

Biodiversity Assessment

Biogeography

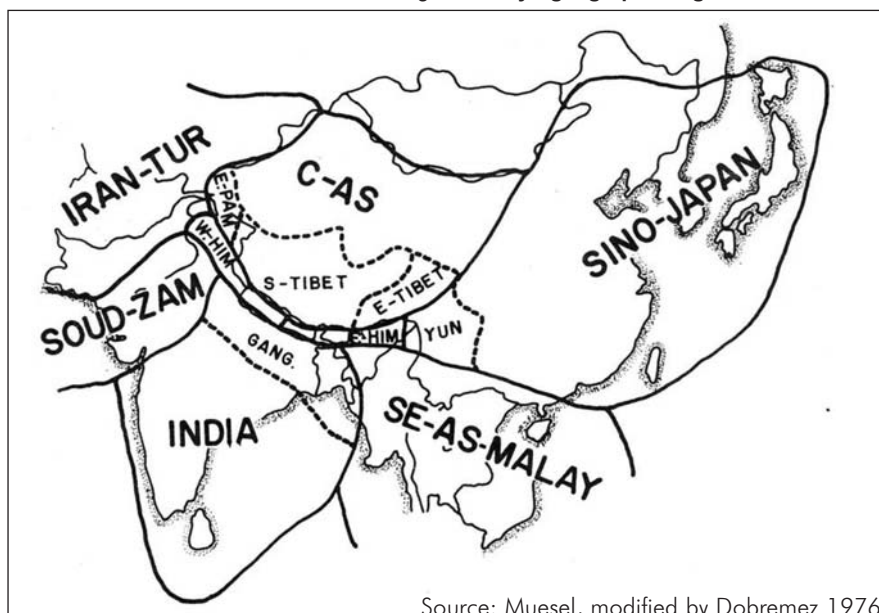
Nepal's geological history has given rise to the country's complex biogeography reinforced by its presence at the crossroads of two biogeographic realms: Palearctic in the north, and Palaeotropical in the south (Udvardy 1975). Zoo-geographically, Nepal falls within two biogeographical realms: Indo-Malayan and Palearctic. Phyto-geographically, Nepal lies at the crossroads of six floristic regions: Central Asiatic in the north, Sino-Japanese in the east, Southeast Asia-Malaysia in the south-east, Indian in the south, Sudano-Zambian in the south-west, and Irano-Turanian in the west (Figure 1).

Phyto-geographical studies of Nepali flowering plants indicate that the lower sub-tropical and tropical bioclimatic belts below 1500m altitude are floristically related to the south-east Asia-Malaysian and Indian floristic regions. The central belt, composed of upper sub-tropical and temperate bioclimatic zones at altitudes ranging from 1500m to 3000m, are floristically related to the Sino-Japanese floristic region. The sub-alpine and alpine zones above this belt are floristically related to the central Asiatic floristic region. The floristic relations of Nepal with the Sudano-Zambian and Irano-Turanian floristic regions

are feeble in magnitude in the western parts of Nepal (Shakya 1983).

Adding variety to this diverse mix are plants from the arid highlands of the Tibetan Plateau (central Asian elements) in the north and plants from Indo-Gangetic elements (Indo-Chinese and Indo-Malayan regions) found in the southern lowland plains or Terai, representing widespread species from the humid tropics that extend deep into Southeast Asia. Understanding the distribution of plants within the Himalayas requires an examination of both the floristic regions found in the area and its geological history. Indicator species such as the Indian horsechestnut (*Aesculus indica*) and Deodar cedar (*Cedrus deodara*) are predominantly found in the west, while Evergreen broadleaf (*Castanopsis hystrix*) and the Sikkim larch (*Larix griffithiana*) are predominant in eastern and central Nepal.

Figure 1. Phytogeographic regions of South Asia



Source: Muesel, modified by Dobremez 1976

Vegetation types

Climatic and vegetation classifications

Adam Stainton (1972) used the following climatic and vegetation divisions in his classification of forest types in Nepal.

1. Terai and outer foothills, including the Siwalik Hills and valleys
2. Midlands and southern slopes of the main Himalayan ranges
 - a. Western Midlands
 - b. Central Midlands
 - c. Eastern Midlands
 - d. South of Annapurna and Himalchuli
3. Jumla-Humla region
4. Dry river valleys
5. Inner valleys
6. Arid zone

Stainton recognised 35 forest types classified into 10 major groups. This categorisation has been widely adopted in later work.

Jean-François Dobremez (1972, 1976) recognised four domains (western, northwestern, central, and eastern); six levels, and 11 sublevels of bioclimatic zones. Under these bioclimatic zones, Dobremez et al. (1970-1985) in their eight ecological maps of Nepal identified 136 ecosystems. These were later reduced to 118 by ICIMOD/MENRIS in 1995, by grouping closely allied types together during the process of map digitisation (BPP 1996). In 1998/1999, IUCN revised the classification of vegetation types and

devised a list of 59 kinds of vegetation for use by the Tree Improvement and Silvicultural Component (TISC/NRMSAP) /Natural Resource Management Sector Assistance Programme. The 59 kinds of vegetation have been further reduced to 36 in order to present a simplified ecological picture of Nepal's vegetation, based upon climax or near-climax vegetation type spread over potential areas of ecological homogeneity (Annex 1.1) (TISC/NRMSAP/MFSC 2002).

Ecoregional classification

The ecoregional classification made by WWF's US Conservation Science Program categorises Nepal's landmass into nine land-based ecoregions defined by ecological feature, climate, as well as by their plant and animal communities. Of these, three are considered in the 'Critical/Endangered' conservation status; three are considered 'Vulnerable'; and three 'Stable/Intact'. (Table 5) (NGS and WWF 2001).

Vegetation maps

Schweinfurth (1957) developed the first vegetation map of the Himalayas and laid the foundations for more detailed work in Nepal by later authors. Dobremez and his co-authors, including three Nepali scientists, TB Shrestha, PR Shakya, and DP Joshi, prepared a series of ecological maps of Nepal. Stearn (1960), using climatological, floristic, and ecological data, proposed a broad categorisation of Nepal into three geographic regions: Western Nepal (corresponding to the Karnali River system from the western boundary of Nepal to 83°E

longitude), dominated by western Himalayan flora; Eastern Nepal (corresponding to the Koshi River system from the eastern boundary of Nepal to 86°30'E longitude), dominated by an eastern Himalayan flora; and Central Nepal (between 83° and 86°30'E), comprising an inter-mediate zone between these two floras (Table 6). This classification was used to indicate distribution of plant species in Nepal (*Enumeration of the Flowering Plants of Nepal*, Hara et al. 1978, 1979, and 1981).



P. R. Shakya

Steppe-Caragana, Berberies, among others, at Lower Mustang 2780m

Table 5. Ecoregions, Distribution and Conservation Status

Symbol	Ecoregion Type	Distribution	Conservation Status
IM0115	Himalayan subtropical broadleaf forests	Bhutan, India, Nepal	Critical/ Endangered
IM0301	Himalayan subtropical pine forests	Bhutan, India, Nepal, Pakistan	Vulnerable
IM0401	Eastern Himalayan broadleaf forests	Bhutan, India, Nepal	Stable/Intact
IM0403	Western Himalayan broadleaf forests	India, Nepal, Pakistan	Critical/Endangered
IM0501	Eastern Himalayan sub-alpine conifer forests	Bhutan, India, Nepal	Vulnerable
IM0502	Western Himalayan sub-alpine conifer forests	India, Nepal, Pakistan	Vulnerable
IM0701	Terai-Duar savannah and grasslands	Bhutan, India, Nepal	Critical/Endangered
PA1003	Eastern Himalayan alpine shrub and meadows	Bhutan, China, India, Myanmar, Nepal	Relatively Stable/ Intact
PA1021	Western Himalayan alpine shrub and meadows	India, Nepal	Relatively Stable/Intact
Note: IM = Indo-Malayan, PA = Palearctic			
Source: NGS and WWF, 2001 Available at http://www.nationalgeographic.com/wildworld/			

Zoologists Swan and Leviton (1962) used a system of seven ecological zones based on altitude, but did not differentiate between east-west patterns.

Two landmark publications in 1972, both the result of many years of fieldwork by their respective authors, combined climatic and phytogeographic regions (Stainton 1972; and Dobremez 1972, 1976). These two systems of vegetation classification are widely used today and are outlined in tables below. Other notable contributions to plant ecology and vegetation studies in Nepal have been made by George Meihe and co-workers from 1990 onwards. In all these systems, generalisations need to be made as vegetation zones are greatly affected by local conditions, particularly rainfall and aspect. Sometimes the boundaries are abrupt and clear; but often they are gradual and intergraded over quite large areas. The vegetation pattern for the whole country is a complex mosaic and the categorisation is open to debate.

Diversity at different altitudes

The monsoon climate and vast altitudinal range in Nepal create a wide array of habitats, from lowland (as low as 67m above mean sea

level), evergreen tropical forests in the Terai and low hills (below 1000m), through temperate sub-alpine broadleaved and coniferous forests to the tree line (Table 7). Above this, rhododendron scrublands extend up to the high alpine meadows before plant life gives way to frozen and biologically barren snow-capped peaks including Mount Sagarmatha (8848m). The highest recorded flowering plants such as the Scree plant (*Ermania himalayensis*) of the Brassicaceae family are found at around 6000m. The deep river valleys and gorges create their own microclimates. Dramatic vegetation changes can be seen over relatively small areas with differing aspects and altitudes.

Terai-Siwaliks (below 1000m)

The biological diversity contained in the Terai and Siwalik Hill (lowlands) ecosystems are of international significance, both in view of the numerous globally threatened species of fauna and flora they harbour, as well as because of the diversity of ecosystems contained within the area (BPP 1995). The Terai is densely populated resulting in incalculable encroachment and pressure on forest resources. The lowlands are mostly dominated by Sal (*Shorea robusta*), tropical deciduous riverine forests and tropical evergreen forests. Sparse cover of Sal forests remain in eastern and central Nepal, the bulk having succumbed to widespread logging and deforestation, but they still form some magnificent stands of tall trees in western Nepal.

In recognition of the magnitude of biodiversity of the lowlands, the Government of Nepal has established five protected areas in the Terai and

Table 6. Phytogeographical Divisions

Divisions	West	Centre	East
Boundary	Western frontier to 83° 00' East longitude	83° 00' East longitude to 86° 30' East longitude	86° 30' East longitude to Eastern frontier

Table 7. Bioclimatic and Equivalent Physiographic Zones			
Altitude (m)	Bioclimatic Zones	Physiographic Zones	BPP/NBY
Above 5000	Nival	High Himal	Highlands
4501 to 5000	Upper Alpine	High Mountains	
4001 to 4500	Lower Alpine		
3501 to 4000	Upper Sub-Alpine		
3001 to 3500	Lower Sub-Alpine		
2501 to 3000	Upper Temperate	Mid-Hills	Mid-Hills
2001 to 2500	Lower Temperate		
1501 to 2000	Upper Sub-Tropical		
1001 to 1500	Lower Sub-Tropical		
501 to 1000	Upper Tropical	Siwaliks	Terai-Siwaliks
Below 500	Lower Tropical	Terai	
Domain north-west, Dobremez (1976) localised in the trans-Himalaya Sources: Dobremez 1972, LRMP 1986			

Siwalik Hills. These are the Koshitappu Wildlife Reserve, Parsa Wildlife Reserve, Chitwan National Park, Bardia National Park, and Shuklaphanta Wildlife Reserve. While the Terai ecosystems are well represented within these protected areas, coverage of the Siwalik Hill ecosystems is less comprehensive (Maskey 1996).

Out of the 23 ecosystems described by Dobremez in the lowlands, 15 are included in the current protected areas of Nepal. The Biodiversity

Profiles Project (BPP 1995) lists 1,885 species of angiosperms, 61 species of bryophytes, and 81 species of pteridophytes from the Terai and Siwalik Hills. To date, most of the exploratory work on the flora of Nepal has been done in the mid-hills mountains. Recent studies and surveys of floral species in the Terai and Siwalik Hills are expected to alter this count significantly. Faunal diversity in the different ecological zones is not well categorised but is, reported to be high in the Terai and Siwalik Hills (BPP 1995).



R N Suwal

Black scorpion, Lumbini



P R Shakya

Bombax cieba L., Kaski 1300m



R Suwal

Red Jungle fowls (*Gallus gallus murgae*)



U R Bhujju

Sal (*Shorea robusta* Gaertn, 2005) Shankarnagar Forest, (Rupandehi)

Out of the 833 bird species found in Nepal, the Biodiversity Profiles Project lists 648 species in the Terai and Siwalik Hills. Some 111 of them are species confined to this area alone. The lowland fauna is seen to be more endangered than mid-hills or mountain fauna because of greater human activity in the lowlands of the Terai and Siwalik Hills (HMGN/MFSC 2002).

Studies indicate evidence of an estimated 1,499 species of flowering plants found at altitudes of 1000m and below.

Mid-Hills (1000-3000m)

The Mid-Hills constitute the greatest ecosystem and species diversities in Nepal. The great diversity of terrain and the occurrence of subtropical to temperate flora and fauna in this zone account for this. Nearly 32% of the forests in Nepal are found in the Mid-Hills, and the zone includes 52 types of ecosystems. Dobremez (1996) presented the origin of flora in central Nepal and their distribution in 11 sublevels under five main levels (from Tropical to Nival types) of vegetation, and 15 Himalayan biogeographical domains. He pointed out the occurrence of the highest number of angiosperms in the Mid-Hills, particularly between the altitudes of 2000-2500m. The Biodiversity Profiles Project (BPP 1995) lists 3,364 species of angiosperms, 493 species of bryophytes, 272 species of pteridophytes, and 16 species of gymnosperms in the Mid-Hills. Furthermore, 557 species of butterflies, 76 species of fish, 29 species of amphibians, 56 species of reptiles, 691 species of birds, and 110 species of mammals are listed in the mid-hills (HMGN/MFSC 2002).

Studies indicate evidence of an estimated 2,028 species of flowering plants found at between 1000m to 2000m altitude, and 1,989 species growing at between 2000m to 3000m.

Highlands (above 3000m)

The Nepal Highlands are a point of convergence of two major geographical regions of the world: the Palaearctic region to the north, and the Palaetropical or Indo-Malayan region to the south. Thirty-eight major ecosystems are found in the Highlands. In recognition of the significance of these ecosystems, the Government of Nepal has established seven protected areas in the Highland mountains (and three protected areas spanning the Mid-Hills and



Bistorta millitii field, Chhedi Patan, Khaptad National Park

U R Bhujju

Highlands), covering 78.52% (20,939km²) of the total protected areas. These protected areas represent 30 of the 38 highland ecosystems (HMGN/MFSC 2002).

The Highlands are relatively less diverse in both flora and fauna than the Mid-Hills and lowlands due to adverse environmental conditions. They are, however, characterised by large numbers of endemic species. The highlands host around one-third of the total forest cover of Nepal representing birch oak, rhododendron, juniper, fir, cedar, larch, and spruce forests. About 420 phanerogamic species have been recorded above 5000m on both sides of the Himalayan range in the Everest region (Miehe 1989).

Studies indicate evidence of an estimated 1,645 species of flowering plants found between 3000m to 4000m; and 1,071 species above 4000m

Species diversity

Global comparison

Nepal comprises only 0.1% of land area on a global scale but possesses a disproportionately rich diversity of flora and fauna at genetic,

species, and ecosystem levels. The species are found in the dense tropical monsoon forests of the Terai, in the deciduous and coniferous forests of the country's subtropical and temperate regions, and in the sub-alpine and alpine pastures and snow-covered Himalayan peaks. Comprehensive summaries of species diversity are presented in **Tables 8 and 9**.

Diversity of flora

There has been comparatively more research on higher groups of plants (angiosperms and gymnosperms); research on the lower groups has not been as extensive or systematic. Collection of Nepali specimens was initiated in 1802 by Buchanan Hamilton, and was continued by N Wallich in 1820-21. Since then, many parts of Nepal have been well explored. Major herbaria that house Nepali specimens are found in the National Herbarium and Plant Laboratories, Kathmandu; the Natural History Museum, London; Herbaria of the Royal Botanic Garden, Kew; the University of Tokyo, Japan; the Smithsonian Institution, Washington DC; the University of Grenoble, France; and the Royal Botanic Garden, Edinburgh. It is estimated that

the British Museum has over 40,000 specimens, the University of Tokyo about 100,000 specimens, and the National Herbarium and Plant Laboratories of Kathmandu, 150,000 specimens. Moreover, approximately 10,000 specimens are housed in various institutions in Tribhuvan University (TU). Nepali herbarium specimens are also housed in 38 herberia throughout the world (Shakya 2002).

The Flora of Nepal programme was initiated by the National Herbarium and Plant Laboratories of Godavari under the Department of Plant Resources (DPR-MFSC 1997). The Department of Plant Resources was established in 1960-61, and has established seven district offices for the development of plant resources activities at the district level. The Ministry of Forests and Soil Conservation (MFSC), TU, and the Nepal Academy of Science and Technology (NAST) have signed an agreement to produce a comprehensive list of flora of Nepal. The Department of Plant Resources has published 32 books and booklets about local and regional flora, and TU has published several papers on the subject. Several Master of Science dissertations from TU have studied local flora, ecology, and biological diversity. Foreign institutions actively involved in the Flora of Nepal Programme include the Natural History Museum in London, the University of Tokyo, and the Royal Botanic Garden of Edinburgh.

Bacteria. Between 3,000 and 4,000 bacteria species have been identified around the world. Enormous numbers of uncultured bacteria are yet to be identified from soils, deep sea sediments, and the digestive tracts and pockets of a wide variety of animals and insects (WCMC 1992). This important group of organisms has not received adequate attention in Nepal yet, and the study of bacteria in diverse habitats is needed.

Lichens. During the International Workshop on Lichen Taxonomy held in Kathmandu in 1994, lichenologists estimated about 2,000 lichen species in Nepal. Lichens are found in all climatic zones. Forty-eight lichen species are reported to be endemic to Nepal. Sharma (1995) identified 471 species from 79 genera and 30 families. Studies on lichens have been carried out mainly in eastern and central Nepal. Lichens from the lowland Terai and Siwalik Hills are much less known, and those of western Nepal remain largely unexplored.

Table 8. Comparative Totals of Plant Species of the World and Nepal

Group (Life Form)	World Number	Nepal	
		Number#	%
Flowering Plants	231,638*	6,391	2.76
Pteridophytes	10,369*	534	5.15
Lichens	>17,000**	471	2.77
Bryophytes	>14,000**	668	4.77
Fungi	>70,000**	1,882	2.69
Algae	>40,000**	687	1.72
Total	>403,000	10,633	2.80
Sources: * UNEP-WCMC 2006; ** WCMC 1992; # Modified after Malla and Shakya 1998			

Table 9. Comparative Total of Animal Species in the World and in Nepal

Group (Life Form)	World Number	Nepal ¹	
		Number	%
Mammals	4,675 ⁺	185	3.96
Birds	9,799 [@]	874	8.90
Herpeto	12,650	195	1.54
Amphibians	4,780 ⁺	118	2.47
Reptiles	7,870 ⁺	78	0.99
Fish	10,000 [@]	187	1.87
Butterflies	17,500 [#]	651	3.72
Moths	160,000 [#]	785	0.49
Spiders	39,490 [*]	175	0.44
Sources: ⁺ Uetz, P. 2000, [@] BirdLife International 2006, ¹ IUCN. 2003, [#] Smithsonian Institution 2007, [*] Platnick, NI. 2006, ¹ Annexes to this document			

Fungi. Adhikari (1999) listed 1,822 species of fungi belonging to 585 genera and 80 families. However, studies on fungi have mainly focused in the Mid-Hills and high altitude regions and in the Kathmandu Valley, and exploration in the lowlands has been inadequate. Little is known about the distribution of fungi in Nepal.

Algae. Baral (1995) identified 687 species of algae belonging to 150 genera and 50 families in Nepal, with 12 species presumed to be endemic. Most work on algae has been concentrated in the High Mountain and Mid-Hills regions. The Terai belt, which supports luxuriant growths of algae owing to its hot and humid climate, has not been extensively investigated yet.

Bryophytes. A total of 853 species of bryophytes (mosses and liverworts) has been recorded (Kattel and Adhikari 1992) and 668 species of bryophytes listed, of which 627 species are found in eastern Nepal, and 283 species in central Nepal (BPP 1995) (**Annex 1.2**). The largest number of bryophyte species, 493, has been recorded in the Mid-Hills (subtropical and temperate zones); 347 in the High Mountains (alpine and sub-alpine zones); and 61 in the Siwalik Hills and Terai (tropical zone). The bryophytes of eastern and central Nepal have been reasonably well studied, but work is still required on the bryophytes of western Nepal.

Pteridophytes. An enumeration of pteridophytes (ferns and fern allies) was compiled by Iwatsuki (1988). Iwatsuki recorded 380 species, with 258 distributed in the eastern region, and 97 in the central region of Nepal. No collections have been made from western Nepal. The greatest number of pteridophyte species was recorded in the Mid-Hills: 272 species in subtropical and temperate zones. The Siwalik Hills and the Terai tropical zones hold 81 species, the High Mountains (alpine and sub-alpine zones) 78 species, and the high Himalayas (Nival zone) just one species. **Pteridophytes of Nepal**, published in 2002 by the Department of Plant Resources, enumerated 534 species of ferns and fern allies representing 35 families and 102 genera (**Annex 1.3**) (DPR-MFSC 2002).

Gymnosperms. Gymnosperms have been the best studied topic amongst the vascular plants of Nepal. Altogether, 27 species of gymnosperms have been listed (Koba et al. 1994). These

include 20 indigenous species belonging to 13 genera and 10 families (Shrestha 1984-85).

Angiosperms. The angiosperm flora of Nepal is impressively high on a global scale in view of the limited area of the country. Koba et al. (1994) extended the lists of flowering plant species prepared by Hara and Williams (1979); Hara et al. (1978;1982), enumerating 5,806 species belonging to 203 families. To this number, a list of 50 species has been added by Akiyama et al. (1998) bringing the total angiosperm species count in Nepal to 5,856. The introduction of additional species new to Nepal has raised this number to 5,891 (Malla and Shakya 1998). However, Hara et al. (1978) and the World Conservation Monitoring Centre (Caldecot et al. 1994) estimate a total of 6,500 species. This figure is corroborated by the Biodiversity Profiles Project (1995) ranking Nepal as having the tenth richest flowering plant diversity in Asia. On a world scale, Nepal ranks 31st (Caldecot et al. 1994).

Calculations for the Nepal Biodiversity Resource Book 2006 was based on the checklists including BPP (1995), eflora of Nepal (Press, JR, Shrestha, KK, and Sutton, DA. 2000), and the Flora Himalaya Database (Dobremez et al. 1967-2005). The findings indicate evidence of 6,391 phanerogamic species in Nepal representing 1,590 genera, and 231 families (**Annex 1.4**). The species number also includes infraspecific taxa (subspecies, varieties, and forma).

Table 10. Families Represented by Higher Numbers of Genera and Species

Family	Species*	Genus
1. Poaceae (Gramineae)	454	126
2. Asteraceae (Compositae)	450	110
3. Orchidaceae	423	98
4. Fabaceae (Leguminosae)	362	94
5. Rosaceae	236	29
6. Cyperaceae	213	19
7. Ranunculaceae	208	21
8. Scrophulariaceae	190	41
9. Lamiaceae (Labiatae)	162	46
10. Apiaceae (Umbelliferae)	144	48
11. Gentianaceae	134	15
12. Brassicaceae (Cruciferae)	124	42
13. Rubiaceae	121	37
14. Saxifragaceae	108	6
15. Primulaceae	107	6
16. Caryophyllaceae	105	16
17. Euphorbiaceae	102	30

including infraspecific levels

Source: BPP 1995, Flora Himalayan Database 1967-2005

The top ranking families in terms of the highest numbers of genera (over 90), and species (362 and above), are **Poaceae**, **Asteraceae**, **Orchidaceae**, and **Fabaceae** (Table 10).

Diversity of fauna

The number of fauna species in Nepal is relatively high. Higher fauna groups have been relatively well studied. The taxonomy and distribution of lower fauna groups, with the exception of butterflies and to some extent spiders, are yet to be studied. A comprehensive **Fauna of Nepal** guide is essential in order to understand the status of such species for their effective conservation.

Platyhelminthes. Helminths are invertebrate animals with bilateral symmetry and without appendages. Most of these species are parasitic and are found in the wild as well as within domestic plants and animals. In Nepal, helminths are not well studied and helminthological work is confined to the Kathmandu Valley. A checklist of 168 species of helminth parasites has been compiled: 33 species belong to trematodes, 67 to nematodes, 36 to cestodes, and 32 species are plant Nematodes (Gupta 1997). Some common plant helminth parasites include the *Melioidogyne incognita*, *M. arenaria*, and *M. javanica*, all of which cause damage to vegetables. *Ascaris lumbricoides*, *Ancylostoma duodenale*, and *Taenia* species are common human parasites.

Spiders. Thapa (1995) reported 144 species of spiders belonging to 17 families. Some 109 species were new to science at the time of their

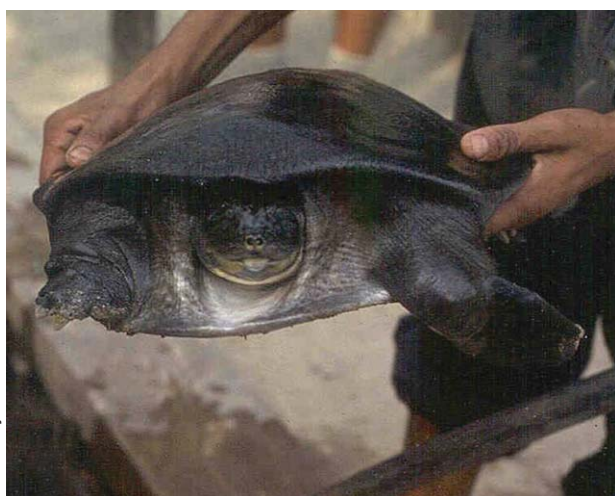
identification in Nepal. Most have been collected from the High Mountains and Mid-Hills. The far-western region and the entire lowland Terai and Siwalik Hills need further study. With the additional contributions of Thapa and Rana (2001), 175 species of spiders have been identified (**Annex 2.1**).

Insects. An inventory by Thapa (1997) enumerates 5,052 species of insects; 1,131 species were discovered for the first time and described from Nepali specimens. *Apis laboriosa*, the world's largest honeybee; *Attacus atlas*, the world's largest Atlas moth; and *Epiophlebia laidlawi*, a relict dragonfly species, are three insect species unique to Nepal. A list of 564 species of insects representing 17 orders, with the exception of Lepidoptera, is presented in **Annex 2.2**.

Butterflies and Moths. Among Nepal's fauna, butterflies are the best studied group throughout the country (Smith 1994; 1997). In 1995, 640 species of butterflies were recorded in different ecological zones. The Red Data Book of the Fauna of Nepal (BPP 1995) listed 142 species of which 12 were endangered, 43 vulnerable, and the remaining 87 species susceptible to becoming threatened in the future. Four species and 25 subspecies are possibly endemic. There are 557 species found in the Mid-Hills, 325 in the Terai, and 82 in the highlands (BPP 1995). Some 2,253 species of moths excluding *Microlepidoptera* have been recorded in Nepal (HMGN/MFSC 2002). The current list includes 651 species of butterflies (**Annex 2.3**) and 785 species of moths (**Annex 2.4**) (Thapa, 1998; and Khanal, B. 2006).

Fish. The fishes of Nepal have been fairly well documented. There are 187 species. (**Annex 2.5**) (Shrestha, J. 1995; and DNPWC 2001). Many taxonomic changes have been made in the genera and species of fish by Shrestha, J. (2001) who listed a total of 182 species belonging to 11 orders, 31 families, and 93 genera. Altogether, 34 species are known to be threatened and eight species are endemic to Nepal.

Amphibians and Reptiles. Shah (1995) listed 143 species of amphibians and reptiles in Nepal. Forty-three species include one salamander; four toads, and 38 frogs. The 100 species of reptiles include 24 lizards, 14 turtles, two crocodiles, and 60 snakes. Studies of amphibians and reptiles have been carried out in a number of areas



Black Soft-shelled turtle (*Melanochelys trijuga indopeninsularis*), Karnali River



R N Suwal

Bar headed Geese (*Anser indicus*) flying over the skies of Chitwan National Park

including the Arun Valley in eastern Nepal, Chitwan National Park in central Nepal, and the Annapurna-Dhaulagiri region in western Nepal. There are 195 species of herpetofauna, including 77 amphibians and 118 species of reptiles in Nepal (**Annex 2.6**) (Shah, K. 1995; and Shah and Tiwari 2004).

Birds. The birds of Nepal have been well studied. A total of 874 bird species have been recorded by 2006 (BCN. 2006, Inski 1991; Fleming 1976; and Baral 2005). BPP records included 854 species of birds including 11 species listed as extinct. The DNPWC/BCN checklist included 862 species of birds; other sources reported 12 additional species.

An additional 20 species of birds have been added to the BPN list since 1996 (**Table 11**).

Of the total 874 species of birds, 62% are resident birds, 14% are winter visitors, 12% are passage migrants, 6% summer visitors, 5% residents and migrants, and 1% summer and winter visitors (**Annex 2.7**).

Mammals. A comprehensive account of Nepal's mammalian fauna has been produced by Suwal and Verheugt (1995) who listed 181 mammal species belonging to 12 orders and 39 families.

Table 11. Bird Species Added to the BPN Checklist

SN	Scientific name	Common name
1.	<i>Acrocephalus melanopogon</i>	Moustached Warbler
2.	<i>Anser albifrons</i>	Greater White-fronted Goose
3.	<i>Aplonis panayensis</i>	Asian Glossy Starling
4.	<i>Calidris canutus</i>	Red Knot
5.	<i>Carpodacus rodopeplus</i>	Spot-winged Rosefinch
6.	<i>Emberiza pallasi</i>	Pallas's Bunting
7.	<i>Gavia stellata</i>	Red-throated Loon
8.	<i>Mycerobas icterioides</i>	Black-and-yellow Grosbeak
9.	<i>Oenanthe picata</i>	Variable Wheatear
10.	<i>Oenanthe xanthopyrma</i>	Rufous-tailed Wheatear
11.	<i>Pericrocotus erythropygius</i>	White-bellied Minivet
12.	<i>Ploceus megarhynchus</i>	Finn's Weaver
13.	<i>Porzana bicolor</i>	Black-tailed Crane Sp
14.	<i>Prinia burnesii</i>	Rufous-vented Prinia
15.	<i>Pyrhula erythaca</i>	Grey-headed Bullfinch
16.	<i>Riparia diluta</i>	Pale Martin
17.	<i>Seicercus whistleri</i>	Whistler's Warbler
18.	<i>Sphenocichla humei</i>	Wedge-bellied Wren Babbler
19.	<i>Sturnus sturninus</i>	Purple-backed Starling
20.	<i>Syrrhaptes tibetanus</i>	Tibetan Sandgrouse
Sources: BCN 2006, Baral H. 2005, Inskipp C. 2000		

The current list includes 185 species of mammals (Annex 2.8). The four new additions are the binturong (*Arctictis binturong*), Indian mongoose (*Herpestes nyula*), Himalayan marmot (*Marmota himalayana*) and Tibetan gazelle (*Procapra picticaudata*) (Table 12). The Indian mongoose (*Herpestes nyula*) is not included in the general mammal checklist although it is mentioned in the BPP document (BPP. 1995). Mammals are well represented in the protected areas of Nepal.

Species distribution

Species distribution is examined from two perspectives: confinement, and richness. Confinement analyses the number of species distributed in a given region; richness assesses the total number of species found.

Species confinement

Of the total number of mammal species identified, the Terai-Siwaliks region harbours the highest number of confined species, including 35 mammal species, 111 bird species, 46 herpeto species, and 106 fish species (Table 13). The central phytogeographical region harbours the highest number of confined species including 28 mammal species, 24 bird species, 40 herpeto species, and 31 fish species (Table 14). Collectively, the central Terai-Siwaliks region contains the highest number of species confined to a region. The number of species spatially confined to the specific regions such as the Central Highlands, Eastern Mid Hills, and Western Terai-Siwaliks are presented in Table 15.

Table 12. New Additions to the Mammals Checklist				
SN	Common name	Scientific Name	Location	Source
1	Binturong	<i>Arctictis binturong</i>	CNP	CNP Plan 2000
2	Indian Mongoose	<i>Herpestes nyula</i>	ACA	BPP 1995g
3	Himalayan Marmot	<i>Marmota himalayana</i>	ACA	KMTNC 2005
4	Tibetan Gazelle	<i>Procapra picticaudata</i>	ACA	KMTNC 2005
Source: Nepalnature.com				

Table 13. Fauna Species Confined to Physio-graphical Regions				
Altitudinal Zones	Mammals	Birds	Her-peto	Fish
Highlands	30	21	6	3
Mid Hills	32	24	32	14
Terai-Siwaliks	35	111	46	106
Sources: Annexes 2.5 to 2.8				

Table 14. Fauna Species Confined to Phytogeographical Regions			
Divisions	West	Center	East
Mammals	10	28	7
Birds	4	24	19
Herpeto	13	40	30
Fish	5	31	12
Sources: Annexes 2.5 to 2.8			

Species richness

Based on phytogeographical and altitudinal zoning, Nepal’s landmass can be divided into nine blocks. Among them the central Mid-Hills harbour the highest number of mammals (55%) and birds species (77%); the central Terai-Siwaliks harbour the highest number of herpeto (45%), and the eastern Terai-Siwaliks houses 74% of fish species. Overall, richness in species is highest in the central Mid-Hills, followed by the central Terai Siwaliks, the eastern Terai Siwaliks, the western Terai Siwaliks, the eastern mid-hills, the central Highlands, the western Mid-Hills, the eastern Highlands, and finally the western Highlands (Table 16 and Figure 2).



U R Bhuiju

Tiger (*Panthera tigris*) pugmarks found at Chitwan National Park

Table 15. Fauna Species Confined to Physiological-Phytogeographical Regions

Region (Spatial confinement)	Mammals	Birds	Herpeto	Fish
Highlands	15	15	1	-
Central Highlands	10	5	3	-
Eastern Highlands	3	-	-	-
Western Highlands	2	1	2	3
Mid-Hills	14	10	10	4
Central Mid-Hills	13	10	11	9
Eastern Mid-Hills	3	4	8	1
Western Mid-Hills	2	0	3	0
Terai and Siwalik	23	83	20	71
Central Terai and Siwalik	5	10	17	22
Eastern Terai and Siwalik	1	15	6	11
Western Terai and Siwalik	6	3	3	2
Central Region	0	0	9	0
Eastern Region	0	0	16	0
Western Region	0	0	5	0

Sources: Annexes 2.5 to 2.8

Endemism

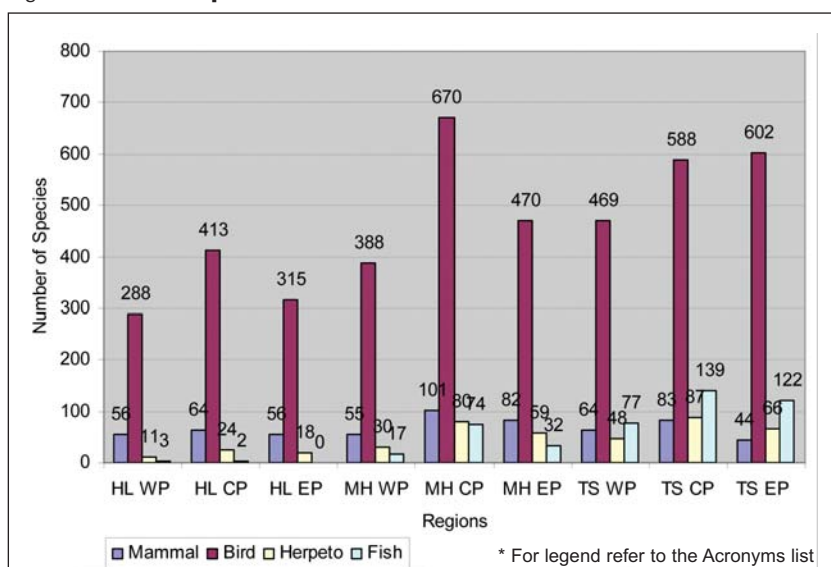
Of the 246 endemic plants recorded, eight species were presumed extinct from Nepal (Shrestha and Joshi 1996). Thirty-two species from this list have been reported to have originated elsewhere. In spite of these deductions, 185 species including infraspecific taxa have been added to the checklist of endemic plants, bringing the total count of endemic plant species to 399. These calculations are based on various sources including Dobremez et al. (1967-2006) and Press et al. (2000).

Of 399 endemic flowering plants in Nepal, about 63% are from the high mountains, 38% are from the Mid-Hills. Only 6% are from the Terai and Siwaliks. The central region contains 66% of total endemic species followed by the western (32%), and eastern regions (29%) (Annex 1.5).

Table 16. Faunal Species Richness by Region

Region	Mammal		Bird		Herpeto		Fish	
	#	%	#	%	#	%	#	%
Western Highlands	56	30	288	33	11	6	3	0
Central Highlands	64	35	413	47	24	12	2	0
Eastern Highlands	56	30	315	36	18	9	0	1
Western Mid-Hills	55	30	388	44	30	15	17	17
Central Mid-Hills	101	55	670	77	80	41	74	2
Eastern Mid-Hills	82	44	470	54	59	30	32	40
Western Terai/Siwalik	64	35	469	54	48	25	77	41
Central Terai/ Siwalik	83	45	588	67	87	45	139	9
Eastern Terai/Siwalik	44	24	602	69	66	34	122	74
Endemic to Nepal	1	1	2	0	14	7	6	3

Sources: Annexes 2.5 to 2.8

Figure 2. Faunal Species Distribution

One mammal and one bird species each may be considered endemic in Nepal. From the mammals species, the Himalayan fieldmouse (*Apodemus gurkha*) (Thomas 1924) found in central Nepal between the altitudes of 2200-3600m is an endemic mammal species in Nepal. It was classified as 'Lower Risk-Least Concern' in 1994, and assessed in 1996 by the IUCN Red List of Threatened Species (Baillie, J. 1996; and Wilson, D.E. and Reeder, D. M (eds.). 2005). The Spiny Babbler (*Turdoides nipalensis*) is Nepal's endemic bird species. It is found in the six mountain protected areas: Khaptad National Park, Bardia National Park, Shivapuri National Park, Makalu-Barun National Park, Annapurna Conservation Area, Manaslu Conservation Area, and Kangchenjunga Conservation Area. It is classified as the species of 'Least Concern' in the IUCN Red List in 2001 (BirdLife International. 2004). The Nepal Kali (*Lophura leucomelanos leucomelanos*) is



R N Suwal

Blood pheasant (*Ithaginis cruentus*), Sagarmatha National Park

another species endemic to Nepal (Inskipp, C. 2000).

Fourteen species of herpetofauna are endemic to Nepal. Of these, four species (*Paa ercepeae*, *Melanochelys trijuga indopeninsularis*, *Python molurus bivittatus* and *Rana chitwanensis*) are listed as 'Near Threatened' in the IUCN Red List, and three species, *Rana humeralis*, *Megophrys parva* and *Polypedates maculatus* as of 'Least Concern'. Similarly, the Burmese rock python (*Python molurus bivittatus*) is protected under the NPWC Act of Nepal, and also listed in the CITES Appendix I. The Che-quered keelback (*Xeno-chrophis piscator piscator*) is listed in the CITES Appendix III (**Annex 2.6**).

Six species of fish are endemic in Nepal. Among them, three species of Asala (*Schizothorax macro-phthal-mus*, *Schizothorax nepalensis* and *Schizothorax raraensis*) are recorded only in Rara National Park. The Chuche Asala (*Schizo-tharaichthys annandalei*) is recorded in BNP, the 'Jalkapur Totiyara' (*Barilius jalkapoorei*) is recorded in Bardia National Park, and Koshitappu Wildlife Reserve, and the 'Tite machha' or bitter fish (*Psilorhynchus pseudecheneis*) is recorded in Sagarmatha National Park, and Makalu-Barun National Park.

In 1995, 108 species of spiders were recorded as endemic in Nepal. This included 33 species that were rare in distribution, and three threatened species (**Annex 2.1**) (Thapa. 1995).

Threatened species

A system for version numbering has been adopted for the IUCN Red List of Threatened Species. The system was developed to clarify the process of classification and to open the way for modifications as and when necessary (**Boxes 3 and 4**). From the Red List, it is clear that no species recorded in Nepal are classified in the categories of 'Globally Extinct (EX)', 'Extinct from the Wild (EW)', and 'Not Evaluated (NE)'.

Thirty-four species of plants are included in the IUCN Red List (**Annex 1.6**). Of them, two species (*Andrewsianthus ferrugineus*, Grolle family and *Diplocolea sikkimensis*) Amakawa family are considered 'Endangered'; five are considered 'Vulnerable' (*Cycas pectinata*, a wild palm; *Dalbergia latifolia*, Indian rosewood; *Scaphophyllum*, Horik; *speciosum*, *Takakia ceratophylla*, sporophyte; and *Ulmus wallichiana*), Himalayan elm; two are 'Near Threatened' (*Aglaia cucullata* English common maple and *Cupressus torulosa* Bhutan cypress), 24 of 'Least Concern', and one (*Taxus wallichiana*) 'Data Deficient' (IUCN. 2006).

As a part of the BPP report series, the National Red Data Book (NRDB) of the Fauna of Nepal has been prepared to review the conservation status of wildlife species in Nepal. This document also identified faunal elements which require urgent legal protection. The NRDB includes 59 mammal species, 279 bird species, 35 herpeto species, and 34 fish species (**Table**

Box 3. Versions and Categories of the IUCN Red List of Threatened Species

The proposals presented in this document result from a continuing process of drafting, consultation and validation. The production of a large number of draft proposals has led to some confusion, especially as each draft has been used for classifying some set of species for conservation purposes. To clarify matters, and to open the way for modifications as and when they become necessary, a system for version numbering has been adopted as follows:

Version 1.0: Mace and Lande (1991)

The first paper discussing a new basis for the categories, and presenting numerical criteria especially relevant for large vertebrates.

Version 2.0: Mace et al. (1992)

A major revision of Version 1.0, including numerical criteria appropriate to all organisms and introducing the non-threatened categories.

Version 2.1: IUCN (1993)

Following an extensive consultation process within SSC, a number of changes were made to the details of the criteria, and fuller explanation of basic principles was included. A more explicit structure clarified the significance of the non-threatened categories.

Version 2.2: Mace and Stuart (1994)

Following further comments received and additional validation exercises, some minor changes to the criteria were made. In addition, the Susceptible category present in Versions 2.0 and 2.1 was subsumed into the Vulnerable category. A precautionary application of the system was emphasised.

Version 2.3: IUCN (1994)

IUCN Council adopted this version, which incorporated changes as a result of comments from IUCN members, in December 1994. The initial version of this document was published without the necessary bibliographic details, such as date of publication and ISBN number, but these were included in the subsequent reprints in 1998 and 1999. This version was used for the 1996 IUCN Red List of Threatened Animals (Baillie and Groombridge 1996), The World List of Threatened Trees (Oldfield et al 1998) and the 2000 IUCN Red List of Threatened Species (Hilton-Taylor 2000).

Version 3.0: IUCN/SSC Criteria Review Working Group (1999)

Following comments received, a series of workshops were convened to look at the IUCN Red List Criteria following which, changes were proposed affecting the criteria, the definitions of some key terms and the handling of uncertainty.

Version 3.1: IUCN (2001)

The IUCN Council adopted this latest version, which incorporated changes as a result of comments from the IUCN and SSC memberships and from a final meeting of the Criteria Review Working Group, in February 2000.

All new assessments from January 2001 should use the latest adopted version and cite the year of publication and version number.

Source: IUCN 2001



P R Shakya

Lithocarpus pachyphylla (Curz) Rehder forest, Panchthar, 2500m

Box 4. 2001 Categories of the IUCN Red List of Threatened Species

EXTINCT (EX) : A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

EXTINCT IN THE WILD (EW) : A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

CRITICALLY ENDANGERED (CR) : A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see Section V), and it is therefore considered to be facing an extremely high risk of extinction in the wild.

ENDANGERED (EN) : A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see Section V), and it is therefore considered to be facing a very high risk of extinction in the wild.

VULNERABLE (VU) : A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see Section V), and it is therefore considered to be facing a high risk of extinction in the wild.

NEAR THREATENED (NT) : A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

LEAST CONCERN (LC) : A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable, or Near Threatened. Widespread and abundant taxa are included in this category.

DATA DEFICIENT (DD) : A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

NOT EVALUATED (NE) : A taxon is Not Evaluated when it has not yet been evaluated against the criteria.

Note: As in previous IUCN categories, the abbreviation of each category (in parenthesis) follows the English denominations when translated into other languages.

Source: IUCN 2001

17). Updated checklists suggest that four species of mammals and seven species birds from this list are now extinct. Of the mammals, two species, namely the Cheetah (*Acinonyx jubatus*) and the Black musk deer (*Moschus fuscus*) have probably never been recorded in Nepal; the remaining two, the pigmy hog (*Sus salvanius*) and the Indian

chevrotain (*Moschiola meminna*) are likely to have become extinct in Nepal (IUCN-Nepal 1995).

The National Red Data Book (NRDB) of Nepal

Of the 11 bird species listed in the BPN (BPP 1995), as 'Extinct' in Nepal, sightings of three species have recently been reported. The

Hodgson's hawk cuckoo (*Hierococcyx fugax*) was sighted in Koshitappu Wildlife Reserve (Baral, HS 2005), the black-breasted parrotbill (*Paradoxornis flavirostris*) in the Annapurna Conservation Area (Suwal, RN. 2003), and the long-tailed sibia (*Heterophasia picaoides*) in Chitwan National Park (BES 2006). The fourth species, the green cochoa (*Cochoa viridis*) was already listed in

Table 17. List of Faunal Species in the NRDB

NRDB Status	Mammals	Birds	Herpeto	Fish
EXN = Extinct Nepal	4	7	0	0
C = Critically endangered	5	6	0	0
E = Endangered	11	53	1	1
V = Vulnerable	16	112	6	10
S = Susceptible	23	101	28	23
Subtotal	59	279	35	34
% of Total	32	32	18	18
Total number of species	185	874	195	187
Sources: Annexes 2.5 to 2.8				

the bird checklist of the Makalu-Barun National Park - BPN Technical Report Number 14 (BPP 1995, and Jackson et al. 1990) (Table 18).

Altogether, 173 mammal species are listed as Threatened by IUCN, one as Critically Endangered (Pigmy hog *Sus salvanius*), 11 as Endangered (EN), 21 as Vulnerable, 19 as Near Threatened, 120 as of Least Concern, and one Data Deficient (Csorba's mouse-eared bat *Myotis csorbai*).

Of the total 874 species of birds, three species are classified as Critically Endangered (the Slender-billed vulture *Gyps tenuirostris*, the Pink-headed duck *Rhodonessa caryophyllacea*, and White-rumped vulture *Gyps bengalensis*). Six are classified Endangered, 23 as Vulnerable, 25 as Near Threatened, and 813 as of Least Concern (Table 19) (IUCN 2006).

Protected species

Under the Forest Act 1993, the Government of Nepal has banned the collection, use, sale, distribution, transportation, and export of three species: 'Pancha ounle' (*Dactyloctenium aegyptium*), 'Okhar ko bokara' (*Juglans regia* bark), and 'Kutaki' (*Picrorhiza scrophi lariflora*) effective 12 February 2001. The government has also banned the export of eight species of plants and rock exudes (*shilajit*) except for their processed product, and upon the permission of the Department of Forests, and transportation, export, and felling of seven tree species for commercial purposes (Annex 1.7) (MFSC 2007).

Seventy-two species of plants have been inventoried for their commercially important biomaterials. The five major species with the highest export value of biomaterials are the Soap nut tree (*Sapindus mukorossi*), Nepal pepper (*Zanthoxylum armatum*), lichens (*Parmelia*) spp, Cotton paper (*Persia bombycina*) and a medicinal indigenous plant called 'Anaryatikta' and other

Table 18. List of Bird Species Classified as Extinct from Nepal in BPN

Common name	Scientific name	Status	Remarks
Black-breasted parrotbill	<i>Paradoxornis flavirostris</i>	VU	Sighted in ACA (Suwal, RN 2003)
Green cochoa	<i>Cochoa viridis</i>	LC	Sighted in MBNP (BPP 1995h, and Jackson et al. 1990)
Hodgson's hawk-cuckoo	<i>Hierococcyx fugax</i>	LC	Sighted in KWR (Baral, HS 2005)
Jungle bush quail	<i>Perdica asiatica</i>	LC	
Long-tailed sibia	<i>Heterophasia picaoides</i>	LC	Sighted in CNP (BES 2006)
Pink-headed duck	<i>Rhodonessa caryophyllacea</i>	CR	
Red-faced liocichla	<i>Liocichla phoenicea</i>	LC	
Rufous-necked hornbill	<i>Aceros nipalensis</i>	VU	
Rusty-bellied shortwing	<i>Brachypteryx hyperythra</i>	VU	
Silver-breasted broadbill	<i>Serilophus lunatus</i>	LC	
White-bellied heron	<i>Ardea insignis</i>	EN	
Source: BPP 1995			
VU = vulnerable; LC = least concern; CR = critical; EN = endangered			

Table 19. Number of Species in the IUCN Red List

Category	Symbol	Plants	Mammals	Birds	Herpeto
Critically Endangered	CR	-	1	3	1
Endangered	EN	2	11	6	3
Vulnerable	VU	5	21	26	7
Near Threatened	NT	2	21	26	4
Least Concern	LC	24	130	813	39
Data Deficient	DD	1	1	-	10
Total		34	185	874	64
Sources: Annexes 1.6, 2.6 to 2.8					

names (*Swertia chirayita*) (Annex 1.7) (Nepal Nature dot Com 2005).

Twenty-seven species of mammals, nine bird species, and three reptile species are listed as protected under NPWC Act 1973 (Annexes 2.6 to 2.8, and Annex 2.34). An additional 10 species of fish and 12 species of butterflies have since been identified as needing protection (HMG/N/MFSC 2002).

In 2003, the Government of Nepal approved the Working Policy on Wild Animal Farming, Breeding, and Research. Under this provision, activities related to seven species of mammals, one species of amphibian (the gharial crocodile *Gavialis gangeticus*), all of 77 species of snakes, and the total 874 species of birds including the three protected ones are restricted (Annex 2.9) (GoN/MFSC 2003).

CITES

Nepal is a signatory of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) since 1975. A number of Nepali species are listed under various CITES appendices as follows (Table 20 and Box 5):

- Vascular plants – One hundred thirty-nine species of plants (two species of orchids namely, *Paphiopedilum insigne* and *Paphiopedilum venustum* in Appendix I; 132 in Appendix II; five species namely, *Cycas pectinata*, *Gnetum montanum*, *Meconopsis regia*, *Podocarpus neriifolius*, and *Tetracentron sinense* in Appendix III (Annex 1.8)
- Mammals - Sixty-six species (28 species in Appendix I; 14 species in Appendix II; 24 species in Appendix III (Annex 2.8)
- Birds - One hundred and twenty-eight species (16 species in Appendix I; 95 species in Appendix II; 17 species in Appendix III (Annex 2.7)
- Reptiles - Eleven species in total. Four species, the Bengal monitor (*Varanus bengalensis bengalensis*); Yellow monitor (*Varanus*

Table 20. Number of Species in the CITES Appendices				
Appendices	Plants	Mammals	Birds	Herpeto
I	2	28	16	8
II	132	14	95	13
III	5	24	17	3
Total	139	66	128	24
Source: http://www.cites.org/eng/resources/species.html				
Sources: Annexes 1.8, 2.6 to 2.8				

flavescens); Burmese rock python (*Python molurus bivittatus*); and Asiatic rock python (*Python molurus molurus*) are in Appendix I. Four species, the Indian egg-eating snake (*Elachistodon westermanni*), Asiatic rat snake (*Ptyas mucosus mucosus*); Monocellate cobra (*Naja kaouthia*); and King cobra (*Ophiophagus Hannah*) are in Appendix II. Three species, the chequered keelback (*Xenochrophis piscator piscator*), common cobra (*Naja naja*), and Russell's viper (*Daboia russelli russelii*) are in Appendix III (Annex 2.6);



Aconitum spicatum (Bhrul.) Stapf., Ghurchi Lekh, found in Jumla at 3140m

P R Shakya

Box 5. CITES Appendices

Article II Fundamental Principles

1. Appendix I shall include all species threatened with extinction, which are or may be affected by trade. Trade in specimens of these species must be subject to particularly strict regulation in order not to endanger further their survival and must only be authorized in exceptional circumstances.
2. Appendix II shall include:
 - (a) All species which although not necessarily now threatened with extinction may become so unless trade in specimens of such species is subject to strict regulation in order to avoid utilization incompatible with their survival; and
 - (b) Other species which must be subject to regulation in order that trade in specimens of certain species referred to in sub-paragraph (a) of this paragraph may be brought under effective control.
3. Appendix III shall include all species which any Party identifies as being subject to regulation within its jurisdiction for the purpose of preventing or restricting exploitation, and as needing the co-operation of other Parties in the control of trade.
4. The Parties shall not allow trade in specimens of species included in Appendices I, II and III except in accordance with the provisions of the present Convention.

Note: When both Appendix I and Appendix II are mentioned to a particular taxon on one date, Appendix I takes precedence in the list, according to the Explanatory Note for the CITES Appendices.

Source: CITES 1979

- Amphibians – Five species: the mugger crocodile (*Crocodylus palustris*), gharial (*Gavialis gangeticus*), Indian roofed-turtle (*Pangshura tectum*), three-keeled land tortoise (*Melanochelys tricarinata*), and Indian softshell turtle (*Aspideretes gangeticus*) are in Appendix I; another 10 species are in Appendix II (**Annex 2.6**);
- Insects – Three species of butterflies, the Kaiser-I-hind (*Teinopalpus imperialis*), golden birdwing (*Troides aeacus*), and common birdwing (*Troides Helena*) are in Appendix II.

Species in protected sites

Protected sites

The 23 protected sites in the country consist of 16 protected areas: nine national parks, three wildlife reserves, three conservation areas, and one hunting reserve. Four Ramsar sites include Koshitappu Wildlife Reserve; and the four World Heritage sites include Sagarmatha National Park and Chitwan National Park. The Kathmandu Valley World Heritage site includes three monumental zones with particular significance to biodiversity: Swayambhu, Pashupati, and Changunarayan (**Table 21**).

With the exception of the eastern Mid-Hills (MH-E), these protected areas represent the remaining altitudinal zones (Highlands, Mid-Hills, and Terai-Siwaliks), and phyto-geographical regions (West, Center, and East). The Ramsar sites are confined only to the Terai-Siwalik regions. Most of the World Heritage sites are located in the central region (**Table 22**).

The protected sites are managed under the legal system. The protected areas are all managed under the National Parks and Wildlife

Conservation Act 1973 (as amended in 1974, 1983, 1990, 1993, and 2005), and other pertinent regulations. Thus, all the species found in these areas are legally protected in-situ.

Of the Ramsar sites, two (Bishazari Tal Ramsar Site and Koshitappu Wildlife Reserve) are already within the Protected Areas system. The two other Ramsar sites (Ghodaghodi Tal Ramsar Site and Jagdishpur Reservoir Ramsar Site) are protected under the Forest Act 1993 (as amended 1999) and Forest Regulations 1995. Similarly, two World Heritage sites, Chitwan National Park and Sagarmatha National Park, are managed under the National Parks and Wildlife Conservation Act. The other two heritage sites, Lumbini and Pashupati, are managed under special Acts: the Lumbini Area Development Trust Act 1985, and the Pashupati Area Development Act 1987. The remaining heritage sites, Swayambhu and Changunarayan, are managed under the Forest Act 1993 (amended 1999) and Forest Regulations 1995.

Flora

The flowering plant checklists based on records available in 2006 specify 2,532 species of vascular plants represented by 1,034 genera and 199 families in the protected sites (**Annex 1.9**). Of 399 endemic species, 130 species are found in protected sites (**Annex 1.5.1**). Variations in records are primarily due to variances in intensity of floral explorations in given sites.

Biodiversity Profiles Nepal was based upon estimation of the potential number of floral species

Table 21. Number of Protected Sites

Names	Protected sites	Number
National parks	Khaptad National Park, Bardia National Park, Rara National Park, Sshey-Phoksundo National Park, Chitwan National Park, Sshivapuri National Park, Langtang National Park, Sagarmatha National Park, Makalu-Barun National Park	9
Wildlife reserves	Shuklaphanta Wildlife Reserve, Palsa Wildlife Reserve, Koshitappu Wildlife Reserve	3
Conservation areas	Annapurna Conservation Area, Manaslu Conservation Area, Kangchenjunga Conservation Area	3
Hunting reserve	Dhorpatan Hunting Reserve	1
Ramsar sites	Ghodaghodi Tal Ramsar Site, TRS, Jagdishpur Reservoir Ramsar Site, Bishazari Tal Ramsar Site (Koshitappu Wildlife Reserve is listed in Protected Areas)	3
World Heritage sites	Lumbini World Heritage Site, Kathmandu Valley: Swayambhu World Heritage Site, Pashupatinath World Heritage Site, Changunarayan World Heritage Site (Chitwan National Park and Sagarmatha National Park are listed in Protected Areas)	4

Source: TISC/NARMSAP/MFSC 2002

Table 22. Protected Sites in the Altitudinal and the Phytogeographical Regions		
Highlands - West <i>Protected Area</i> Shey-Phoksundo National Park	Highlands - Center <i>Protected Areas</i> Annapurna Conservation Area Manaslu Conservation Area Langtang National Park	Highlands - East <i>Protected Areas</i> Sagarmatha National Park Makalu Barun National Park Kangchenjunga Conservation Area <i>World Heritage site</i> Sagarmatha National Park (also listed in Protected Areas)
Mid Hills - West <i>Protected Areas</i> Khaptad National Park Rara National Park Dhorpatan Hunting Reserve	Mid Hills - Center <i>Protected Area</i> Shivapuri National Park <i>World Heritage sites</i> Swayambhu World Heritage site Pashupati World Heritage site Changu Narayan World Heritage site	Mid Hills - East
Terai and Siwalik - West <i>Protected Areas</i> Bardia National Park Shuklaphanta Wildlife Reserve <i>Ramsar sites</i> Ghodaghodi Tal Ramsar Site Jagdishpur Reservoir Ramsar Site	Terai and Siwalik - Center <i>Protected Areas</i> Chitwan National Park Parsa Wildlife Reserve <i>Ramsar site</i> Bishazari Tal Ramsar Site World Heritage site Lumbini World Heritage Site Chitwan National Park (also listed in Protected Areas)	Terai and Siwalik - East <i>Protected Area</i> Koshitappu Wildlife Reserve <i>Ramsar Site</i> Koshitappu Wildlife Reserve (also listed in Protected Areas)

Source: TISC/NARMSAP/MFSC 2002

Table 23. Floral Data of Protected Sites				
SN	Protected Sites	BPN Estimate of Flowering Plants	Flowering Plants	Pteridophytes
1	Khaptad National Park	567	289	6
2	Bardia National Park	839	167	6
3	Rara National Park	1,070	88	0
4	Shey-Phoksundo National Park	1,579	174	0
5	Chitwan National Park	919	227	7
6	Langtang National Park	3,689	976	67
7	Shivapuri National Park	2,122	449	0
8	Sagarmatha National Park	1,074	160	0
9	Makalu-Barun National Park	3,073	280	4
10	Shuklaphanta Wildlife Reserve	202	535	18
11	Parsa Wildlife Reserve	919	293	5
12	Koshitappu Wildlife Reserve	237	154	4
13	Dhorpatan Hunting Reserve	1,150	58	0
14	Annapurna Conservation Area	3,430	451	5
15	Manaslu Conservation Area	NA	587	0
16	Kangchenjunga Conservation Area	NA	77	0
17	Ghodaghodi Tal Ramsar Site	NA	383	5
18	Jagdishpur reservoir Ramsar Site	NA	15	1
19	Beeshazar Tal Ramsar Site	NA	36	1
20	Lumbini World Heritage Site	NA	72	0
21	Swayambhu World Heritage Site	NA	109	0
22	Pashupati World Heritage Site	NA	74	0
23	Changunarayan World Heritage Site	NA	21	0

Sources: BPP 1995f, 1995g and 1995h., and Annexes 1.9.1-1.9.23
 SN = Site Number

using the coordinates of latitudes and longitudes and altitudinal variations for each protected area. **The Nepal Biodiversity Resource Book** presents currently reported data, which tends to be much

less than projections (**Table 23**). For example, 3,689 species of flowering plants were expected in Langtang National Park; the reported number is much less: 976. In the Dhorpatan Hunting Reserve

the figures are 1,150, and 58, respectively. However, in Shuklaphanta Wildlife Reserve, the reported number is 535, twice the 202 species previously estimated.

Among protected areas, Langtang National Park recorded 1,043 species of flora in the area; this is the highest number of species in any given area. Dhorpatan Hunting Reserve recorded 58: the lowest. Similarly, there are 388 species in Ghodaghodi Tal Ramsar Site compared to 16 in Jagdishpur Reservoir Ramsar Site, 109 in Swayambhu, and 21 in Changunarayan (Annexes 1.9.1 to 1.9.23 and Figure 3). The variations in count are primarily due to varied intensity of floral explorations in the given sites.

Fauna

Of the total 181 mammal species, 28 are found only outside the protected sites (Table 24). This count does not include the four extinct species.

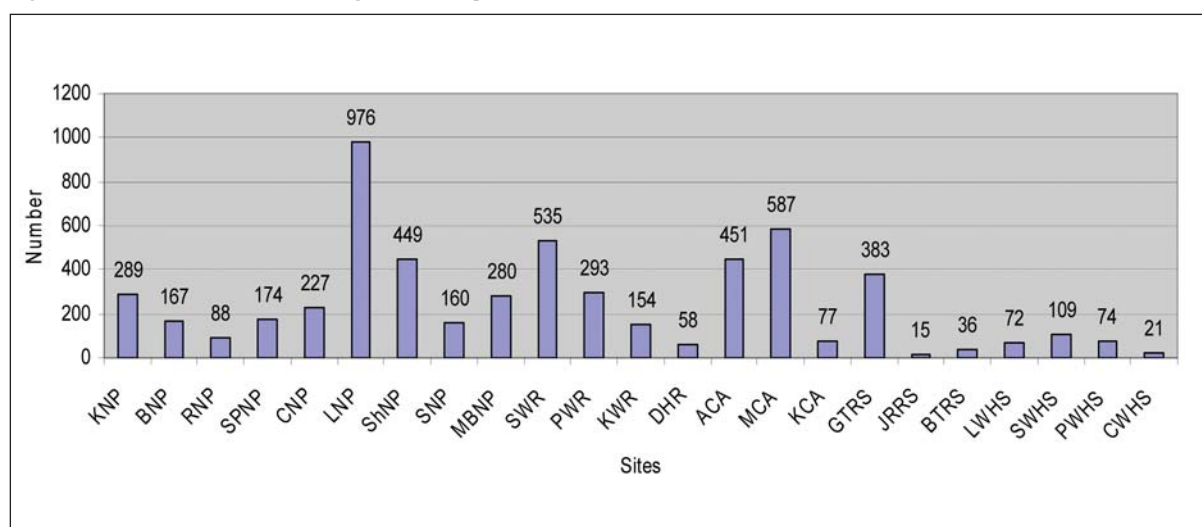
Of the species found outside protected areas, 15 are species of bats; 10 are species of shrew, rats and Pikas; and three species of the Large-toothed ferret badger (*Melogale personata*); the Malayan porcupine (*Hystrix brachyura*); and the Tibetan antelope (*Pantholops hodgsoni*).

Species	Total Number	Number	%
Mammals*	181	28	15
Birds*	867	44	5
Herpeto	195	65	33
Fish	187	25	13
* Excluding extinct species four mammals and seven birds			
Sources: Annexes 2.5 to 2.8			

Of the 867 species of birds found in the country, only 37 species (5%) are found outside protected sites (Table 24). This count does not include the seven extinct species. Of them, 14 species are migrants, four species are summer/winter visitors, and 19 species are residents.

One-third of the total 65 herpeto species are, however, found outside protected sites. Only 25 species of fish are found outside protected sites (Table 24). There are 56 species of herpeto fauna in the Annapurna Conservation Area and Chitwan National Park. There are no herpeto species at all in the Manaslu and Kanchenjunga conservation areas. Similarly, there are 124 species of fish in Bardia and Chitwan national parks, 105 in Koshitappu Wildlife Reserve, and none at all in the five other protected areas.

Figure 3. Number of Flowering Plants by Protected Site



KNP=Kangchenjunga National Park; BNP=Bardia National Park; RNP=Rara National Park; SPNP=Shey-Phoksundo National Park; CNP=Chitwan National Park; LNP=Langtang National Park; ShNP=Shivapuri National Park; MBNP=Makalu-Barun National Park; SWR=Shuklaphanta Wildlife Reserve; PWR=Parsa Wildlife Reserve; KWR=Koshitappu Wildlife Reserve; DHR=Dhorpatan Hunting Reserve; ACA=Annapurna Conservation Area; MCA=Manaslu Conservation Area; KCA=Kangchenjunga Conservation Area; GTRS=Ghodaghodi Tal Ramsar Site; JRRS=Jagdishpur Reservoir Ramsar Site; BTRS= Bishazari Tal Ramsar Site; LWHS=Lumbini World Heritage Site; SWHS=Swayambhu World Heritage Site; PWHS=Pashupati World Heritage Site; CWH=Changunarayan World Heritage Site

Ex-Situ conservation and specimens preservation

Apart from conservation of species in the wild, efforts have been made towards ex-situ conservation and specimen preservation.

Botanical gardens and herbarium

Botanical gardens are established and managed under the Department of Plant Resources in various ecological locations of the country. The botanical gardens conduct landscape development, ex-situ and in-situ conservation, as well as conservation with educational programmes and pilot productions.

The Central Botanical Garden (82 ha) is located at Godavari (1515m) in the south-east corner of Kathmandu Valley, at the base of the Phulchoki Hill (2715m). It is surrounded by evergreen natural forests of mainly *Schima wallichii* and *Castanopsis indica*. *Alnus nepalensis* are concentrated along the watercourses. Some common trees and shrubs of this garden are the Lapsi tree (*Choerospondias axillaris*), Box myrtle (*Myrica esculenta*), an evergreen shrub, *Mohonia*, (*Mahonia napaulensis*), Nepalese firethorn (*Pyracantha crenulata*), Brambling raspberry (*Rubus ellipticus*), *Zizyphus lotus*, *Stranvaesia nussia*, *Prunus cerasoides* (cherry family), and *Pyrus pashia*. The temperature ranges between 20°C and 30°C during summer, and -5°C to 20°C during winter.

Since their establishment in October 1962, much of the activities in the botanical gardens have centred around enriching the gardens with indigenous plants so as to integrate the collection with scientific investigation, conservation, education, and demonstration.

Eighty-nine species of trees, 26 species of shrubs, 50 species of herbs, and 12 species of climbers are conserved in the central garden. Special features of the garden include the Japanese cherry garden, flowering peaches, plantations made by very important persons (VIPs), usually prominent visitors to the gardens, and representation of the Fagaceae and Magnoliaceae gardens. A number of exotic species such as 31 trees and shrubs including *Sequoia sempervirens*, *Metasequoia glyptostroboides*, *Platanus orientalis*, *Liriodendron tulipifera*, *Ginkgo biloba*, and *Acer truncatum* have also been recorded.

A number of medicinal plants are cultivated in the botanical gardens. They include *Ephedra gerardiana*, *Mentha spicata*, *Aceorus calamus*, *Podophyllum hexandrum*, *Asperagus racemosus*, *Houttuynia cordata*, and *Costus speciosus* as ex-situ germplasm conservation. Some exotic medicinal plants such as *Coptis suaveolens*, *Solanum surattense*, *Mentha piperata*, *Aloe vera*, and *Nepeta* sp. are also conserved here.

Major landmarks of the garden include the orchid, cactus, and tropical species greenhouses; and fern, lily, bulb, and rose gardens. The Nepali terrace and the Japanese style rock and water gardens are also focal pieces. The orchid house alone contains about 90 orchid species including the *Dendrobium densiflorum*, *Ceologyne cristata*, *Calanthe masuca*, and *Pleione hookeriana*.

Other botanical gardens in the country by location, altitude, and year of establishment are:

1. Maipokhari Botanical Garden, Ilam, 2200m (1992)
2. Dhanusha Botanical Garden, Dhanushadham, Dhanusha, 100m (1998)
3. Vrindaban Botanical Garden, Hetauda, Makawanpur, 500m (1962)
4. Daman Botanical Garden, Daman Makawanpur, 2140m (1962)
5. Tistung Botanical Garden, Tistung, Makawanpur, 1700m (1962)
6. Dhakeri Botanical Garden, Banke, 130m (1962)
7. Mulpani Botanical Garden, Kapurkot, Salyan, 2000m (1990)
8. Dhitachor Botanical Garden, Jumla, 2500m (1990)
9. Godavari Botanical Garden, Godavari, Kailali (1998)
10. Deoria Botanical Garden, Dhangadhi, Kailali, 100m (1998)

The National Herbarium (KATH⁶), a part of the National Herbarium and Plant Laboratories under the Department of Plant Resources at Godavari, houses over 161,800 specimens of plants, and is the largest herbarium in Nepal. It was established in 1960 with the objective of exploring and providing knowledge by conducting research on plant resources of Nepal. It has 12 departments in the specific fields of Phanerogams, Cryptogams, Economic Botany, Cytology, Anatomy, Tissue Culture, Plant Breeding, Plant Genetic Resources, Floriculture, Plant Protection, Ecology and Environment, and Medicinal Herbs.

⁶Herbarium Code for the National Herbarium as per the Index Herbariorum

The Department of Plant Resources, together with the herbarium and botanical gardens, is the scientific authority on flora for the implementation of CITES in Nepal.

The Central Department of Botany of Tribhuvan University was established in 1965, and manages a herbarium (TUCH⁷) that houses 20,000 specimens.

Central Zoo – National Trust for Nature Conservation

The Central Zoo (6.5 ha) houses 119 species of 970 animals including 206 mammals of 33 species, 321 birds of 60 species, 424 fish of 17 species, and 19 reptiles of nine species (**Annex 2.10**).

Of the mammals, five exotic species are the Buinea pig (*Cavia aperea*), bippopotamus (*Hippopotamus amphibious*), Lion-tailed macaque (*Macaca silenus*), Siamang (*Symphalangus syndactylus*), and White mice (*Mus musculus*). Similarly, there are three exotic reptile species: the Chinese alligator (*Alligator sinensis*), Giant land tortoise (*Testudo gigantia*), and Red-eared slider turtle (*Trachemys scripta elegans*). All the fish species in the zoo are exotic whereas only 15 of the 60 species of birds are exotic.

Some species are better represented in the zoo: the Blackbuck has a population of 43 animals, the highest number of animals within the mammal species. The Spotted deer and guinea pigs have 25 animals each. There are also 22 rabbits and 14 white mice and Barking deer each. The 74 Greylag geese constitute the highest bird population within the species followed by 42 budgerigars, 21 Scaly-breasted munias, 15 Golden pheasants, and 10 Rose-ringed parakeets.

Successful results of captive breeding of species such as tigers, leopards, and other animals has distinguished the zoo as a source of gene pool for some ungulate species such as the Blackbuck, Barking deer, and Spotted deer. Several translocations of these animals have been carried out to initiate establishment of new populations in Bardia National Park and Pashupati areas.

Hetauda municipality maintains a mini zoo (0.3ha) integrated with a public park and a picnic spot. The zoo was established in 1991 and includes animals such as the Spotted deer, Barking deer, hares, birds, and tortoises.

Captive breeding and translocation

Captive breeding of crocodiles has been carried out successfully in the Gharial Farm in Chitwan. Although the population of gharial crocodiles was close to extinction, the breeding effort has revived its population. The Gharial Breeding Centre was established in 1978 at Kasara in Chitwan. By 2005, 661 captive bred gharials have been released into the various rivers of Nepal. Crocodile breeding has also been initiated in Bardia National Park (**Table 25**).

The Elongated tortoise (*Indotestudo eleongata*) has also been successfully hatched at the Gharial Breeding Centre from seed animals brought from the Hetauda Mini Zoo. At present there are six adult male, ten adult female, and three adolescent tortoises at the Centre. Altogether there are 60 tortoises of eight species in the breeding centre (DNPWC 2005).

The Elephant Breeding Centre at Khorsor, Chitwan, and the elephant stables in Shuklaphanta, Bardia, Chitwan, Parsa, and Koshitappu are noteworthy for elephant breeding. There are 171 domesticated elephants in Nepal. Seventy-seven are under government ownership, and are spread out over the five lowland protected areas (Shuklaphanta Wildlife Reserve, Bardia National Park, Chitwan National Park, Parsa Wildlife Reserve and Koshitappu Wildlife Reserve); as well as the breeding centre at Khorsor, Chitwan. The National Trust for Nature Conservation has maintained nine domesticated elephants (three in Bardia National Park, five in Chitwan National Park and one in the Central Zoo). Ten hotels inside and outside Chitwan National Park (CNP) and outside Bardia National Park (BNP) also maintain 85 domesticated elephants for tourism

Table 25. Gharial Crocodile Release to their Natural Environment

Year	Narayani	Kali	Rapti/ Tamor Tal	Kosi	Karnali	Babai	Total
1981-1989	183	35	5	85			308
1990-1999	139		12		23		224
2000-2005	63	10	56	-	-	-	129
Total	385	45	73	85	23	50	661

Source: DNPWC annual Report 2004-2005

⁷ Herbarium Code for the Tribhuvan University herbarium as per the Index Herbariorum

Table 26. Domesticated Elephants in Government Camps				
Names of Camps	Government	NTNC	Private Camps	Total
Shuklaphanta Wildlife Reserve	7	-	-	7
Bardia National Park	10	3	5	18
Chitwan National Park	42	5	80	127
Parsa Wildlife Reserve	8	-	-	8
Koshitappu Wildlife Reserve	10	-	-	10
Central zoo	-	1	-	1
Total	77	9	85	171
Sources: Kharel, FR 2006, and Suwal, RN 2003				

and research (Table 26) (Kharel, FR 2006, and Suwal, RN 2003).

Following government formulation of the 'Working Policy on Wildlife Farming, Breeding and Research' in August 2003, eight parties have

taken initiatives towards farming the Spotted deer, monkeys, birds, and snakes as of 2005 (DNPWC 2005).

Research related to wildlife has been continued since the enactment of the working policy, with added focus on mechanisms to facilitate both in-situ, and ex-situ measures. Translocation of rhinoceros has been successfully carried out with the objectives of establishing a viable rhino population in the BNP, a breeding population in Shuklaphanta Wildlife Reserve, and to safeguard this endangered species from poaching and natural calamities such as floods, fire, and epidemics. Founder



MENRIS

A shrine around Sagarmatha National Park

populations of 13 rhinos were reintroduced to BNP from CNP in 1986. Most of the translocated females conceived shortly after they were released, indicating their acceptance of the new habitat. In 1991, 25 rhinos were translocated to the Babai Valley in the northeastern part of BNP. The rhino population in BNP had increased to 45 by 1995, but the population density of rhinos in the park remains low (0.3 animals/km²) compared to that of RCNP (8-10 animals/km²). The trans-location of rhinos to BNP is expected to bolster the creation of a viable rhino population (Jnawali 1995).

Since 1986, a total of 87 rhinos have been translocated to BNP from CNP, and four have been translocated to Shuklaphanta Wildlife Reserve. During the translocation in April 2003, 10 rhinos, seven of which were radio collared, were released across Babai Valley in the eastern Chisapani sector of BNP (Table 27).

Translocation of 25 blackbucks was also carried out in 1992. The animals were collected from the Central Zoo and released into semi-wild conditions in Bardia National Park (Bhandari et al. 1992). Similarly, 32 ungulates were translocated from the zoo into the Pashupati area.

Natural History Museum - Tribhuvan University

The main objective of the Museum is to nurture Nepal's natural history and serve as a research and educational facility in Nepal for scientists, teachers, students, and other scholars. The Museum maintains a well managed scientific record of Nepalese flora and fauna. A large number of floral and faunal specimens are exhibited at the Museum's exhibition hall.

Table 27. Rhino Translocations				
Year	Male	Female	Total	Translocations
1986	8	5	13	Chitwan to Bardia
1991	8	17	25	Chitwan to Bardia
1999	2	0	2	Chitwan to Bardia
1999	2	0	2	Sarlahi to Bardia
2000	8	8	16	Chitwan to Bardia
2000	1	3	4	Chitwan to Shuklaphanta
2001	2	3	5	Chitwan to Bardia
2002	5	5	10	Chitwan to Bardia
2003	3	7	10	Chitwan to Bardia
Total	39	48	87	
Source: DNPWC Annual Report 2002-2003				

The Museum manages the Swayambhu Environment Garden (1 ha) representing the medicinal plants of Nepal. The garden consists of three primary components: the public park, an experimental park, and a nursery. The Museum serves as the scientific authority of fauna for CITES implementation in Nepal.

Wildlife museums in the protected areas

The protected areas maintain local museums for research as well as for educational purposes. They mainly house wildlife parts collected from within specific protected areas. They also put on display materials confiscated from poachers and smugglers. Among these, the collections at the museums of Khaptad, Bardia, Chitwan, Sagarmatha, Makalu-Barun, Koshitappu national parks, and Annapurna Conservation Area are significant. Similar items are housed in the forest guard training center storerooms at Tikauli under the Department of Forests.



Some rare birds, Koshitappu Wildlife Reserve
(Govind Joshi)