (1979), Gangwar and Singh (1989) studied different developmental stages of *P. demoleus* on different varieties of citrus. From Thailand and India Matsumoto and Noerdjito (1996) reported immature stages of *P. demoleus* and from Java and Indonesia on different citrus varieties including *Citrus hystrix*, *Citrus aurantifolia* Swingle and *Citrus ambiyocarpa* Ochse. Roberts (2001) reported *Papilio polytes* and *P. demoleus* larvae on citrus plants. Lime and Pomelos are mostly preferred but they also feed on *Zizyphus* and other members of Rutaceae family such as *Ruta gravealus* and *Glyeosims pentaphylla.* Herbison (2002) reported that *P. polytes* feed on curry leaf and citrus plants. Suwarno (2009) noted the effect of family Rutaceae as the host plant on *Papilio polytes* Larvae. Suwarno et al. (2007) observed the effect of different host plants on the life cycle of *Papilio polytes*. Suwarno et al. (2010) also reported the oviposition preference on selected host plants by *Papilio polytes*. The aim of the present study was to know the host preference and their effects on biology and developmental behavior of common mormon (*Papilio polytes)* which were fed curry leaf and different citrus varieties available in the lower Sindh of Pakistan.

Material and Methods

The rearing of Common mormon, *Papilio polytes* L., was successfully performed, in semi natural condition of wooden cages of size 10x15x10 feet, covered with nylon net, and placed in the natural environment at Tando Muhammad Khan Lower Sindh. The selected 10 pairs of each female forms *P. polytes* f *cyrus* and *P. polytes* f *stichius*, were transferred for rearing in two wooden cages that have grown their host plants; the Curry leaf *Murray koenigii* and eight varieties of citrus plants Citrus willow leaf *Citrus reticulata* Blanco, Citron *Citrus medica* L., Khatta Root Stock *Citrus aurantium*, Kaghzi Lime *Citrus aurantifolia* Chirstm, Sweet Lime *Citrus aurantifolia* Swingle, Common Jamberi *Citrus limonia* L., Eureka lemon *Citrus limon* L., and Orange Washington *Citrus sinensis* L. The plants were planted in soil and also some in the pots. Five plants of one meter height belonging to each variety were selected for the experiment. The plants were placed randomly in a free choice environment for the species. Seasonal flowering plants were also planted and honey solution was provided as the food supplement. The adults activity observations were taken daily by counting the numbers of eggs laid by the ten pairs of butterflies of each form on their favorite host plants. For the observation of development behavior, the larvae were collected from the respective plant varieties and transferred to the plastic jars of size 15x12x6cm, larvae were provided the respective host plant leaves twice a day. The various aspects of the host preference i.e. larval period, larvae pupated, browth index value, pupal period, adult emergence, adult sex ratio, adult longevity were observed on curry leaf and eight different varieties of citrus plants.

Results and Discussion

Selected host plants preference on curry leaf and eight different varieties of citrus plants by *Papilio polytes* was more on those plants which had newly emerged leaves and buds. These plants preferred by *Papilio polytes* female forms, were encountered as most favorable giving higher productivity rate of eggs, larvae and pupae. The data presented in table (1 and 2) shows number of eggs laid, mean larval duration, number of larvae pupated, growth index value, pupal period, number of pupa emerged, sex ratio and longevity in days in relation to different host plants. The growth trend of *Papilio polytes* f *cyrus* shows (table 1) that curry leaf (*Murraya koenigii*) was recorded as highest growth index value 5.333 followed by *Citrus reticulate* Blanco being 4.375, in *Citrus aurantifolia* Christm 3.636, in *Citrus limonia* being 3.75 and minimum in *Citrus sinensis* L. 3.125. On the basis of growth index value the host preference of *P. polytes* f *cyrus* is as follows as *Murraya koenigii* > *Citrus reticulate* Blanco > *Citrus medica* L. > *Citrus aurantrium* L. > *Citrus aurantifolia* christm > *Citrus aurantifolia* Swingle > *Citrus limonia* L. > *Citrus limon* L. > *Citrus sinensis* L., while in case of *Papilio polytes* f *stichius* (table 2), the relation indicates that curry leaf (*Murray koenigii*) was recorded producing highest growth index value 6.0, followed by Citrus willow leaf (*Citrus reticulate*) 5.161, Kaghzi lime (*Citrus aurantifolia* christm) 5.0, Common jamberi (*Citrus limonia*) 3.870, and minimum in Orange Washington (*Citrus sinensis*) 3.030. On the basis of the growth index value the host preference of larvae of *P. polytes* f *stichius* was found as like the following sequence,

Murraya koenigii > *Citrus reticulate* Blanco > *Citrus medica* L. > *Citrus aurantium* L. > *Citrus aurantifolia* Christm > *Citrus aurantifolia* Swingle > *Citrus limonia* L. > *Citrus limon* L. > *Citrus sinensis.* The above observation indicate that shorter the larval period greater is the number of larvae pupated and higher the growth index value. Further, it was also seen that the number of pupae emerged were highest in curry leaf and lowest in Orange Washington. This study evaluates that *P. polities* lays eggs on curry leaf as well as all varieties of citrus plants but their numbers and duration of life cycle are different. Duport (1913) reported short life cycle on curry leaf, and citrus plants (*Citrus reticulate Citrus medica, Citrus aurantium, Citrus arantifolia, Citrus sinensis*) and identified citrus trees were highly attacked by *P. polytes*). The values of the present study are very closely similar to those of Deport (1913) and Margabandhu (1933). They have found *P. polytes* as serious pest on orange plant while we have observed *Citrus reticulate* was the highest attacked plant. The attack of *Citrus medica* on *P. polytes* f *cyrus* and *P. polytes* f *stichius* shows the features presented by Margabandhu (1933) and Roberts (2001). They reported that *P. polytes* breeds on all the species of family Rutaceae, citrus and curry leaf. In the present study, the *Papilio polytes* rearing was conducted on curry leaf and eight different varieties of citrus plants that confirm the effects of Roberts (2001). It was also noted that the consumption and utilization of different host plants by the pests have major influence on survival and duration of life stages and adult emergence. The third female form's (*P. polytes* f *romulus*), host preference was not noted due to insufficient number of female adults emergence during the rearing of *Papilio polytes.*

References

Ayyar, T. V. R. 1940. Handbook of Economic Entomology for South India. Govt Press, Madras, 302pp.

Abreral, B. D. 1990. The butterflies of Australian region craft. Pri. Ltd. Sing., 392pp.

Duport, L. 1913. Notes on certain diseases and enemies of cultivated plants in the Far Eeast, Rev. App. Ent. Ser. A2:490

FAO. 1970. Report to the government of the countries of the Near East and North Africa on the citrus production problems in Near East and North Africa based on the work of H. Chapol. Report UN Develop. Programme. 95pp.

Table 1: Growth index value of developmental stages of P. polytes f cyrus to curry leaf (Murraya Koenigii) and eight different varieties of citrus plants

Scientific/Common Name of Host Plants	Mean Larval Period (days)	No of Larvae % Pupated	Growth Index Value	Pupal Period (days)	No of pupa Emergence	*P. polytes* (Male)	*P. polytes* f *stichius*	*P. polytes* f *cyrus*	*P. polytes* f *romulus*	Survival %
Murraya koenigii (Curry leaf)	15	90	6	12.5	80	40	30			70
Citrus reticulate Blanco (Citrus willow leaf)	15.5	80	5.161	13	70	20	30	10		60
Citrus medica Linn (Citron)	15.5	80	5.161	12	70	20	40			60
Citrus aurantium Linn (Khatta root stock)	15.5	80	5.161	13	60	30	20			50
Citrus aurantifolia Christm (Kaghzi lime)	16	80	5	13	60	10	30		10	50
Citrus aurantifolia Swingle (Sweet lime)	16	60	3.87	12	50	30	20			50
Citrus limonia Linn (Common jamberi)	16	60	3.87	13.5	60	20	30			50
Citrus limon Linn (Eureka lemon)	16	50	3.03	12	40	10	30			40
Citrus sinensis Linn (Orange Washington)	16	50	3.03	13.5	30	20	20			40

Table 2: Growth index value of developmental stages of *P. polytes* f *stichius* to curry leaf (*Murraya Koenigii*) and eight different varieties of citrus plants

Scientific name of host Plants	Common name of host Plants	Total No of Larvae	Mean Larval period (days)	No of Larvae %Pupated	Growth Index value	Pupal period (days)	No of pupa emergence	P. polytes (Male)	P. polytes f. stichius	P. polytes f. cyrus	P. polytes f. romulus	Survival %
Murraya koenigii	Curry leaf	10	15	90	6.0	12.5	80	30	50			80
Citrus reticulate Blanco	Citrus willow leaf	10	15.5	80	5.161	13	70	20	50			70
Citrus medica Linn	Citron	10	15.5	80	5.161	12	70	40	30			70
Citrus aurantium Linn	Khatta root stock	10	15.5	80	5.161	13	60	20	20	20		60
Citrus aurantifolia Christm	Kaghzi lime	10	16	80	5.0	13	60	20	40			60
Citrus aurantifolia Swingle	Sweet lime	10	16	60	3.870	12	50	30	20			50
Citrus limonia Linn	Common jamberi	10	16	60	3.870	13.5	60	30	20	10		60
Citrus limon Linn	Eureka lemon	10	16	50	3.030	12	40	10	30			40
Citrus sinensis Linn	Orange washington	10	16	50	3.030	13.5	30	10	20			30

FAO. 1972. Report to the government of Saudi Arabia on research in plant protection based on the work of H. E. Martin, Report UN Develop. Programme.

Finke, M. D. and Scriber, J. M. 1988. Influence on larval growth of the eastern black swallowtail butterfly *Papilio polyxenes* (Lepidoptera:Papilionidae) of seasonal changes on nutritional parameters of Umbelliferae species. American Midland Nat. 119 (1):45-62.

Gangwar, S. K. and Singh, Y. P. 1989. Consumption and utilization of different citrus species by *Papilio demoleus* L. Nutri Ecol. Ins. and Env. 171-177.

Herbison, D.E. 2002. *Papilio demoleus* papilionidae(donherbisonevons@yahoo.com)

Khan, A. R. 1940. Insect pest number, Punjab Agriculture College, Lyallpur, Punjab Fruit Journal. 13:40-41

Linnaeus, C. 1758. Systema Nature, Edition X: 464pp.

Malik, J. M. 1970. Notes on the butterflies of Pakistan in the collection of Zoological Survey Department, Karachi, Part 1. Rec. Zool. Surv. Pakistan. 2 (2):25-54.

Margabandhu, V. 1933. Insect pest of orange in northern Ciereas. Rev. App. Ent. Ser. A.21:502

Matsumoto, K. and Noerdjito, A. 1996. Establishment of *Papilio demoleus* L. (Papilionidae:Lepidoptera) in Java. J. Lepidopterous Society, 50(2)139-140.

Pipatwatanakul, A. 1979. Ecological investigation on the lemon butterfly *Papilio demoleus* L. (Lepidoptera:Papilionidae) and its natural enemies in Thailand. MS Thesis, Kasetsart University, Bangkok, Thailand. 50pp.

Rafi, M. A., Khan, M. R., IIyas, M. and Safdar, M. 1999. Distribution and diversity of genus *Papilio* (Lepidoptera Papilionidae) in Rawalpindi and Islamabad Pak. J. Sci., 51(1-2)

Rafi, M. A. and Khan, M. R. 1999. Host preference of lemon butterfly, *Papilio demoleus* L. in the North Barani area of Pakistan. Pak. J. Sci. Res., 51:3-4.

Roberts, T. J. 2001. The butterflies of Pakistan. Oxford University Press, Karachi.180 pp.

Srivastava, K. P. and Ahlawat, Y.S. 1999. Pest management in citrus Research Periodicals and Book Publishing House, India. 320pp.

Suwarno, S., Che Salmah M. R., Abu Hassan, A. and Norani, A. 2007. Effect of different host plants on the life cycle of *Papilio polytes* (Lepidoptera:Papilionidae) Common mormon butterfly. Journal Biosains, 18 pp 35-44.

Suwarno, S. 2009. Larval performance of *Papilio polytes* L. (Lepidoptera:Papilionidae) on four Rutaceae host plant species. Journal Natural 91. pp. 45-49.

Suwarno, S., Che Salmah M. R. and Abu Hassan, A. 2010. Oviposition preference of swallowtail butterfly. *Papilio polytes* (Lepidoptera:Papilionidae) on four Rutaceae (Sapindales) host plants species. Insect Science 17 pp 369-378.

Talbot, G. 1939. The Fauna of British India, Butterflies, Vol.1, Covers Papilionidae and Pieridae, Taylor and Francis Ltd., London. 600pp.

Uesugi, K. 1991. Temoral changes in records of the mimetic butterfly *Papilio polytes* with establishment of its model *Pachliopta aristolochiae* in Ryukyu Island Japan, Department of Biology, University of the Ryukyus, Nishihara, Okinawa, Jap. J. Ento. 59(1):183-198.

Waldbauer, G. P. 1968. Consumption and utilization of food by insects. Adv. Insect Physiol. 5:229-288.

Rec. Zool. Surv. Pakistan 20:83-91 (2011)

Ethnobotany of Kala-Chitta Hills, district Attock, Punjab, Pakistan

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Abstract
The objective of the study was to document the wealth of medicinal plants and report the ethno-botanical potential of the Kala Chitta Hills (Salt Range) of District Attock, Pakistan. Thirty-nine Medicinal plants species of salt range belonging to 19 families have been reported. Awareness raising and training of the communities for conservation, and phyto-chemical studies of medicinal plants are recommended.

Key Words: Ethnobotany, Indigenous knowledge, Local people, Medicinal plants, Kala-Chitta, Pakistan

Introduction

Plants have always been more important than politics human race today and in the history. Even today, millions of subsistence farmers have no idea who their nominated political leaders are, but they know a great deal about their plants – sometimes even more than scientists. Furthermore, plants have had a greater historical impact than politicians. In Pakistan what the western world would identify as Herbal medicine is referred to as *Unani* (Greek) medicine. This system of medicine was introduced by the Greco-Arabic society, who based many of their theories and remedies on Ayurveda, a practice using medicinal plants dating back to approximately 2,500 BC (Sher, 1998). "Ethnobotany is the study of how the people of a particular culture and region make the use of indigenous plants" (WWF, 2012).

Ethno-medicinal study is the most important approach to follow the natural resource management by indigenous people. It is a multidisciplinary science of botany, ecology and anthropology. This multidisciplinary approach gives more insight into the management of medicinal reserves in a period of tremendous environmental stress. Unfortunately due to the human factors, which have influenced the ecological balance of these delicate ecosystems, we are presently faced with possibility of losing our forests. Actually plants play their role in existence of life on this planet. This is a complex work where an ethno-medicinal study can bridge the social and natural world separated so much in education and professional training. All aspects of people-plant relationship should be studied in relation to sustainable management of this golden gift of God (Ibrar, 1998).

Keeping this in view, the ethno-medicinal survey was carried out in Kala-Chitta hills of District Attock and to collect information about the hitherto undocumented medicinally important plants.

Study Area

District Attock lies between 33°- 7' and 34°- 0' North latitude and 71°- 45' and 73°- 0' East longitude. It is bounded on the North and West by the River Indus and in the East by Haripur and Rawalpindi districts while in its South lies the Chakwal district (GoP, 1984; Anonymous, 1998). The rainfall as a whole is scanty and uncertain. Its yearly distribution is even worse. The annual average rainfall in the Attock district is 409.09mm (GoP, 1968). The mean maximum temperature in January is 17.92°C and the mean minimum January temperature is 3°C. The mean maximum June temperature is 41°C and minimum is 38°C (GoP, 1968).

Kala-Chitta hills are among the most important hills of district Attock. This wall of hills, which runs across the northern part of the district and cuts off the Attock Tehsil from the other Tehsils is a rough wedge with its base resting on the Indus and gradually tapering as it proceeds eastward till it dies away on the border of the Fatehjang and Rawalpindi District, about 26 km north west of Rawalpindi Cantonment and within about 5 km of the western extremity of the Margalla mountain range. Its breadth at its base is about 20 km and its

length is 77 km. The hilly tract is formed of two portions; the southwestern portion is known as the Kala Pahar or Black mountain and on its northern side lies the Chitta, or White hill differing very much in appearance from each other. Its structure is, therefore, of considerable geological interest (Garbett, 1995).

Material and Methods

A questionnaire was devised to identify the knowledge of rural people about the collection of plants and their ethno-medicinal uses within the community. Several expeditions were made from August to November, 2011 and from February to May, 2012. The fieldwork is based on interviews and transect walks. Available literature, surveys, general meetings, and direct observations during transect walks added to information required for the study.

One of the methods used during the fieldwork was face to face interviews and filling of questionnaires. For this purpose a sample of 100 informants from local people including hakims and medicinal businessmen were interviewed for collection of ethno-medicinal data through the questionnaire. The ethno-medicinal profile of the area was studied by frequent surveys of Kala-Chitta hills and surrounding villages.

During the study general meetings were held, wherever possible, attended by both male and female members of community, resource persons, local hakims, collectors and sellers of medicinal herbs to reconfirm validity of information collected during individual interviews.

The plants collected in wild from different sites of Kala-Chitta hills were dried, preserved and identified with the help of Flora of Pakistan (Nasir & Rafiq, 1995). Confirmation of taxonomy of collected plants was carried out in the herbarium of Quaid-i-Azam University, Islamabad. After identification the plants were deposited as voucher specimens for further references in the herbarium.

Results and Discussions

Results of the present investigation are based on 39 medicinally important plant species belonging to 19 families of Angiosperms. The well represented families were *Acanthaceae, Apocynaceae, Asclepiadaceae, Asteraceae, Brassicaceae* and *Leguminoseae* (details in Table 1).

The availability of medicinal plants studied was maximum in Spring (50%) followed by Winter and Summer season (20% each) and least in Autumn (only 10%).

The interviews with various age groups for their knowledge of medicinal plants showed that older people possessed maximum understanding regarding the utility of medicinal uses of local plants (55%) followed by the elder (30%), and the youngs (15%). Most of the people interviewed (both local and Hakims) were over the age of 50 years. Their existing knowledge had passed on from past generations. It is very essential that this knowledge should be documented and updated according to the modern requirements. This will not only help to make the life of the people of remote areas easy but will also pass on useful knowledge to those who are interested in finding new sources of drugs from the plants. Local people can provide information about economically important and very useful plants of the area which could otherwise be missed from taxonomists during their plant collection trips.

Medicinal plants were used by all old people (above 60 years of age) for various treatments as they were reluctant to consult doctors for medication. About 50% of the age group of 30-60 years used the local medicinal plants and were always ready to consult doctors. Only 20% people in the age group of 15-30 years used local medicinal plants and were fond of consulting doctors while the children of less than 15 years age had 50% chances of either utilizing local plants or consulting a doctor depending upon the decision of the elders.

About 85% locals and 15% visitors utilized the local medicinal plants as medicines. As the source of transfer of this knowledge is oral and not written in these areas, there is always a danger of losing any of the useful traditional information during communication. Another difficulty for the older generation is to pass their knowledge to younger generation due to generation gap. So it is really urgent to share the indigenous knowledge with every member of society for the benefit of mankind. We have to preserve this knowledge in written form so that everybody can take benefit from it when and as required (Ambara, 2001).

All the available medicinal plants resources of the Kala-Chitta hills serve the local community as there is deficiency of local trained medical manpower and

practioners from other areas are reluctant to work in this remote area. Therefore, the widespread use of folk herbal remedies appears to be not only a case of preference but also of a situation without any alternative. Such a system of medical treatment upon which the majority of the population has been relying for generations with considerable success, should not be overlooked for further medical investigations.

Some efforts have been made to asses the possibility of grafting *Olea europea* (Olive) on the native *Olea ferruginea* (Kao) to make it more profitable and sustainable species for the local people. In this regard experimental trials have already been done at National Agricultural Research Center, Islamabad. It was found successful but the results are still not practically applied in the area .This should be practically applied in the area as the Kao is deteriorating day by day due to excessive illegal cutting. *Peganum hermal* (Hermal) had an extra-ordinary growth in the area. This is damaged by the visitors of Khyber Pakhtunkhwa Province, resulting in its stunted and scanty growth. Efforts should be made for its proper exploitation through protection .This will not only make it available for us when and as required but will also help to restore these species and local ecosystem.

Other species like *Withania coagulans* (Axoan), *Adhatoda vesica* (Bhekkar), *Argyrlobium roseum* (Makkhi booti) and *Sesamum indicum* (Til) etc. can provide tremendous benefits if protected. Proper markets should be explored for the economic utilization of the products of the medicinal plants so that people can earn additional income from these plants. Involvement of economic factor will also encourage the people to pay attention towards sustainable management of the plants. Further investigations, phytochemical as well as pharmacological, should be made in such potentially important areas to provide basis to medicine industries to earn foreign exchange.

Studies on traditional medicinal plants revealed that the local people prefer folk medicine not only due to low cost but as part of their social life and culture. So it is necessary to acquire and preserve this traditional system of plant utilization by proper identification and documentation. Due to increase in population, demands of these plants increases, causing great pressure on the products of the area. This continuous pressure for last few decades has damaged the natural characteristic of ecosystem of the area.

Conclusion

Results of the present investigation were based on 39 medicinally important species. Besides their major utilities like apiculture, sericulture, food and fruits etc. these plant species have other benefits too. The survey indicated that the study area has plenty of medicinal plants to treat a wide spectrum of human ailments. Thus there is a need to raise awareness of local people regarding these plants and to provide them training in collection and processing of the plants and their parts for economic benefits and conservation of species and ecosystem.

References

Ambara, K. 2001. Ethnobotanical Potential, Phyto-sociology and Conservation Status of Mountain Elum, Buner. Department of Biological Sciences, Quaid-e-Azam University, Islamabad, Pakistan, 2001. pp : 1-5.

Anonymous. 1998. District Census Report of Attock.

Garbett, H.G.1995.The Attock Gazetteer. Government of Pakistan, Islamabad 1995. pp.10-15, 28-37, 68-83.

GoP. 1984. Economic Survey Report. Government of Pakistan, Islamabad, pp.53-57.

GoP. 1968. Reconnaissance Soil Survey of Attock. Government of Pakistan, Karachi. pp. 45-46.

Ibrar, M. 1998. Ethnobotanical Studies of Margalla Hills National Park Islamabad, Pakistan 1998. Department of Biological Sciences, Quaid-i-Azam University, Islamabad, Pakistan 1998, pp. 1-5, 28-31, 47-76, 125-131.

Nasir, Y. J. and Rafiq, R. A. 1995. Wild Flowers of Pakistan. Edited by T. J. Roberts, Oxford University Press, Karachi: pp.298.

Sher, H. 1998. Marketable value of the wild medicinal plants and their propagation on large scale in upper Swat valley. ERP report No. 2. 8, Pakistan.

WWF. 2012. What is Ethnobotany? http://www.wwfpak.org/ethno_whatis.php (Retrieved in October, 2012)

Table 1. Medicinal Plants

(i) Acanthaceae

1. Botanical Name = *Adhatoda zylanica* L
   Local Name = Bhekkar
   Part use = Leaves and flowers
   Flowering Period = March-April
   Voucher Specimen No = 1
   Uses = Leaves are used for cough and wounds in the crushed form. They are also used in dysentery, specially in cattles.

(ii) Amaranthaceae

2. Botanical Name = *Achyranthes aspera* Linn.
   Local Name = Puthkanda.
   Part use = Roots, Leaves and Stem.
   Flowering Period = September-April
   Voucher Specimen No = 5
   Uses = Decoction in water is used for asthma, cough, stomach pain, dropsy, piles and skin eruption.

3. Botanical Name = *Aerva jawanica* L
   Local Name = Khip
   Part use = Aerial parts
   Flowering Period = Throughout the year(mostly July-September)
   Voucher Specimen No = 6
   Uses = Plant powder is used for Kidney stone. It is anti inflammatory and has diuretic activites.

4. Botanical Name = *Amaranthus viridis* Linn.
   Local Name = Chauli.
   Part use = Leaves.
   Flowering Period = July –October
   Voucher Specimen No = 7
   Uses = It is emollient and antidote (against) for scorpion and snake bite. Also used for joint pain.

(iii) Apiaceae

5. Botanical Name = *Carum copticum* Benth & Hook.
   Local Name = Ajwain.
   Part use = Seeds.
   Flowering Period = March-April
   Voucher Specimen No = 8
   Uses = Digestive ailments, diarrhea, dysentery, gastritis, Bone fewer and abdominal pain.

(iv) Appocynaceae

6. Botanical Name = *Rhazya stiricta* Dcne
   Local Name = Sawa Venra
   Part use = Leaves and branches.
   Flowering Period = December-March
   Voucher Specimen No = 91
   Uses = Extract of leaves is used in digestive ailments ,diarrhea, dysentery and gastritis. Branches used to cure toothache .

7. Botanical Name = *Carissa opaca* stapf ex haines
   Local Name = Gungir
   Part use = Whole plant

Flowering Period = April-June
Voucher Specimen No = 9
Uses = Root is grounded and put in worm infested sores of animals. Leaf decoction is used for asthma.

(v) Asclepiadaceae

8. Botanical Name = *Calotropis procera* R.BR.
Local Name = Akk.
Part use = Unripened flowers, sometime whole plant.
Flowering Period = Throughout the year.
Voucher Specimen No = 21
Uses = It is used for Gastritis, abdominal diseases, malaria, cholera and asthma.

9. Botanical Name = *Caralluma edulis* L.
Local Name = Choung
Part use = Whole plant
Flowering Period = Throughout the year
Voucher Specimen No = 13
Uses = It is used as vegetable and juice of the plant is used for diabetes.

10. Botanical Name = *Tylophora hersuta* L.
Local Name = Gilow
Part use = Roots and leaves
Flowering Period = July-August
Voucher Specimen No = 15
Use = Roots and leaves decoction is used for jaundice. The dried leaves are emetic and blood purifier.

(vi) Asteraceae

11. Botanical Name = *Ageratum conyzoides* Linn.
Local Name = Neeli booti
Part use = Leaves and inflorescence juice.
Floweing Period = February - April
Voucher Specimen No = 10
Uses = It is used to cure wounds and is antidote for snake bite.

12. Botanical Name = *Xanthium strumarium* Linn.
Local Name = Chhota Dhatura.
Part use = Roots, fruit and seeds.
Flowering Period = January-March
Voucher Specimen No = 14
Uses = It is sedative and diuretic and is used in stomach diseases. It is demulcent and its cooling effect is given in small Pox and dysentery.

13. Botanical Name = *Calendula arvensis* Linn.
Local Name = Zergul.
Part use = Flowers.
Flowering Period = March-May
Voucher Specimen No = 19
Uses = It is used to strengthen far eye side. Also used for heart diseases and healing of the skin.

14. Botanical Name = *Helianthus annuus* Linn.
Local Name = Suraj Mukhi.
Part use = Seed oil.
Flowering Period = May-July

	Voucher Specimen No	=	94
	Uses	=	It is an expectorant. It is used for cold and cough, bronchitis, Malaria and fewer.
15.	Botanical Name	=	*Saussuria hetromalla* L
	Local Name	=	Kali Ziri
	Part use	=	Roots
	Flowering Period	=	March-June
	Voucher Specimen No	=	35
	Uses	=	It is an aphrodisiac tonic and is useful in liver diseases, kidney and chest complaints.
16.	Botanical Name	=	*Artimisia scoperia* Walds & Kit.
	Local Name	=	Dona jhan
	Part use	=	Whole plant
	Flowering Period	=	August-November
	Voucher Specimen No	=	16
	Uses	=	Infusion of the plant is used as purgative and is used to cure earache.
17.	Botanical Name	=	*Conyza canadensis* (L.) Cronquist.
	Local Name	=	Paleet
	Part use	=	Whole plant
	Flowering Period	=	August-October
	Voucher Specimen No	=	11
	Uses	=	Used as homeostatic, astringent, diuretic. It is used to treat dysentery and diarrhea.
18.	Botanical Name	=	*Sonchus asper* L.
	Local Name	=	Dodal
	Part use	=	Whole plant
	Flowering Period	=	March-May
	Voucher Specimen No	=	46
	Uses	=	It is diuretic, cooling, sedative and antiseptic. It is useful in cough, bronchitis, asthma and phthisis.

(vii) Brassicaceae

19.	Botanical Name	=	*Capsella bursa-pastoris*.
	Local Name	=	Jangli Saro
	Part use	=	Seeds.
	Flowering Period	=	February-March
	Voucher Specimen No	=	24
	Uses	=	It is useful in Dropsy, Diarrhoea, and healing of wounds.
20.	Botanical Name	=	*Brassica alba* L.
	Local Name	=	Chitti Sarson
	Part use	=	Whole plant, seeds.
	Flowering Period	=	February-April
	Voucher Specimen No	=	27
	Uses	=	Its oil is used for cooking. Young plant and inflorescence is used as a vegetable.
21.	Botanical Name	=	*Eruca sativa.*
	Local Name	=	Tara mira / Jumiha.
	Part use	=	Leaves and seeds.
	Flowering Period	=	February-April
	Voucher Specimen No	=	28

Uses = It has warming and stimulating properties and has pungent smell' It is used for rheumatism and joint pain.

(viii) Caeselpinaceae

22. Botanical Name = *Cassia fistula* L
Local Name = Amaltas
Part use = Pods, seeds.
Flowering Period = April-May
Voucher Specimen No = 41
Uses = It is used as astringent, blood purifier, detergent resolvent, styptic. Seeds are used in conjunctivitis, skin eruption, leprosy and haematuria.

23. Botanical Name = Bauhinia variegate L.
Local Name = Kachnar
Part use = Bark, flowers, bud, root.
Flowering Period = February-April
Voucher Specimen No = 40
Uses = Bark is used as anthelmintic tonic and is useful in skin diseases. Dried buds are used in dysentery piles and diarrhea.

(ix) Cannabinaceae

24. Botanical Name = *Cannabis sativa* Linn.
Local Name = Bhung.
Part use = Whole plant.
Flowering Period = April -October
Voucher Specimen No = 53
Uses = It act as sedative,norcotic intoxicant and antispasmodic. It is useful in diarrhea.

(x) Capparidaceae

25. Botanical Name = *Capparis spinosa* Forsk.

Local Name = Karin.
Part use = Branches.
Flowering Period = May-July
Voucher Specimen No = =55
Uses = It is useful for chest pain, general pain and rheumatism.

(xi) Caryophyllaceae

26. Botanical Name = *Stellaria media* L.
Local Name = Gandel
Part use = Whole plant
Flowering Period = May-August
Voucher Specimen No = 66
Uses = Plant is known as cooling and astringent. It is also used in plasters to be employed on broken bones and swellings.

27. Botanical Name = *Silene conoidea* L.
Local Name = Chhota Takla
Part use = Whole plant
Flowering Period = Febrauary-April
Voucher Specimen No = 67
Uses = The plant is known as emollient and used in bath.

(xii) Chenopodiaceae

28. Botanical Name = *Chenopodium album*

Local Name = Bathu
Part use = Whole plant
Flowering Period = February-March
Voucher Specimen No = 73
Uses = It has cooling effect. It is used to cure liver diseases and jaundice.

(xiii) Convolvulaceae

29. Botanical Name = *Convolvulus arvensis* Linn.
Local Name = Lali poli/ Hiran padi.
Part use = Whole plant, leaves especially.
Flowering Period = January-March
Voucher Specimen No = 26
Uses = It is useful for piles and skin wound. Roots are purgative.

30. Botanical Name = *Cuscuta reflexa* Roxb.
Local Name = Akash bail.
Part use = Whole plant.
Flowering Period = January-February
Voucher Specimen No = 20
Uses = It is useful in diarrhea, and dysentery of goat and sheep and baldness in males.

(xvii) Crassulaceae

31. Botanical Name = *Bryophyllum pinnatum* Kurz.
Local Name = Zakham-e-Hayat / Patharchutt.
Part use = Leaves and Juice (Mucilage).
Flowering Period = November - December
Voucher Specimen No = 79
Uses = It is used against Hypertension, Gastro-intestinal trouble, Depression, Renal calculus (Kidney's stone) and skin diseases.

(xiv) Cyperaceae

32. Botanical Name = *Cyperus rotundus* Linn.
Local Name = Deella
Part use = Whole plant, especially roots
Flowering Period = May-July
Voucher Specimen No = 33
Uses = It is used to cure chronic roars on scales of Children and abdominal pain.

(xv) Euphorbiaceae

33. Botanical Name = *Euphorbia helioscopia* L
Local Name = Chattri dodak
Part use = Whole plant
Flowering Period = February-March
Voucher Specimen No = 32
Uses = It act as cathoratic, anthelmintic and purgative.

34. Botanical Name = *Ricinus communis*
Local Name = Arind
Part use = Seeds and leaves
Flowering Period = Throughout the year
Voucher Specimen No = 34

Uses = It is useful for intestinal swelling, jaundice, constipation and rheumatic swelling. It makes intestine soft.

(xvi) Fumariaceae

35. Botanical Name = *Fumaria parviflora* Hussk.
Local Name = Shatera/ Papra
Part use = Whole plant
Flowering Period = December-February
Voucher Specimen No = 68
Uses = It is used for blood purification, piles. It is diuretic and anthelmintic. It is useful in skin allergy.

(xviii) Lamiaceae

36. Botanical Name = *Salvia moorcroftiana* exBk
Local Name = Ghoulkund
Part use = Leaves and roots
Flowering Period = February-April
Voucher Specimen No = 87
Uses = It is useful for headache, relief high fever, skin diseases.

37. Botanical Name = *Salvia officinalis.*
Local Name = Garden Sage.
Part use = Leaves.
Flowering Period = January-March
Voucher Specimen No = 36
Uses = It is recommended for fever, ulcer of mouth and throat, liver and Kidney trouble. It is used as a hair tonic.

(xix) Leguminosae

38. Botanical Name = *Medicago falcate* L.
Local Name = Mathri / Mathray.
Part use = Leaves and seeds.
Flowering Period = January - April
Voucher Specimen No = 25
Uses = It is a powerful tonic. It is useful for Back pain.

39. Botanical Name = *Dalbergia sisso.*
Local Name = Tali / Shesham.
Part use = Leaves and wood.
Flowering Period = March-April
Voucher Specimen No = 3
Uses = Leaves extract used for softening and cleaning the hairs. It is a hair tonic and promote the growth of long hairs .

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Inventory and indigenous uses of the flora of proposed Zoo-cum-Botanical Garden, Islamabad

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Abstract
The flora of proposed Zoo-cum-Botanical Garden Banigala, Islamabad was documented in special reference to economic and medicinal plants alongwith their indigenous uses. Field surveys were carried out throughout the year, and specimens identified. Information regarding uses was collected from local inhabitants through semi-structured interviews. The flora of ZCBG consists of 129 species comprising of 21 trees, 22 shrubs, 64 herbs, 19 grasses and 2 climbers. The total species of plants represent 114 genera and 50 families. Out of them 103 (81.7%) plants possess medicinal values. Other economically important species are used as fodder (29 species: 23%), fuel wood (26 species: 20 %), raw material for industry and other income generation (22 species: 17.4%), wild fruit/food (11 species: 8.7%) and timber (7 species: 5.5%).

Key Words: Flora, Inventory, Zoo-cum-Botanical Garden, Islamabad, indigenous knowledge

Introduction

The idea of development of Botanical Garden was incorporated in the Master Plan of Islamabad in 1968. In January 1989 physical possession of the reserved forest land was handed over to Zoological Survey of Pakistan by Capital Development Authority (CDA) for development of Zoo-cum-Botanical Garden (ZCBG). The reserved forest site for ZCBG is covered with lush green ranges and great scenic beauty. The forest is rich in plants having great economic importance of direct benefits (fuel-wood, wild food, fodder, medicine).

The ZCBG lies in the sub- humid continental highlands, covers an area of 725 acres. The altitude of the area varies between 530 and 800m with latitude 33-5° and longitude 30°- 6'and 73°- 8' East. Mean average annual rainfall is about 1000mm, about 70% of which is received during monsoon. The climate is characterized by hot summers and cold winters. June is the hottest month with mean maximum temperature of 38°C and January being the coldest month with mean minimum temperature of 3°C (Ahmed et al., 1989). The adjoining villages are predominantly populated and most of the inhabitants are poor and depend on state owned forest resources for their livelihood.

Inventory is a credible and widely-recognized resource that plays a significant role in promoting scientific research, conservation planning, and effective enforcement of environmental laws that deal with plant conservation. Indigenous knowledge is the systematic information that remains in diverse social structures. It is usually unwritten and preserved only through oral tradition, and it refers to the knowledge system of indigenous people and minority cultures. Traditional knowledge of biodiversity concerns the names, uses, and management of plants and animals as perceived by the local and or indigenous people of a given area (Berlin, 1992). Plants play important role not only in ecosystem but are also an economic component of biodiversity. Plants with medicinal properties enjoyed the highest reputation throughout the world in different medical systems and have also been traditionally employed for medicinal purpose from historical times. The use of plant as a source of medicine is based upon experience of many generations of traditional physicians and herbal practitioners found in different societies. Modern medicine made unparalleled progress. The benefits, however, are not available to vast populations especially in the third world. The poor and those living away from towns and cities are the worst affected. Pakistan is a developing country with limited resources, where 60% of population lives in rural areas, natural herbs are the only hope for health. In Pakistan research in the field of natural herb products needs to be enhanced as the country is rich in flora. Keeping this in view, the present study was initiated, to document the flora of ZCBG and their indigenous information which may lead to conservation and sustainable utilization of plants of the area.

Material and Methods

The study was conducted during October 2009 to September 2010. The total study area was regularly surveyed once-a-week during the period. A large number of plant specimens or their parts throughout four seasons were collected, dried, pressed and mounted on herbarium sheets. Plants specimens were identified with the help of Flora of Pakistan (Stewart, 1972; Nasir and Ali, 1972; Nasir and Rafiq, 1995). The identified specimens were taken to International Islamic University and Quiad-i-Azam University, Islamabad for re-confirmation and were deposited in the Phyto-chemical Laboratory at ZCBG, Islamabad. Information about Ethnobotanical data and traditional uses of plants was obtained by semi-structured interviews from experienced rural folk, traditional herbal medicine practitioners of community and also available literature (Shinwari et al., 2003; Ullah and Rashid, 2007; Jabeen et al., 2009; Ahmad et al., 2009.

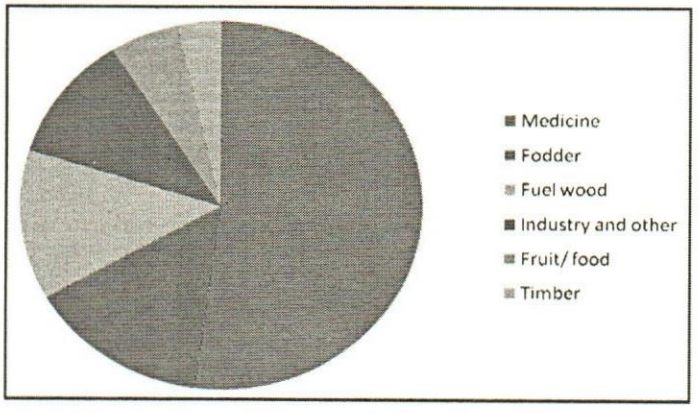

Figure 1. Uses of different plants collected from the Zoo-cum-Botanical Garden, Banigala, Islmabad

Results and Discussion

Present study revealed that flora of ZCBG consists of 129 species comprising of 21 trees, 22 shrubs, 64 herbs, 19 grasses and 2 climbers. The total species of plants represent 114 genera and 50 families. Out of them 103 (81.7%) plants possess medicinal values. Other economically important species are used as fodder (29 species: 23%), fuel wood (26 species: 20 %), raw material for industry and other income generation (22 species: 17.4%), wild fruit/food (11 species: 8.7%) and timber (7 species: 5.5%) as shown in Figure 1.

The detailed description of indigenous uses of flora from the ZCBG, Islamabad are shown in Table 1 and Table 2. For each species; plant family, botanical names, local names and their uses are given. The results of the present study (Table 1) show floral diversity in ZCBG and their economic importance.

During the survey 103 herbs belonging to 88 genera and 43 families were identified with medicinal uses. The major plant families which contribute in folk medicine were Asteraceae (8 spp.), Poaceae (8 spp.), Moraceae (7 spp.), Euphorbiaceae (6 spp.), Fabaceae (4 spp.), Malvaceae (4 spp.), Rhammaceae (4 spp.), Solanaceae (4 spp.), Acanthaceae (3 spp.), Apocynaceae (3 spp.), Boragnaceae (3 spp.), Compositae (3 spp.), Lamiaceae (3 spp.), Mimoaceae (3 spp.), Papilinaceae (3 spp.), Tiliaceae (3 spp), Amaranthaceae (2 spp.), Asclepiadaceae (2 spp.), Convulvaceae (2 spp.), Maliaceae (2 spp.), Myrthaceae (2 spp.), Polygonaceae (2 spp.), Zygophyllaceae (2 spp.) while Apiaceae, Bombaceae, Brassiaceae, Canabiaceae, Chenopodiaceae, Floccourtiaceae, Juncaceae, Laniaceae, Lythraceaceae, Nyctagenaceae, Oleaceae, Oxidaceae, Polypoidaceae, Primulaceae, Puniaceae, Rosaceae, Sapinadaceae, Serophulariaceae, Ulmaceae, Verbenaceae, and Vitaceae had one species each.

Plants are the main source of phyto-medicine which have proved to be effective, safe, inexpensive and culturally acceptable. The local community is dependent on plant resources for their health care, fodder, fuel-wood, food and wood. The roots of *Justicia adhatoda* are useful in asthma, bronchitis and other chronic coughs. Dried leaves are used in the treatment of bronchial asthma. It is also indicated in the treatment of internal haemorrhage, cough, local bleeding, thrombocytopenia and pyorrhea (Ahmad et al., 2009). The leaves of *Saussorea hetromala* are used to treat wounds and seeds are carminative. The leaves and roots are effective against snake bite, plant is diuretic, and depurative and is used in urinary tract disease. The root is applied as a paste on swellings, and joints and is used in dysentery in children (Shinwari & Khan, 2000). Kao *(Olea ferruginea)* has cold effect and is used in summer. Its leaves are grinded and juice is taken for pimples. Kao is used as favorite fodder and fuel wood (Jabeen et al., 2009). Due to unsustainable utilization, overgrazing, and spread of alien invasive species in the ZCBG, several important species are, at least, locally endangered.

Conclusion

The use of ethno-medical information has contributed to health care worldwide. The traditional medical knowledge of indigenous people is under

threat as little effort has been made to understand and document their Knowledge. It is very likely that with the passage of time vital information on plant local name, uses and their characteristics will be lost. Main causes of decline of floral diversity in the forest of ZCBG are over exploitation of vegetation, climate change and illegal grazing. Spread of invasive species is also threat to forest as invasive species are playing inhibitoryz effect on native flora like *Lantana camara*, *Parthenium hysterophorus* and *Xanthium stramarium* etc. Jain et al. (1989) reported that *Lantana camara* poses a serious problem to fauna and flora because of its toxic effects as it contains certain allelopathic compounds.

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References

Ahmad, M., Anwar, M. and Akbar, G. (1989). Effect of Exclosure on vegetation composition and Forage Yield of Bannigala Reserve Forest. Pakistan j.Agric.Vol.10 (2) 149-157

Ahmad, S. S., Mahmood, F., Dogar, Z. U. L., Khan, Z. I., Ahmad, K., Sher, M., Mustafa, I. and Valeem, E. A. 2009. Priortization of medicinal plants of Margalla Hills National Park, Islamabad on the basis of available Information Pak. J. Bot., 41(5): 2105-2114.

Berlin B. 1992. Ethnobiological Classification: Principles of Categorization of Plant and Animals in Traditional Societies. New Jersey: Princeton University Press.

Jain, R., Singh, M. and Dezman, D. 1989. Qualitative and quantitative characterization of phenolic compounds from Lantana camara leaves. Weed Sci. 37:302-307

Jabeen, A., Khan, M. A., Ahmad, M., Zafar, M. and Ahmad, F. 2009. Indigenous uses of economically important flora of Margallah Hills National Park, Islamabad, Pakistan. African Journal of Biotechnology, Vol. 8 (5) 763-784.

Nasir, E., and Ali, S. I. 1972. Flora of West Pakistan. An annotated catalogue of vascular Plants of W

Nasir, J. Y. and Rafiq, R. A. 1995. Wild flowers of Pakistan. In T. J. Roberts (eds.) Oxford Univ. Press, Karachi. Pakistan. Fitoterapia, 79: 468-473.

Qureshi, R. A. and Ghufran, M. A. 2007. Indigenous knowledge of selected medicinal wild plants of district, Attock, Punjab, Pakistan, 39(7): 2291-2299.

Shinwari, Z. K., Khan, A. A. and Nakaike, T. 2003. Medicinal and other useful plants of Swat, Pakistan. Nature Conservation Soc. Japan. pp 9-34.

Shinwari, M. I and Khan, M. A. 2000. Folk use of medicinal herbs of Margalla Hills National Park, Islamabad,Journal of ethnopharmacology. 45- 56.

Stewart, R. R. 1972. Annotated catalogue of vascular plants West Pakistan and Kashmir. Fakhri Printing Press, Karachi.

Ullah, A. and Rashid, A. 2007. Weeds and Livelihood in Mankial Valley, Hindukush Range, Pakistan. Pak J. Weed Sci. Res., 13(1-2): 27-32.

Table1. Ethanobotanical importance of flora of Zoo-cum-Botanical Garden, Banigala, Islamabad

Family	Species	Local Name	Nature	Uses
Acanthaceae	*Barleria cristrata* Linn.	Tardelu	Herb	Medicinal
Acanthaceae	*Dicliptera roxburghiana* Nees		Herb	Medicinal
Acanthaceae	*Justicia adhatoda* L.	Bhaikar	Shrub	Fuel wood, Medicinal
Alliaceae	*Allium griffthii* Boiss	Chohta pyaz	Herb	Fodder and Medicinal
Amaranthaceae	*Amaranthus viridis* L.	Jungle chuali	Herb	Medicinal
Amaranthaceae	*Digeria muricata* (Linn.)Mart	Tara rar	Herb	Medicinal
Apiaceae	*Torilis leptophylla* L.Reichenbach fil.		Herb	Medicinal
Apocynaceae	*Carissa opaca* Stapf ex Haines	Granda	Shrub	Fuel wood, fruit and medicinal
Apocynaceae	*Nerium oleander* L.	Kanair	Shrub	Medicinal
Apocynaceae	*Periploca aphylla* Dcne	Bata	Herb	Medicine for wild animals
Asclepiadacae	*Calotropis procera* (Willd.) R.Br.	Aak	Shrub	Medicinal
Asclepiadacae	*Pergularia tomentosa* L.		Shrub	Fodder
Asclepiadacae	*Tylophora hirsuta* Wall	Galu	Herb	Medicinal
Asteraceae	*Artemisia scoparia* Waldst. & Kit.	Manja	Herb	Medicinal
Asteraceae	*Conyzanthus squamatus* (Spreng) Tamamsch.		Herb	Medicinal
Asteraceae	*Centaurea iberica* Trevir & Spreng		Herb	Medicinal
Asteraceae	*Erigeron conyzanthus*		Herb	Ethno-veterinary medicine
Asteraceae	*Echinops echinatus* DC.	Kanderi bhattar	Herb	Medicinal
Asteraceae	*Erigeron conyzanthus*		Herb	Veterinary medicine and used as food plants by the larvae of some Lepidoptera species
Asteraceae	*Launea procumbens* (Roxb) Ramayya & Rajagopal	Lassi bhattar	Herb	Medicinal
Asteraceae	*Parthinium hysterophorus* L.	Chatak chandan	Herb	Medicinal
Asteraceae	*Saussurea heteromala* (D.Don) Hand Mazz	Kali zari	Shrub	Medicinal
Asteraceae	*Xanthium strumarium* Linn.	Chohta dhattura	Shrub	Medicinal
Bombacaceae	*Bombax ceiba* L.	Simbal	Tree	Fuel-wood, industrial, medicinal
Boraginaceae	*Borago officinalis*		Herb	Food, oil, medicine
Boraginaceae	*Cynoglossum lanceolatum* Forssk	Cheeroo	Herb	Fodder and medicinal
Boraginaceae	*Ehretia obtusifolia* Hochst.exDc.	Pan	Tree	Fuel-wood, fruit, timber
Boraginaceae	*Trichodesma indicum* (Linn) R Br	Kallri booti	Herb	Medicinal
Brassiaceae	*Lepidium apetalum* Willd	Halim	Herb	Medicinal
Funariaceae	*Funaria hygrometrica* Hedw (Funaria)	Herb	Herb	Medicinal
Cannabinaceae	*Cannabis sativa* L.	Bhang	Herb	Medicinal
Celastraceae	*Gymnosporia royleana* Wall ex Lawson.	Pattaki	Shrub	Fodder, fuel-wood & medicinal

Chenopodiaceae	*Chenopodium ambrosioides*L.	Chandan bathwa	Herb	Medicinal
Compositae	*Conyza bonariensis* (L.) Cronquist.		Herb	Medicinal
Compositae	*Conyza Canadensis* (L.) Cronquist.	Paleet	Herb	Medicinal
Compositae	*Sonchus arvensis* Kit.	Dodh bhatal	Herb	Medicinal
	Convolvulus microphyllus Seib ex Spreng.		Herb	Medicinal
Convolvulaceae	*Ipomea carnea* Jack	Morning glowery	Shrub	Stem is use for making paper, medicinal
Convolvulaceae	*Leptadenia angustata*		Herb	
Cyperaceae	*Cyperus glomeratus* Linn.		Herb	Fodder & used in mat making
Euphorbiaceae	*Chrozophora hierosolymitana*		Herb	Medicinal
Euphorbiaceae	*Euphorbia helioscopia* L	Chahtri dodak	Herb	Gum & Leaves are used for tea substitute, medicinal
Euphorbiaceae	*Euphorbia indica* Lam.		Herb	Medicinal
Euphorbiaceae	*Euphorbia prostrata* Ait	Hazar dani	Herb	Medicinal
Euphorbiaceae	*Euphorbia royleana* Bioss	Danda thor	Shrub	Medicinal
Euphorbiaceae	*Ricinus communis* L.	Arind	Shrub	Fuel-wood, medicinal
Fabaceae	*Rhyncosia minima* (L.)D.C		Herb	Forage, medicinal
Fabaceae	*Lespedeza juncea* (L.f.) Var.		Herb	Medicinal
Fabaceae	*Medicago denticulata* Willd	Singi	Herb	Forage, fodder and green manure
Fabaceae	*Vicia faba* L.		Herb	Food
Flacourtiaceae	*Flacourtia indica* (Burm.f.) Merill	Kokoh	Tree	Fruit, gum, medicinal
Juncaceae	*Juncus effusus* L.		Herb	Candle wicks, basket and medicinal
Lamiaceae	*Otostegia limbata* (Bth.)Bioss	Chiti booti	Shrub	Fuel-wood, medicinal
Lamiaceae	*Calmintha umbrosa*		Herb	
Lamiaceae	*Ajuga bracteosa* Wall. ex Benth.	Kauri booti	Herb	Medicinal
Lamiaceae	*Salvia aegyptiaca* L.		Herb	Fodder & medicine
Laniaceae	*Linum corymbulosum* Reichenbach		Herb	Medicinal
Liliaceae	*Asparagus gracilis* Royle en Baker	Shah gandal	Climber	Food, Medicinal
Lythraceae	*Woodfordia fruticosa* (L) S. Kurz	Dhawi	Shrub	Fuel-wood and medicinal
Meliaceae	*Cedrela toona* Roxb. ex Rottl. & Willd	Toon	Tree	Timber, furniture, dyes and medicinal
Meliaceae	*Melia azedarach* Linn.	Drekh	Tree	Fodder, timber and medicinal
Malvaceae	*Abutilon indicum* (L.) Sweet		Herb	Medicinal
Malvaceae	*Malvastrum coromandelianum* (L.) Garcke	Yard sonchal	Herb	Medicinal
Malvaceae	*Sida cordata* (Burm f.) Borass	Barier	Herb	Medicinal
Mimmoaceae	*Acacia modesta* Wall.	Phauli	Tree	Fuel-wood, timber, medicinal
Mimmoaceae	*Acacia nilotica* (L.) Delile	Kikar	Tree	Fuel-wood, medicinal

Mimmoaceae	*Albizia lebbeck* (L.) Benth	Shereen	Tree	Fuel-wood, fodder, medicinal
Moraceae	*Broussonetia papyrifera* Vent	Kala toot	Tree	Fodder, industrial, Medicinal
Moraceae	*Ficus glomerata* Roxb		Tree	Fruit, medicine
Moraceae	*Ficus palmata* Forsk.	Anjir	Tree	Fruit, medicinal
Moraceae	*Ficus religiosa* L	Peepal	Tree	Fodder, fruit, timber and medicinal
Moraceae	*Ficus virens* Dryand	Wild fig	Tree	Fruit, Fodder, Medicinal
Moraceae	*Morus alba* L	Sufaid toot	Tree	Fuel-wood, fodder, fruit and medicinal
Moraceae	*Morus nigra* L.	Toot	Tree	Fruit, fodder, fuel wood & medicinal
Myrtaceae	*Callistemon citrinus* (Curtis) Stapf	Bottle brush	Tree	Tea, dye, wood
Myrtaceae	*Eucalyptus citriodora*	Safeda	Tree	Oil, saw timber, tannin, medicine
Nyctaginaceae	*Boerhaavia diffusa* auct, plur			Medicinal
Oleaceae	*Olea ferruginea* Royle	Kau	Tree	Fodder, fuel-wood, Medicinal
Oxalidaceae	*Oxalis corniculata* L.	Khatmithra	Herb	Medicinal
Papilionaceae	*Argyrolobium roseum* (Camb.) Jaub. & Spach	Makhan booti	Herb	Medicinal
Papilionaceae	*Crotalaria medicaginea* Lam.		Herb	Medicinal
Papilionaceae	*Dalbergia sissoo* Roxb. ex Dc	Shisham,Tali	Tree	Fodder, fuel-wood, timber, Medicinal
Papilionaceae	*Lotus corniculatus* L.		Herb	Fodder
Papilionaceae	*Tephrosia uniflora* Pers.	Andhri	Herb	Medicinal
Poaceae	*Aristida adscensionis* L.		Grass	Medicinal
Poaceae	*Arundo donax* L.	Nari	Grass	Musical instrument, walking sticks, paper making and medicinal
Poaceae	*Avena sativa* L.	Jandar	Grass	Food, Fodder and medicinal
Poaceae	*Setaria glauca* (L.) P. Beauv.	Wakha	Grass	Fodder
Poaceae	*Chrysopogan auchri* (Boiss) Stapf.		Grass	Fodder
Poaceae	*Cymbopogon jawarancusa* (Jones) Schult	Kattan	Grass	Medicinal
Poaceae	*Cynodon dactylon* Linn.	Khabbal	Grass	Fodder, medicinal
Poaceae	*Dactyloctenium aegyptium* (Linn) P. Beauv.		Grass	Food, medicinal
Poaceae	*Dichanthium annulatum* Stapf.	Blue stem	Grass	Fodder
Poaceae	*Digitaria coeninola Var.ramosa* Vickery		Grass	Forage
Poaceae	*Equisetum arvensis* Linn.	Herb	Grass	Hair tonic and anti-lice
Poaceae	*Euolaliopsis binata* (Retz)	Bhabir	Grass	Use in paper industry, crafts and ropes
Poaceae	*Eragrostis poaeoides* P. Beauv.	Allamanda	Grass	Medicinal
Poaceae	*Imperata cylindrica* (L.) P. Beauv.	Dab	Grass	Cultivated for prevention of soil erosion, used in paper

Poaceae	*Octhochloa compressa* (Forssk)Hilu	Darier	Grass	Fodder
Poaceae	*Polypogon monspeliensis* (L.) Desf		Grass	Used in making ropes
Poaceae	*Saccharum munja* Roxb.	Sarrot	Grass	Fodder
Poaceae	*Saccharum spontaneum* L.	Kai	Grass	Used in making broom, fodder, and medicinal
Poaceae	*Themeda anathera* (Nees) Hack.		Grass	Fodder
Polygonaceae	*Polygonum barbatum* (L.)		Herb	Medicinal
Polygonaceae	*Polygonum plebejum* R. Br.	Kheer wal	Herb	Medicinal
Polypodiaceae	*Adiantum masum*		Herb	Medicinal
Primulaceae	*Anagallis arvensis* L.	Dhabbar	Herb	Medicinal
Puniaceae	*Punica granatum* L.	Anar	Shrub	Fuel-wood and medicinal
Rhamnaceae	*Sageretia brandrethiana* Aitch	Ganghair	Shrub	Medicinal
Rhamnaceae	*Ziziphus mauritiana* Lam.var Spontanea (Edgew.)	Bair	Shrub	Fuel-wood, fruit, medicinal
Rhamnaceae	*Ziziphus spina-christi* Willd.	Bair	Shrub	Fuel-wood, fruit, medicinal
Rhamnaceae	*Ziziphus nummularia* (Burm. f.) Wight & Arn	Jher bair	Shrub	Fuel-wood, fruit, medicinal
Rosaceae	*Spirea japonica* L.f.		Shrub	Ornamental plant, use for landscaping
Sapindaceae	*Dodonaea viscosa* (L.) Jaeq	Sanatha	Shrub	Fuel-wood, Medicinal
Serophulariaceae	*Bacopa monnieri* L. Westein	Brambhi booti	Herb	Medicinal
Solanaceae	*Datura alba* Nees	Dhattura	Herb	Medicinal
Solanaceae	*Solanum nigrum* L.	Kach Mach	Herb	Medicinal
Solanaceae	*Solanum surattense* Burm. f	Mokri	Herb	Medicinal
Solanaceae	*Withania coagulans* Dunal	Dodi paneer	Herb	Fuel-wood, Medicinal
Tiliaceae	*Corchorus olitorius* L.	Tussah jute	Herb	Fibre, food and medicine
Tiliaceae	*Corchorus trilocularis* L.	Jungli jute	Herb	Food and medicine
Tiliaceae	*Grewia optivia* Drummond ex Burret	Dhaman	Tree	Fuel-wood, Fodder, fruit, timber &fibre
Tiliaceae	*Grewia tenax* (Forssk). Aschers & Schweinf.	Kango	Shrub	Fruit, Fodder, fire wood & fiber
Typhaceae	*Typha elephantina* Roxb.	Kundar	Grass	Making baskets and mats
Ulmaceae	*Celtis australis* var.	Sweet berry	Tree	Fruit, wood and Medicinal
Verbenaceae	*Lantana camara* L.	Panch phalli	Shrub	Ornamental plant and medicine
Verbenaceae	*Verbena tenuisecta*		Herb	Ornamental plant
Vitaceae	*Vitis trifolia* L.		Climber	Fruit and medicinal
Zygophyllaceae	*Fagonia cretica* L. var.		Herb	Medicinal
Zygophyllaceae	*Peganum harmala* L.	Hermal	Herb	Medicinal

Table 2. Plants with Medicinal Importance of Zoo-cum-Botanical Garden, Banigala, Islamabad

Family	Species	Part used	Medicinal importance
Acanthaceae	*Barleria cristrata*	Roots, leaves & seeds	Used in swelling, cough, rheumatism, pneumonia, snake bite, ear and eye ailments
Acanthaceae	*Dicliptera roxburghiana*	Leaves & fower	General tonic
Acanthaceae	*Justicia adhatoda*	Leaves, flower, stem & root	Asthma, Bronchitis, chronic cough, internal haemorrhage, thrombocytopenia and pyorrhea
Amaranthaceae	*Amaranthus viridis*	Leaves	Amenorrhea, scorpion sting and snake bite
Amaranthaceae	*Digeria muricata*	Entire plant	Anti fungal & antibacterial
Apiaceae	*Torilis leptophylla*	Entire plant	Antibacterial & antiseptic
Apocynaceae	*Carissa opaca*	Fruit & flower	Eye disorder and aphrodisiac, asthma
Apocynaceae	*Nerium oleander*	Entire plant	Cardio tonic, diuretic, expectorant and scabies
Apocynaceae	*Periploca aphylla*	Entire plant	The milky juice is used as an external application to tumors and swellings and said to be useful in cerebral fever and also stomach ache
Asclepiadaceae	*Calotropis procera*	Root bark, leaves & flower	Abdominal pain, Asthma, malarial fever, joint and waist pain
Asclepiadaceae	*Tylophora hirsuta*	Roots & leaves	Asthma, high blood pressure, diarrhea, rheumatism and allergy
Asteraceae	*Artemisia scoparia*	Seed, flower & stem	Purgative, also used as cure for ear ache, to relieve jaundice, to remove damp heat, antibacterial, antiseptic.
Asteraceae	*Centaurea iberica*	Ariel part	Alleviate pain and inflammatory symptoms in rheumatoid arthritis, high fever, head ache and for wound healing
Asteraceae	*Echinops echinatus*	Root bark and entire plant	Treatment of skin itching, anti-inflammatory, whooping cough, hemorrhoids, skin ulcers
Asteraceae	*Erigeron conyzanthus*	Entire plant	Veterinary medicine
Asteraceae	*Launea procumbens*	Entire plant	Used in painful micturation. It is also used as galactagogue for cattle
Asteraceae	*Parthinium hysterophorus*	Entire plant	Skin disorder and dysentery
Asteraceae	*Saussurea heteromala*	Seed & leaves	Leaves are antiseptic, applied to wounds. Seeds are carminative. Plant exhibits CNS depressant & hypothermic properties.
Asteraceae	*Xanthium strumarium*	Leaves, root & seed	Sedative, epilepsy, leprosy, diuretic, small pox and dysentery
Bombaceae	*Bombax ceiba*	Spines	Astringent, alterative, restorative, tonic, stimulant
Boraginaceae	*Borago officinalis*	Leaves & flower	used in hyperactive gastrointestinal, respiratory and cardiovascular disorders & as expectorant
Boraginaceae	*Cynoglossum lanceolatum*	Entire plant	It is used for healing, naso-pharyngeal affections, stomach troubles, vermifuges. Root is used in treatment of eye trouble
Boraginaceae	*Trichodesma indicum*	Entire plant	Effective against snake bite, diuretic, depuratives and is used in urinary disease, swelling and joints pain and is used in dysentery in children.
Brassiaceae	*Lepidium apetalum*	Seeds	Anti-oxidant
Cannabinaceae	*Cannabis sativa*	Entire plant	Tonic, narcotic, sedative, and anodyne.
Chenopodiaceae	*Chenopodium ambrosioides*	Entire plant	Used to relieve backache and joints pain and inflammation. It is also used for cough and to stop motions in infants. Seeds are stimulant, diuretic and astringent used in dropsy.
Compositae	*Conyza bonariensis*	Ariel part	ulcers, diuretic, healing, refreshing, is also febrifuge, anthelmintic, insecticide, anti-rheumatic, anti diarrheal, anti-ulcer gastric, liver protector against diseases venereal diseases and urinary tract infections, gonorrhea.
Compositae	*Conyza canadensis*	Entire plant	Haemostatic, stimulant, astringent, diuretic; used in dysentery, diarrhoea, and uterine haemorrhage.
Compositae	*Sonchus arvensis*	Entire plant	Diuretic, sedative, cooling hypnotic, diaphoretic, antiseptic, asthma and jaundice
Convolvulaceae	*Convolvulus microphyllus*	Entire plant	Anti-cholestrolemic, reduces triglycerides, phospholipids, non estrified fatty acids and act as tranquilizer.

Convolvulaceae	*Ipomea carnea*	Roots	It acts as toxic to cattle. Used as laxative and to provoke menstruation. Skin diseases and leucoderma, muscle relaxant activity
Euphorbiaceae	*Crozophora heirosolymitana*	leaves, flower, root	Fever, cough, asthma and Tuberculosis.
Euphorbiaceae	*Euphorbia helioscopia*		Cathartic, cholera, eruption, anthelmintic
Euphorbiaceae	*Euphorbia indica*	Leaves, root and stem	Anti diarhoeal activities and dysentery
Euphorbiaceae	*Euphorbia prostate*	Whole plant	Used in chronic fevers, abdominal diseases, ringworm and as nerve tonic & blood purifier.
Euphorbiaceae	*Euphorbia royleana*	Seed	Cathric, anthelmintic
Euphorbiaceae	*Ricinus communis*	Leaves, seed, &oil	Boils, swelling, pain, healing wounds and sores, toothache, constipation
Fabaceae	*Lespedeza juncus*	Roots	Diarrhea & dysentery
Fabaceae	*Rhyncosia minima*	Leaves	Its oil has anti oxidant activity
Fabaceae	*Tephorsea uiflora*	Leaves	Syphilis
Fabaceae	*Vicia faba*	Beans	Parkinson's disease and hypertension
Flaccourtiaceae	*Flacourtia indica*	Leaves, roots and bark	Jaundice, enlarge spleen and cholera
Juncaceae	*Juncus effusus*	Leaves and stem	treatment of sore throats, jaundice, oedema, acute urinary tract infection
Lamiaceae	*Otostegia limbata*	Leaves	Stomach trouble, refrigerant, also used to clean rusted vessels.
Lamiaceae	*Ajuga bracteosa*	Leaves	Stimulant, antibacterial, diuretic, blood purifier effect, antioxidant
Lamiaceae	*Salvia aegyptiaca*	Leaves	demulcent, antispasmodic, cicatrizant, antiseptic and stomachic. diarrhoea, gonorrhoea and haemorrhoids
Laniaceae	*Linum corymbulosum*	Entire plant	Jaundice, hapititis and anti diabetic
Lythraceae	*Woodfordia fruticosa*	Flower, leave & stem	astringent, stimulant, liver complaints, hemorrhoids, dysentery, mucus membrane disorder
Meliaceae	*Cedrela toona*	Flower, bark and seeds	Flowers can be applied to relieve spasms. The bark has been used in the treatment of infantile diarrhoea as well as for dysentery and wounds. Seeds are also useful in treating wounds
Meliaceae	*Melia azedarach*	Fruit, leaves, bark	Used as Refergent, anthelmintic,and treatment of sore throat.
Malvaceae	*Abutilon indicum*	Whole plant	Tonic, expectorant, antiseptic, urinary tract infection, stimulating intestinal secretion, used as a cooling medicine in fever also used for strangury and hematuria
Malvaceae	*Malva sylvestris*	Whole plant	Used for treatment of kidney, bronchial and skin problems
Malvaceae	*Malvastrum coromandelianum*	Entire plant	Healing, pulmonary troubles, diarrhea, and parasitic infections
Malvaceae	*Sida cordata*	Entire plant	Rheumatism, spermatorrhoea, opthalmia, astringent, stomachic, gonorrhoea and piles
Mimmoaceae	*Acacia modesta*	Stem and roots	Gas trouble, dental disorder
Mimmoaceae	*Acacia nilotica*	Leaves, root and bark	Diarrhea, dysentery, leprosy, treat tumors of eye, ear and testis and also act as astringent
Mimmoaceae	*Albizia lebbeck*	Bark,leaves	Astringent, diarrhea, Gonorrhea, piles, and tuberculosis
Moraceae	*Broussonetia papyrifera*	Fruit and leaves	Astringent, and also used in dysentery
Moraceae	*Ficus glomerata*	Fruit	Possess hypoglycemic activity
Moraceae	*Ficus palmata*	Fruit	It acts as a demulcent and laxative, treatment of constipation and lungs disease
Moraceae	*Ficus religiosa*	Fruit, leaves, bark and latex	gonorrhea, astringent, scabies
Moraceae	*Ficus virens*	Leaves & roots	Diabetes
Moraceae	*Morus alba*	Leaves, fruit, branches & trunk	Refergent, anthelmintic, sore throat, astringent, Insulin secretague activity

Moraceae	*Morus nigra*	Leaves, wood, branches, and fruit	Emollient, used for cleaning throat, astringent
Myrtaceae	*Callistemon citrinus*	Flower	Used in cold malaria and cough and dry flowers in migraine
Myrtaceae	*Eucalyptus citridora*	Leaves, shoots	Antiseptic, heals wound, fumigant, skin ailments and hypoglycemic
Nyctaginaceae	*Boerhaavia diffusa*	Leaves & roots	Antibacterial, antioxidant and remedy for jaundice
Oleaceae	*Olea ferruginea*	Wood, leaves & bark	Leaves decoction is used for toothache and gonorrhea while bark is used in fever.
Oxalidaceae	*Oxalis corniculata*	Entire plant	Plant sap is used to cure skin diseases. Leaves are used in snake bite. Leaves are used as cooling agent and refrigerant in stomach disorders, fever and acute head ache. Plant pounded with cumin seeds are taken with water thrice a day for dysentery. It is also used for sensitive teeth.
Papilionaceae	*Argyrolobium roseum*	Entire plant	Jaundice and hepatitis
Papilionaceae	*Crotalaria medicaginea*	Leaves and seeds	Cooling agent, scabies
Papilionaceae	*Dalbergia sissoo*	Leaves	Gonorrhoea, vomiting, stimulant, leprosy
Poaceae	*Avena fatua*	Seeds, leaves	Used in skin disorder, anti narcotics and for increase in fertility
Poaceae	*Eragrostis poaeoides*	Entire plant	Aphrodisiac, tonic, used for increasing milk and butter production in goat
Poaceae	*Aristida adscensionis*	Entire plant	To relieve jaundice, to remove damp heat
Poaceae	*Arundo donax*	Rhizome/root	Cancer and dropsy
Poaceae	*Cymbopogon jawarancusa*	Entire plant	Infusions of burnt whole plant is given for treatment of chicken pox.
Poaceae	*Cynodon dactylon*	Entire plant	Irritation of urinary organs, dropsy, vomiting and piles
Poaceae	*Dactyloctenium aegyptium*	Entire plant, seeds	Astrigent, anthelmintic, itching, anti inflammatory
Poaceae	*Saccharum spontaneum*	Roots and stem	Astringent, emollient, refrigerant, diuretic, purgative, tonic, aphrodisiac.
Polygonaceae	*Polygonum barbatum*	Leaves	Pain, fever, anti inflammatory and diuretic
Polygonaceae	*Polygonum plebejum*	Entire plant	Pneumonia, bowel complaints, used as an excellent remedy for cholera
Polypodiaceae	*Adiantum masum*	Whole plant	Hepatitis
Primulaceae	*Anagallis arvensis*	Entire plant	Antitussive, cholagogue, diaphoretic, diuretic, expectorant, nervine, purgative, stimulant and vulnerary. (Toxic)
Punicaceae	*Punica granatum*	Fruit, bark, leaves	Stomachache, cardiac, cooling, regrigerant, astringent, anthelmintic)
Rhamnaceae	*Sageretia brandrethiana*	Leaves	Rheumatism, spermatorrhoea, opthalmia, astringent, stomachic, gonorrhoea and piles
Rhamnaceae	*Ziziphus mauritiana*	Fruit & leaves	Herbal tea, blood puifier, fever, intestinal worms, dysentery, diabetes
Rhamnaceae	*Ziziphus spina*-Christi	Root bark & fruit	Sedative, ulcer, heals wound, antiseptic, antifungal and anti-noiceptive potency with both central and peripheral effect
Rhamnaceae	*Ziziphus nummularia*	Entire plant	Boils, scabies, astringent, cooling, blood purifier, fever, herbal tea, intestinal worms, dysentery, diabetes
Rosaceae	*Spirea japonica*	Leaves, flowers	Anti inflammation, anti Platelet aggregation and neuro protective
Sapindaceae	*Dodonaea viscosa*	Bark	Bark of the plant is used against hepatitis and joindous astringent, rheumatism, swelling, burns
Serophulariaceae	*Bacopa monneri*	Entire plant	Traditional treatment of epilepsy and asthma. Used as tranquilizer, sedative, cognitive enhancing. Hepatoprotective and antioxidant action
Solanaceae	*Datura alba*		Asthma, muscle spam
Solanaceae	*Solanum nigrum*	Berries, leaves	Tea of younger leaves is used for curing flue, cough and fever. Dried fruits are used for stomach diseases. Cooked as potherb and used to cure inflammation of Internal organs. Poultice of leaves is applied on burnt skins and wounds.
Solanaceae	*Solanum surattens*	Berries, flower	Toothache, applied to broken organs. The berries applied as demulcent and expectorant, cough, asthma, and catarrh
Solanaceae	*Withania coagulans*	Fruit and seeds	Stomach ach and gas trouble

Tiliaceae	*Corchorus oletorius*	Leaves	It has anti oxidant activity
Tiliaceae	*Grewia optivia*	Leaves and flowers	Anti tumor, anti cancer and anti inflammatory
Tiliaceae	*Grewia tenax*	Root, leaves &fruit	Remedy for colds and chest complaints and also as a chief constituent in a typhoid remedy.
Ulmaceae	*Celtis australis*	Leaves & fruit	Astringent, lenitive and stomach
Verbenaceae	*Lantana camara*	Entire plant	Anti pyretic, carminative and used in respiratory system infections
Vitaceae	*Vitis trifolia*	Fruit	Antioxidant
Zygophyllaceae	*Fagonia cretica*	Leaves and twigs	Plant of insecticide and veterinary medicine and also used for treatment of gas trouble.
Zygophyllaceae	*Peganum harmala*	Seeds & leaves	Analgesic, anti inflammatory, anti bacterial, antifungal and anti pruritic

SHORT COMMUNICATION

A note on the kites of Pakistan

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Introduction

Pakistan represents all the three genera of kites found in South Asia. Kites belong to the family Accipitridae, order Accipitriformes are elegant birds, soar and glide on their long angular wings. Kites occur worldwide in warm regions, they are commonly found in a large variety of habitats including both natural and artificial habitat like woodlands, wetlands, savannah, river sides, towns, villages and cities. Some kites live on live food; others are primarily scavengers but also hunt live prey like rodents and reptiles.

Indian or Pariah Kite *Milvus migrans govinda*

The identification of the environmental parameters affecting species habitat preferences is a key to understanding the relationships between habitat features and species distribution. This understanding will provide little evidence base upon which to formulate guidelines for managing different Kite species populations in their preferred distributional ranges in the future. Over the years, during the wildlife surveys the opportunistic information on kites was gathered regarding the preferred habitat distribution.

In India a very old age myth is ascribed to the Indian Black Kite *Milvus migrans.* The shadow of this flying kite if touches to any Human is caused Bad Luck and considered too Bad Aman to him. The shadow of the Bird caused Great Greek Emperor's (Alexander the Great) defeat in India (http//:orientalbirdimages.org/search.php).

Black-shouldered Kite *Elanus caeruleus* Desfontaines

Black-shouldered or Black-winged Kite is a small graceful looking diurnal raptor best known for its hovering over open grassland country. The kite is distinctive with its long wings giving a pale dove grey look in general with white throat, belly and fore crown (King et al., 1986). It is also called Black-shouldered Kite in view of its black shoulders. The bird is distinguished by the absence of black wingtips and short tail in contrast to Pallid Harrier which share the same terrain (Roberts, 1991). The large front-facing eyes and the velvety plumage are unique characters of the genera shared with owls; the genus is considered the primary origin in the Accipitridae.

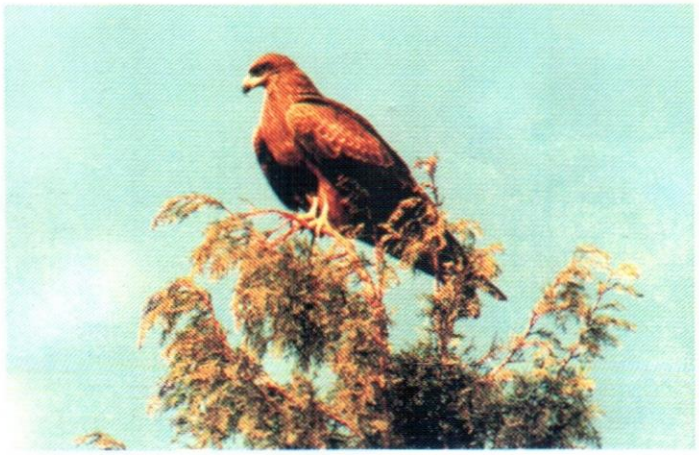
This is the commonest and most wide-spread bird of prey in the Indus plains and deserts occurring from Islamabad through Potohar and Salt Range down to Thatta and Karachi (Sindh). Primarily the species is inhabitant of open land and semi deserts. It has been frequently encountered in desert areas of Lasbella (Balochistan) and Tharparkar (Sindh). The species is a summer visitor in the northern Pakistan and occupies the ranges upto1400m in subtropical zone of Punjab and Khyber Pukhtunkhwa (KPK). Occasionally it is encountered in the environs of Rawal Lake and Marghalla Hills, Islamabad. Pyhala (2001) recorded species breeding in woodlands around Rawal Lake, Islamabad.

The bird is rarely encountered in Balochistan, less common in Punjab and common throughout in Sindh. In the daytime they spend most of their time perching on electric and telephone wires or open trees where they can watch for the prey (Roberts, 1991). Food includes small mammals, birds, reptiles and insects (Parejo, et al., 2001). Nest is built by using twigs in which 3-4 eggs are laid. Most eggs are laid in May. Incubation period is about 26 day and young are fledged and ready to leave the nest 30-35 days after hatching. Breeding have been noted in Lasbella, Khar in the Hab Valley (Balochistan). In sindh, the vast area includes in its spread. Species is

not migratory but make short seasonal movements (Roberts, 1991).

Indian Kite or Black Kite *Milvus migrans* Boddaert

The Indian black kite is a commonly seen bird like crow in the country. It was found all over the country except high mountains and pure large deserts. The black kite was mostly found in a variety of habitats like timberland watercourses to open plains. It was commonly found around villages, towns and cities. This is one of those bird species which make such large flocks even in many hundreds. They were commonly observed taking high flight with wide and long angular wings in search of food during the day time; they were recorded readily swooping down and snatching food held in the hands of children as well they swoop down and pick up boldly the domestic chicks in the close presence of humans. They were also observed in the company of crows looking for food in the garbage and slaughtering houses. The Indian kite is well-adapted to living in cities and towns.



Large Indian Kite *Milvus migrans lineatus* recorded in Galliats Forest, district Abbotabad, KPK. Perching on Large-leaved Elm

This is a medium-sized bird of prey. It has long narrow wings and tail. The head and neck is dirty buff with dark streaks and the upper surface of the body is dark brown. The bird is easily identified by its long angular wings and unlike others the forked tail with dark brown cross-bands. Three sub-species are identified in Pakistan: the *migrans*, *lineatus* and *govinda*. The nominate (*migrans*) is uniformly darker brown on body and wings but the head and neck is paler-whitish. The sub-race Lineated is the largest sized in the genera, usually showing darker ear coverts and a pale line on the mantle and breast. The sub species *govinda* is smaller with lighter ear coverts and streaks on the breast. It has dark plumage than the nominate. However, there is a considerable intergradation in plumage and young birds of all three subspecies (Roberts, 1991).

Black Kite *Milvus migrans migrans* recorded in Rawalpindi, Punjab

The sub species *govinda* is largely confined to the towns of Indus plains, more numerous in the crowded localities and near man where food is abundantly available. A small population of *govinda* is resident year-round in the towns of Balochistan particularly in the central and southern parts. The nominate subspecies *migrans* is a summer breeding visitor in Balochistan (Roberts, 1991) while the *lineatus* is winter visitor in Pakistan (Ali and Ripley, 1989). The author has commonly recorded in Murree Hills (Punjab) and Galliats Forests in distict Abbotabad (KPK) preffering high altitude thick woodland country (moist-temperate fairly dense mixed forest of Conifers and Broad-leaves) at 2500m altitude.

Large Indian or lineated Kite *Milvus migrans lineatus*

A pair was observed collecting nesting material on an old and large tree, Large-leaved Elm *Ulmus wallichiana.* Black kites *govinda* are still widely common in the country, they are most commonly encountered near garbage yards and slaughtering houses. The author has encountered in hundreds at Karachi, Lahore and Rawalpindi, they were evenly found in every village and town of the central and southern Punjab, all over the Sindh and southern

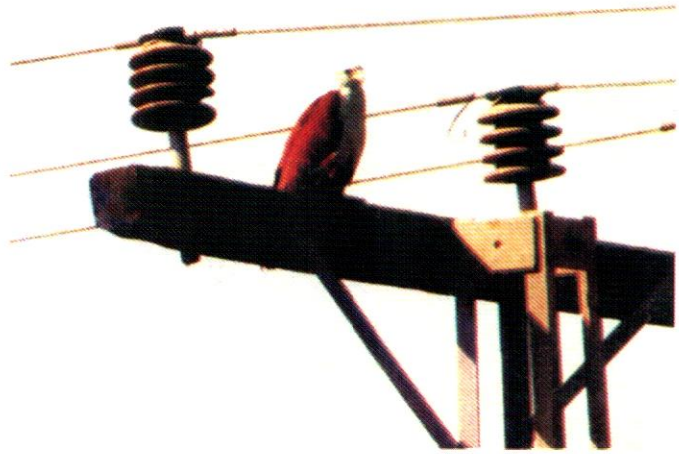
Pariah Kite *Milvus migrans govinda* in Safari Park, Karachi, Sindh

Balochistan. Rarely, they are seen in large flocks greater than 400 birds wheeling in a wide circle, but small flocks are commonly encountered over the towns and cities (Roberts, 1991). In winter, they are gregarious in their roosting and foraging areas. They are locally migratory and their assemblage has been recorded in large numbers at Thatta (Sindh) at the end of the monsoon in search of stranded fish food when the canals are dried out. They are mainly dependent upon the weak or sickly prey or carrion. The Indian populations are well-adapted to live in cities, towns and villages thickly populated by humans where they are frequently available variety of food items. Unlike others of the group they are resourceful hunters and scavenge the dead mice, rat and fish. Black kites are attracted to smoke and fires for escaping prey like lizards and rodents.

Breeding occurs over a much extended period usually begins in winter, the young birds fledgling before the monsoon. The nest is made by using lot of material consisting on twigs, rags, leaves and some stolen items as observed as comb, pencil, paper or other wood items placed on a tree or above the window shades (observations). Most of the nests (*govinda*) were observed at Shisham *Dalbergia sissoo* and Kikkar *Casia arabica* in Punjab, and Peepal *Ficus religiosa* in Karachi (Sindh). Both male and female take part in nest building, incubation and care of chicks. The clutch size is normally 2, or rarely 3 eggs, incubation period is 30-34 days, chicks stays at nest for nearly two months (Roberts, 1991).

Brahminy Kite *Haliaster indus* Boddaert

The Brahminy Kite is also known as the Red-backed Sea-eagle in Australia. It is a medium-sized bird of prey in the family Accipitridae. Being primarily a scavenger they are found mainly on the coastal sites and inland wetlands in the plains where the food is frequently available in the form of dead fish and crabs. They occasionally hunt live prey. The bird is easily identified by its bright chestnut plumage with white head, neck and breast. White



Brahminy Kite *Haliastur indus* in district Badin, Sindh

parts of head and neck are narrowly streaked with blackish brown. Unlike the forked tail in the black kite they are identified by their rounded tail and shorter wings.

In Pakistan, the bird is found marshy and coastal areas of lower Sindh but most commonly occurs in district Thatta. It rarely occurs along the Indus river system in Punjab as well as Panjnand Headworks in Bahawalpur and surroundings of Lal Suhanra. In Balochistan and KPK the kite is either absent or very scarce. Indus delta and rice growing areas in Sindh is stronghold of the species (Roberts, 1991). They also have been recorded at Taunsa Barrage

district DG Khan and Lal Suhanra district Bahawalpur. The author has recorded it in Badin and Thatta districts of Sindh and the same is commonest place of the bird. It has not been recorded in interior Balochistan and KPK.

The nesting season begins in December and continues to April. The nests are constructed of shoots, twigs, sticks and leaves sited on a tree. Both parents take part in nest-building, feeding and caring of young ones but incubation is a duty of the female. The incubation period lasts about 26-27 days (Roberts, 1991).

Status and Habitat Preference

Black Shouldered Kite hunts mostly mice, insects, small bids, reptiles and amphibians and therefore is a bird of open country encountered not far from the water bodies. The bird is locally wide-spread in the Indus plains of Punjab and Sindh extending to the southern parts of Balochistan and in the eastern ranges of the KPK. In recent years no change in the status of Black-shouldered Kites locally was noticed. It is little studied Kite species. Occasionally it is encountered around Rawalpindi and Islamabad (Punjab). It is still less common in its wider range.

The Indian Kite or Black Kite is one of the common raptor in the country, larger resident populations are confined mostly to the big cities, towns, villages and everywhere the human settlements are located. The species is dwindling in the parts of its ranges. The main threat to the species is considered the use of agricultural pesticides, water pollution and hunting.

Brahiminy Kite is evaluated as Least Concern on the IUCN Red List of Threatened Species. However the species is on the decline in its local ranges. The species is restricted to a specific environment of marshes near the coastal areas which is a small tract in the districts Badin and Thatta (Sindh). Draught in the marshy areas and the polluted water is the major threat to this bird.

References

Ali, S. and Ripley, S. D. 1989. Compact Hand Book of the Birds of India and Pakistan. Second Edition, 737pp. New Delhi, India.

http//:orientalbirdimages.org/search.php

King, B., Woodcock, M. and Dickinson E. C. 1986. A field Guide to the BIRDS of Southeast Asia. Collins GraftonStreet, London. 480pp.

Pyhala, M. 2001. Birds of Islamabad: status and seasonality. WWF – Pakistan. Ferozepur Road, Lahore, Pakistan. 133 pp.

Parejo, D., Avilés, J. M., Ferrero, J. J. and Rivera, D. 2001. "Communal roosting and diet of Black-shouldered Kite Elanus caeruleus wintering in the southwest of Spain". Journal Raptor Research 35: 162–164.

Roberts, T. J. 1991. The Birds of Pakistan. Volume 1 (Non Passeriformes), Oxford University Press, Karachi. 598 pp.

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