

NEPAL COUNTRY REPORT ON
Biological Diversity



IUCN—The World Conservation Union

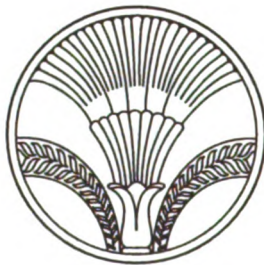
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IUCN Nepal

Tirtha B. Shrestha

NEPAL COUNTRY REPORT ON **Biological Diversity**



IUCN—The World Conservation Union

With contributions from
Dr. Bishnu Bhandari and Mr. Narayan Belbase

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Foreword

Human evolution has followed a path of co-existence and co-evolution with other living beings. Planet earth is the one and only home for all creatures to compete, co-exist and evolve: be it the microscopic algae or bacterium; the giant redwood tree or the blue whale. Biological diversity (as the term is understood today) encompasses all these lifeforms and their designated species, the genetic properties encoded within them and the ecosystems that provide their living space.

The pressure of economic development that accelerated so rapidly after World War II has created a world far different from the one we inherited. The alarming rate of habitat destruction and species extinction has been well documented. Many nations of the world recognised that the life support system of the planet must be safeguarded for future generations and agreed on a global Convention on Biological Diversity (CBD). Nepal was one of the 150 states to sign the CBD during the Earth Summit in Rio de Janeiro on 5 June 1992.

IUCN, in its capacity as a global union, has been helping Nepal to conserve her unique diversity and use her natural resources in a sustainable way ever since Nepal joined the union as a state member in 1973. The Biodiversity Programme at IUCN Nepal was established in 1988 during the implementation of the National Conservation Strategy. A number of background studies, demonstration projects and new initiatives have taken place to assist the government and the public in identifying components of biodiversity important for conservation and sustainable use. This data was gathered together and resulted in the present publication, the ***Nepal Country Report on Biological Diversity***.

Nepal strives to safeguard its natural endowments while contending with population pressure, poverty and the resulting environmental degradation. The setting up of protected area systems and government regulations to protect rare, endangered and threatened flora and fauna has contributed immensely to protecting globally significant wildlife and their habitats. However, the need to improve people's socio-economic condition through conservation, sustainable use and equitable sharing of benefits stands out more vividly than ever. It is now important that natural and social scientists take coordinated action to assist the government and the public in achieving conservation goals.

We hope that this status report will be useful to those involved in the conservation and sustainable use of Nepal's rich biological heritage.

I take this opportunity to thank Dr. T.B. Shrestha for developing the *Nepal Country Report on Biological Diversity* with the active support of his colleagues. Financial assistance from the Swiss Agency for Development and Cooperation (SDC) for preparation of this report is gratefully acknowledged.

Dr. Ambika Prasad Adhikari
Country Representative

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Author

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Wild mushroom (*Morchella esculenta*) is a high-value NTFP commodity for mountain dwellers. This boy waits for his buyer to come and collect a garland of dried mushrooms, which cost more than Rs. 3000 per kg.

Smoked bamboo cylinders are invariably used to fetch water from village streams. Over 18 species of bamboo are used in eastern Nepal for a range of purposes such as traditional writing pens, roofing thatch and ground mats, besides a hoard of household artefacts like baskets and winnowing pans.



Introduction



The diversity of life forms in the biosphere, from the bottom of the sea to the summit of mountains, from deserts to tropical mangroves, and from volcanic craters to Antarctica are so numerous that we have yet to identify most of them. Human beings, with their ever-expanding populations, are now altering the balance on which species have so far co-existed, so that direct actions such as hunting, persecution and collection; and indirect actions such as habitat destruction and modification are causing the extinction and reduction of species in numbers far beyond the natural process.

Never before in the history of civilisation have people and their political leaders focused so deliberately on the question of biodiversity as they did in Rio de Janeiro, Brazil in 1992. The UN Conference on Environment and Development (UNCED – also known as the Earth Summit) produced five documents for five billion people to facilitate their journey into the 21st century.

The five documents are as follows.

1. ***The Rio Declaration on the Environment*** - This has 27 principles defining rights and development responsibilities of nations as they pursue human development and well-being.
2. ***Agenda 21*** - A blueprint for global partnership aimed at reconciling the twin requirements of a high quality environment and a healthy economy for all peoples of the world.
3. ***Convention on Biodiversity*** - A treaty to slow the loss of biological species through conservation and sustainable use.
4. ***Convention on Climate Change*** - A treaty intended to curb emissions of “greenhouse gases” to levels which will not imperil the climate.
5. ***Declaration on Forests*** - The Forest Principles aim to contribute to the management, conservation and sustainable development of forests and to provide for their multiple and complementary functions and uses.

All life forms are dependent upon the living activities of other life forms; and human existence is only possible through coexistence with other living organisms. There has been a gradual realisation that the present trend of resource use threatens not only human life, but life on earth itself.

The world today is governed by different countries with different resource bases and different patterns of resource consumption. Over

half of human nutrition is provided by just three plants: rice, wheat, and maize (Swaminathan in McNeely et al., 1990). Ironically, the countries who contributed these biological boons still face starvation and death in their own region. For example, the countries of the rice area in Asia including India, Nepal, China, Bangladesh, and South East Asia often face food shortages. Similarly, the wheat region of Western Asia, the maize and potato regions of Latin America, and the millet region of Africa all face the problem of food deficit. On the whole, the economically rich countries are poor in biodiversity while the countries rich in biodiversity are economically poor. The Earth Summit could therefore be viewed as a milestone in the process of reconciliation.

Nepal is a signatory to the Convention on Biological Diversity. The preamble of the Convention gives special emphasis to the needs of least developed countries and small island states. Nepal is classed as a least developed country and has the opportunity to fully utilise the financial and other assistance given, in order to handle the full range of issues implicit in the proper implementation of the convention.

His Majesty's Government of Nepal has prepared a number of strategies and plans which address conservation of nature and natural resources. Of these, the National Conservation Strategy (NCS) of Nepal is a landmark, laid down by the Government of Nepal and the National Planning Commission, in collaboration with IUCN—The World Conservation Union. Sectoral plans of the Government such as the Master Plan for the Forestry Sector and the Agricultural Perspective Plan which dovetail with the periodic five year plans also pave the way for making conservation and sustainable use of biological diversity an integral part of national development. But despite all these efforts, ecosystems are being degraded, and genetic diversity and individual species are being reduced due to the growing needs of the human population.

Nepal's wealth of biological diversity and its network of protected areas are recognised worldwide. Conflicts have, however, arisen between conservation and development of the community, not only in areas adjacent to protected areas and national parks, but also in areas which are traditionally protected and culturally respected. Growing congestion on popular trekking and mountaineering routes is leading to environmental

degradation and to loss of biodiversity. Excessive harvesting of biological resources (medicinal herbs, fodder, fibre, wildlife, orchids, and fuelwood) from wilderness areas and over-use of public land such as rangelands, wetlands, rivers, and forest lands for private use have directly contributed to the loss of biodiversity. Environmental stress also has an effect on human lives.

Nepal ratified the Convention on Biological Diversity in September 1993. Article six of the convention calls on the contracting party to prepare a national strategy, plan or programme for the conservation and sustainable use of its biological resources. It recognises the importance of country studies and reports in the preparation of national strategies and action plans. A country report is therefore attempted here to provide a comprehensive view of the current status of Nepal's flora, fauna and ecosystems.

This report covers the present status of knowledge and information on the biodiversity of Nepal, the socio-economic factors affecting them, and the current capacity to conserve them.

The objectives of the country report include:

- providing basic information for the development/implementation of national strategies and action plans;
- providing a scientific basis to determine the national priorities for conservation and sustainable use of biological diversity; and
- determining the measures required to meet the obligations of the convention.

The purpose of the Nepal Country Report on Biological Diversity is not to fill all the gaps in biodiversity information, but to collate what little is known, and identify the processes needed to chart a future course of action.

The butternut tree (*Bassia butyracea*) is a multi-purpose village tree that yields vegetable fat as well as sugar pulp from its fruits. The tree is an excellent source of pollen for domestic honeybees. In some parts of western Nepal, the butternut tree is also donated as dowry to daughters who then comes to harvest their share every year when the fruits are ripe.





Lho Village (3,180m) towards the head of the Upper Budhi Gandaki, is veiled in early morning smoke rising from every household. Firewood (pine and larch) remains the only source of household energy.



Biological Diversity and Environmental Concerns

The sheer variety of life is of enormous value to mankind. The value of heterogeneity is very important for a country like Nepal where some varieties of rice are grown in the tropical zone at altitudes below 1,000m while another is grown in cold, temperate regions above 2,000m, as in Jumla. Studies have shown that there are over 5,160 species of flowering plants in Nepal, a figure two-and-a-half times greater than that of Britain, or more than one quarter of the total flowering plants in the United States. In Nepal, the highest altitudinal record for a flowering plant is set by *Stellera decumbens* (The Guinness Book of World Records) on Mt. Makalu. Nepal has 352 species of orchids, four of which do not occur outside Nepal. *Rhododendron arboreum* is the national flower: in total there are 30 rhododendron species in Nepal. Scientists have named many plants for Nepal, giving them the epithets *nepalensis*, *nipalensis*, *napaulensis*, etc. A recent study showed that 246 species of flowering plants are endemic to Nepal and 8 species are suspected to be extinct (Shrestha and Joshi, 1996). H. Koba et al. (1994) have added another 163 species of plants which are new and/or endemic to Nepal (H. Koba, S. Akiyama, Y. Endo, and H. Ohba, 1994). Knowledge on the occurrence of lower plants such as liverworts, algae, fungi and lichens is still very poor. About 700 species of Nepalese plants are known to possess medicinal properties.

The faunal wealth of Nepal is equally rich. Wildlife biologists estimate that there are approximately 181 species of mammals, including endangered mammals such as the one-horned Indian rhinoceros, the Bengal tiger, the red panda, the snow leopard, and the musk deer. Nepal also claims about 8.5% (844 species) of the world's avifauna. Of these, the bar-headed goose is the highest flying bird, crossing Everest at over 8,000m; the bearded vulture has the broadest wing span of over 2.6m; the saras crane is the tallest bird at 1.5m; the rufous piculet represents the smallest species of woodpecker and so on. Among the birds, the spiny babbler is the only endemic bird of Nepal, while the impeyan pheasant has been recognised as the national bird of Nepal. Nepal's wealth of indigenous freshwater fish amounts to 185 species, amphibians number 43 species, and reptiles 100 species (BPP, 1995). One recent inventory of insects (V.K. Thapa, 1996) lists over 5,000 species of insects. Of them, the giant atlas moth (*Attacus atlas*) is the largest moth in the world and the wild honey

bee (*Apis laboriosa*) is the earth's largest honey bee (Eric Valli and Diana Summers, Nov. 1988).

Although scientists and researchers are continuously adding to the list, specimens and information are somewhat scattered both in terms of time and space. The current picture of Nepal's biodiversity is largely based upon species of vascular plants and vertebrate animals. The complexity of ecosystems and habitats is not yet fully understood, nor is there ample information on lower plants and invertebrate animals. Strategic planning and implementation schedules are needed to unfold the nature, extent, and value of biological diversity and to determine appropriate conservation measures. All of these require scientific data and a management system that would allow not only the storage and retrieval of data and information, but also the identification of data gaps and areas which require immediate action.

1. Environmental Concerns

In Nepal, any environmental issue is an expression of the complex relationship between humans, the mountains and the monsoon. Over 90% of the men and women of Nepal are farmers, highly skilled in both crop cultivation and animal husbandry. The mountains of Nepal – the tallest on the earth's crust and still growing – are the repository of a rich biodiversity and represent a microcosm of the world's climate. The monsoon, which brings life to forests, farmland and farmers alike, is the mechanism by which thousands of rivers originating in the snow and glaciers of the mountains are recharged.

The country is characterised by extreme topographic variation, multiple bioclimatic zones, diverse biota, and an extensive rural population scattered over a largely inaccessible, mountainous terrain. The delicate interface between ecological endowment and economic endeavour often loses its balance through the pressure of population growth and the frequent occurrence of natural hazards caused by an erratic monsoon, landslides, and seismic activity. The increasing demand for environmental resources has been fuelled by unregulated pressure from tourism, concentrated on small, selected locales and by industrial concentration in already stressed areas such as Kathmandu, Pokhara and Biratnagar.

The development requirements of the Nepalese people have always been focused on

satisfying basic material, spiritual and cultural needs. In Nepal, social and systemic impediments to development planning such as absolute poverty, mass illiteracy, and inadequacy of the government mechanism to reach the rural masses are immense. People's power in terms of their traditional knowledge and indigenous technologies has neither been harnessed nor has it been nurtured to empower the Nepalese people to manage their environment. In the process of modernisation, cultural erosion seems to be exceeding natural erosion.

Poverty, Population, and Environment

The Poverty, Population, and Environment (PPE) spiral of Nepal is typical of most developing countries, where the causal effects of poverty on population and vice versa contribute to environmental deterioration. Deforestation, soil fertility loss, soil erosion, declining agricultural yields, unemployment, problems of overcrowding, pollution, and so on are all present in Nepal. Three major consequences of PPE in Nepal – social division, political unrest, and refugee problems – are surfacing, slowly but surely. Mitigation measures require the division of development resources to combat the socio-political problem.

Poverty is being identified today as the key issue in all debates related to development and the environment. If people are provided with adequate food, clothing, and shelter, will there not be a high quality environment in Nepal? If the population growth is maintained at zero level, will there still be encroachment on natural resources? Questions such as these are fundamental to the discussion of the environmental issues of developing countries.

Factors of Change in Nepal's Environment

Malaria eradication and human migration, during the period of 1950-1960, created an altogether new Nepal. The tropical forests of the Tarai were an early victim of human encroachment. The eradication of smallpox and control over diseases of mass devastation caused the population to grow at a rapid rate while family planning and other service sectors struggled to keep up with the population explosion. Over-crowding in the cities and towns brought the additional evils of pollution, drugs, and diseases including AIDS (Acquired Immunity Deficiency Syndrome).

Meanwhile, the deforestation of natural areas threatened the basis of sustenance and subsistence.

Foreign aid and international cooperation lost sight of sustainability and sometimes created more problems, particularly when a project came to an abrupt end. Tourism and industrial growth in other areas created ever-expanding gaps between the 'haves' and the 'have nots'. In catering to the voracious needs of energy consumption by tourists and factories, Nepal's natural resources faced rapid depletion.

2. Government Policies and Institutional Performance

Government policies aimed at resource control have never met with people's approval nor invited their meaningful participation. The democratic government with its inherited authoritarian bureaucracy is equipped with numerous policy documents and promising statements but the present capability of its institutions can barely provide for their implementation.

Planning procedures in Nepal are carried out by the National Planning Commission (NPC). Although most of the plans and strategies relating to the environment, such as the National Conservation Strategy and the Nepal Environmental Policy and Action Plan are formulated within the National Planning framework, sectoral plans are prepared by different line agencies. Problems of overlapping, duplication, and conflicts arising from sectoral plans are encountered during implementation. This is especially true for issues relating to environment and development. The formation of the Environment Protection Council is being viewed as a possible solution to the problems while the creation of the Ministry of Population and Environment is another positive step towards reinforcing environmental management.

Nepal faces the inherent problem of failing to implement master plans and strategies which are based upon expectations of foreign support. A number of management plans, action plans, and strategies have already become obsolete. The National Conservation Strategy (NCS) is one of the few documents that has been implemented as soon as it was adopted by the government. It has been partially implemented in some key areas of concern, and there is an opportunity to expand NCS implementation in consonance with various government line agencies, supporting academic

institutions, and NGOs.

3. The Convention on Biological Diversity – Nepal's Response

Over 90% of Nepalese people live in rural society and pass their life at the interface between farms and forests, rangelands and wetlands.

The primary responsibility for conserving and ensuring the sustainable use of biological resources should be shared between the people and the government. Central and local government, private property owners, businesses, local and indigenous communities, conservation organisations, research institutions, foundations, and community-based organisations all play an essential role in conserving biodiversity and in the sustainable use of bioresources. The Convention on Biological Diversity offers an opportunity to reexamine the functional relationship between people, the integrity of nature and its diversity.

The National Planning Commission collaborated with IUCN–The World Conservation Union to implement the National Conservation Strategy which has biodiversity conservation as a key component. NPC and IUCN then developed the Nepal Environmental Policy and Action Plan (NEPAP) in August 1993. NEPAP identified four priority actions for biodiversity conservation:

- strengthening the Department of National Parks and Wildlife Conservation as the main institution responsible for protected areas,
- ensuring adequate representation of Nepal's major ecosystems in the protected area system,
- involving local people directly in the management of parks,
- preserving endemic and endangered species and their habitats, and
- promoting the role of private and public institutions in setting up a biological resource inventory and in developing conservation measures.

The Swiss Agency for Development and Cooperation (SDC) approved IUCN Nepal's Heritage and Biodiversity proposal for a three year period (1994-96). The Heritage and Biodiversity Conservation Project (HBCP) has generated a number of new initiatives and innovations through field surveys, pilot projects, and database development and publications. It has also increased

interaction with various government agencies; international organisations such as the International Centre for Integrated Mountain Development (ICIMOD), the World Wildlife Fund (WWF), UNDP, and The Mountain Institute (TMI); as well as a large number of NGOs including IUCN members such as the King Mahendra Trust for Nature Conservation (KMTNC), Nepal Forum of Environmental Journalists (NEFEJ), Nepal Heritage Society (NHS), and Environmental Camps for Conservation Awareness (ECCA).

The Convention on Biological Diversity stimulated a certain amount of international support which has been accepted by Nepal. The Government of the Netherlands technical assistance to the Department of National Parks and Wildlife Conservation (DNPWC) to establish a Biodiversity Profile of Nepal (1995) was a major contribution. UNDP signed an agreement with DNPWC in 1993 to support a major biodiversity conservation initiative out of the Global Environment Facility (GEF) fund in order to prepare a Biodiversity Action Plan (BAP) which was awarded to a local NGO, Resources Nepal. The GEF funding of US \$ 3.8 million was allotted for (a) BAP preparation, (b) implementation of the Makalu Barun National Park and Conservation Area management plan with The Mountain Institute, (c) institutional strengthening of DNPWC, and (d) capacity enhancing activities to be implemented by the KMTNC. Besides this,

UNDP also provided funds from its Small Grant scheme to support local NGOs in Nepal. Nepal Forum of Environmental Journalists was identified as a host NGO to oversee the implementation of this project.

IUCN Nepal's Heritage and Biodiversity Conservation Project has been a major source of information and input for these undertakings, particularly the integrated biodiversity database jointly developed by IUCN Nepal and The Mountain Institute, and IUCN's wetlands initiative. The Background Study on the Biodiversity Database for the Kingdom of Nepal prepared by IUCN Nepal in January 1994 under the Biodiversity Support Programme (United States Agency for International Development/World Wildlife Fund/The Nature Conservancy/World Resources Institute USA) served as a base for consensus on the biophysical characterisation of Nepal and on habitat classification as a foundation for database development.

IUCN Nepal is collaborating with His Majesty's Government of Nepal's (HMG/N) Ministry of Forests and Soil Conservation to establish and develop a national focal point for biodiversity. The Planning Division of the Ministry of Forests and Soil Conservation has housed the National Biodiversity Unit which will coordinate biodiversity conservation activities in relation to the implementation of the Convention of Biological Diversity in Nepal.

Diversity is a keyword for defining Nepal, a Himalayan kingdom that links six floristic provinces of Asia and two major world realms, the palearctic and the oriental. The country covers only 0.1% of the world's land but claims 8.5% of its bird species, 4.2% of mammals, 4.2% of butterflies, 2.2% of freshwater fishes, and houses 2.2% of the world's flowering plants. Its cultural diversity is equally rich, with Sherpas and Tibetans dwelling in the highlands, Gorkhalis and a wide range of other ethnic groups living in the mid hills, and Tharus and others in the lowlands. The common denominator in this diversity is the people's agrarian lifestyle, carried out at the interface of farming systems and forestry practices. In fact, over 90% of Nepal's 19 million people are rural farmers.



Terracing is a unique skill developed by the Nepalese during their interaction with the mountain terrain. Even a terrace two metres wide is valuable to farmers. Here, the farmers are growing buckwheat in their narrow terraces along the Arun Valley of eastern Nepal.

Highland dwellers find Tibetan horses most useful for negotiating the high passes and for long treks. Rarefied air is not a problem for this breed of horse.



Country Description

1. Socio-Economic Considerations

Nepal is situated between India and China, the two largest and most heavily populated countries of Asia. It has an area of 147,181 sq km. The country is usually described in terms of five physiographic regions: High Himal (23%), High Mountains (20%), Mid-Mountains (30%), Siwaliks (13%), and Tarai (14%). For administrative purposes the country is divided into 75 districts, 3,912 village development committees and 58 municipalities, one metropolis and three sub-metropolitan areas.

Population

According to the census of 1991, the total population of Nepal was 18,491,097. The population was increasing at an annual rate of 2.08% in 1991. The data on population growth from 1911-2001 are presented in Table 1. Data from 1981-91 indicate that the growth rate in the Tarai and the Inner Tarai districts is highest at 2.72% and 2.81%, followed by the Hill districts at 2.31%. The Mountain districts show the lowest growth rate of 0.99% (*see Table 1*).

Table 1 Growth of Population 1911-2001

Year	Population ('000)	Growth Rate
1911	5639	
1921	5574	(-) 0.13
1930	5,533	0.07
1940	6,284	1.16
1951	9,413	1.65
1952/54	8,473	2.30
1971	11,556	2.07
1981	15,023	2.66
1991	18,491	2.08
1996*	21,127	2.66
2001*	23,832	2.41

* Projected population

Source: HMG, 1996: *Statistical Pocket Book*.

The Mid Western Development Region (MWDR) has the largest area of 42,387 sq km, but the highest population is found in the Central Development Region (CDR), at 6,183,955. The Far Western Development Region (FWDR) is the smallest with an area of 19,539 sq km. The Eastern Development Region (EDR) has the lowest population of 1,679,301. In EDR and CDR, the female population is slightly lower than the male population. In the other development regions, it is the other way around. The average household size in FWDR and MWDR is larger than the national average of 5.6, while EDR has the smallest household size. The number of total households is 3,328,721. The largest and smallest household sizes are in FWDR and EDR respectively (see Table 2).



Rapid increase in population is the major cause for resource depletion in Nepal.

Table 2 Population distribution by households, average household size, sex, and area of development region (1991)

Development Region	Household	Average HH Size	Total	Total Population Male	Female	Area (km sq)
Eastern	821,762	5.4	4,446,746	2,228,589	2,218,160	28,456
Central	1,225,428	5.5	6,183,955	3,147,894	3,036,061	27,410
Western	690,160	5.5	3,770,678	1,821,499	1,949,179	29,398
Mid-Western	4,15,846	5.8	2,410,414	1,200,292	1,210,122	42,378
Far Western	285,525	5.9	1,679,301	822,700	856,601	19,539
Total	3,328,721	5.6	18,491,097	9,220,974	9,270,123	147,181

Note: HH = Household.

Source: HMG, 1996: *Statistical Pocket Book*.

In terms of area, the Hills occupy 50% of the total land, whereas the Mountain and Tarai regions cover 27% and 23% respectively. The Tarai region contains 46.7% of the population whereas the Hills only contain 45.0%. Only a small percentage live in the Mountains (7.8%). The Tarai has the highest population density per square kilometre (253.6) and the highest growth rate of 2.75%. About 38.6% of Tarai land is under cultivation. Population per ha of cultivated land is 6.6, which is lower than the national average of 7.8. The sex ratio is also higher in the Tarai region (see Table 3).

The Central Development Region has the highest percentage of the total population at 33.4%, while the Far Western Development Region has the lowest at 9.08%. The Eastern, Western and Mid Western Development Regions have 24.95, 20.39, and 13.04% of the population respectively.

Table 4 shows that the population of the mountains and hills has decreased over the period 1952/54-1991, while the population of the Tarai has increased. Density/sq km, population/ha of cultivated land, and population growth rates increased from 1952/54 to 1991 (see Table 4).

Table 3 Population, land, arable land and population density by ecological zone

Characteristics	Mountain	Hill	Tarai	Total	Nepal
Area (%)	27.00	50.00	23.00	100	181,147 sq km
Population (%)	7.80	45.50	46.70	100	18,491,097 people/sq km
Density/sq km	27.9	137.3	253.6	-	125.6 people/sq km
Annual population growth rate(1982-91) (%)	1.02	1.61	2.75	-	2.08% per year
Percent of total land under cultivation	3.1	14.3	38.6	-	16.0% of country
Cultivated land (%)	6.90	37.40	55.70	100	2.36 million hectares
Population per ha of cultivated land	9.9	9.6	6.6	-	7.8 people/hectare
Literacy (%)	33.20	43.90	36.50	-	39.6% of country
Sex Ratio (male to female)	98.4	95.3	103.9	-	99.5: 100

Source: CBS, 1995: Population Monograph of Nepal.

Table 4 Population distribution by ecological zone (1952/54-1991)

Year	Mountains and Hills	Tarai	Total	Density/sq km	Population/ha of cultivated land	Annual population growth rate	Population
1952/54	64.8	35.2	100	85	2.1	-	8,256,625
1961	63.8	36.4	100	101	2.4	-	9,412,996
1971	62.4	37.6	100	128	3.1	2.39	11,555,983
1981	56.4	43.6	100	193	4.7	2.62	15,022,839
1991	53.3	46.7	100	254	6.6	2.75	18,491,097

Source: CBS, 1995: Population Monograph of Nepal.

The population density of the Mid Western Development Region is the lowest at 56.87 per sq km. The population density of the Central Development Region is higher, at 225.6 per sq km. The Mid Western and Far Western Development Regions have population densities lower than the other development regions. The Tarai has the highest population density of 253.58 while the population density in the Hills is 137.25 per sq km (Table 5).

Table 5 Population density by ecological zone and development region (1991)

Zones	Eastern	Central	Western	Mid-western	Far-western	Total
Area km ²	28,458	27,410	29,398	42,378	19,539	147,183
Mountain	34.40	75.03	3.37	12.20	41.95	27.85
Hill	132.95	226.98	132.15	88.95	99.18	137.25
Tarai	365.72	325.18	252.87	127.14	139.62	253.58
Total	156.25	225.61	128.26	56.87	85.95	120.63

Source: CBS, 1995: Population Monograph of Nepal.

2. Demographic Characteristics

Fertility, mortality, and migration are the three important variables that cause change in population. In this context, the description that follows is an attempt to explain their status in Nepal.

Fertility

Fertility has not changed greatly in Nepal over the last 30 years as indicated by three major variables: Crude Birth Rate (CBR), Total Fertility Rate (TFR), and Child-Woman Ratio (CWR).

The first CBR recorded in the census of 1952/54 was 45 per 1000. This changed to 42.4 in 1971, 44 in 1981, and 41.6 in 1991.

The Total Fertility Rate has not declined much over the past 22 years. For example, it was 6 in 1965, 6.3 in 1981, and 5.9 in 1987. According to Trussel and P/F methods, it was 5.4 in 1991.

Data on CWR (Child-woman Ratio) indicate that this decreased slightly from 0.656 per woman in 1981 to 0.615 in 1991. The Mid Western Development Region has the highest CWR of 0.687 and the Eastern Development Region, the lowest at 0.585. Ecological zone-wise, CWR in the mountains was 0.632 and lowest at 0.585 in the hills. By place of residence, rural areas figured at 0.632 compared to 0.478 for urban areas.

Mortality

The common indicators of mortality are Crude Death Rate (CDR), Infant Mortality Rate (IMR), and Life Expectancy at birth.

In 1952/54, the Crude Death Rate per thousand was 30, which was reduced to 21 in 1961. HMG (1996) reported that it was 13.5 for the period of 1971-81. In 1991, the male CDR was 12.9 and the female 13.6.

IMR declined drastically from 152 per thousand in 1965-66 to 97 in 1991. For males it was 94 and for females 101.

Demographic data on Nepal indicate that life expectancy at birth has doubled since 1954. It was 27.1 for males and 28.5 for females in 1984. In 1991, it was 55 for males and 53.5 for females.

Migration

The census of 1991 shows that a total of 1,418,206 people were recorded as migrants during the period 1981-91, of which 78% settled in the Tarai. Of the remainder 19% settled in the hills and only 3% in the mountains. The factors for migration include the rich resources of the Tarai, better land, and wider employment opportunities. The emigration factors were land shortages in the place of origin, hardships, and low agricultural productivity.

According to Table 7, about 1.1 million people moved to the Tarai and only 195,761 individuals emigrated outside the region. The net migration to the Tarai region is 64.56% of the total migration figures for Nepal. The percentage of net migration in the mountain region and hills are -53.16 and -11.40 respectively. The highest net migration is found in the Eastern Development Region (20.30%). The Western and Far Western Development Regions show the second (12.89%) and third (12.78) highest rates respectively.

Some 78.4% of the total migrants migrated to the Tarai, which is receiving an influx of migration both from the hills and from neighbouring countries. Uncontrolled migration is likely to lead to over-exploitation of resources in the Tarai.



The older generation hardly migrates to southern Nepal. Goitres develop for want of iodised salt.

Table 6 Migration status of the Tarai (In-migration and out-migration)

Development Region	In-Migration		Out-Migration		Net Migration Percentage of Total Volume of Migration
	No.	Percent	No.	Percent	
Eastern Tarai	362,486	25.56	74,639	5.26	20.30
Central Tarai	235,313	16.59	71,636	5.06	11.54
Western Tarai	197,915	13.96	15,210	1.07	12.89
Mid-western Tarai	128,232	9.04	28,151	1.98	7.06
Far western Tarai	187,393	13.21	6,125	0.43	12.78
Total Tarai	1,111,393	78.36	195,761	13.80	64.56
Hills	267,116	18.83	1,021,039	71.99	-53.16
Mountains	39,751	2.81	201,406	14.21	-11.40

Source: CBS, 1995: *Population Monograph of Nepal*.

Economically Active Population

According to the Census of 1991, 70% of the total population are economically active. The economically active population includes individuals 10 years of age and over. About 60% of the economically active population are male, and 40% are female. The Central Development Region has the highest level of economically active population.

Approximately, 90.2% of the total population live in the rural areas of Nepal and are engaged in agriculture and agri-related activities.

Economic Indicators

The Economic Survey of 1998/99 published by the Ministry of Finance (1999) has presented some facts and figures about the economic situation of

Nepal. According to this survey, the nominal GDP (Gross Domestic Product) at market price in FY 1996/97 was Rs. 269,570 million and revised estimates show that it reached to Rs. 285,702 million in FY 1997/98. According to the survey, the contribution of the agricultural and non-agricultural sector in total GDP in 1996/97 is 40.4% and 59.6% respectively. Per capita GDP at current prices (at factor cost) was Rs. 13,272 and Rs. 13,776 (at producer's prices) during FY 1997/98.

GNP (Gross National Income) reached Rs. 285,174 million at current prices in FY 1996/97, a growth of 12.9% compared to FY 1995/96. The GNP per capita is estimated to be Rs. 13,367 at current prices. The total national investment and total

capital formation at current prices were Rs. 70,401 million and Rs. 58,693 million respectively. The total national investment for FY year 1996/97 was 24.7% of GDP at producers' prices.

Total national consumption in FY 1996/97 in terms of GDP was 87.2% of the GDP at producers' current prices. The share of the government sector in total consumption is estimated to have reached 10.4%. The total national consumption was Rs. 244,650 million, in FY 1996/97.

Gross domestic saving at current prices was estimated at Rs. 35,932 million. National saving

during FY 1995/96 reached Rs. 41,602 million.

The total amount of tax revenue earned by the government was Rs. 24,424.3 million in 1996/97. The total amount of foreign aid committed to Nepal in 1996/97 was Rs. 39,643 million. With regard to foreign loan and debt servicing, the net outstanding foreign loan was Rs. 141,765 million, of which Rs. 1,156.5 million was used for interest payments (HMG, 1998). In mid July 1998 there were about 475 branches of banks serving the country.

Landscapes such as Mustang in the Trans-Himalayan region remain desiccated and dry not only in an ecological sense but also from an economic point of view.



3. Biogeography

Biogeography deals with the patterns of distribution of organisms in space and time. The distribution of organisms, vegetation, and land use types is determined by various environmental factors, both biotic and abiotic. Habitat is generally understood as the living space of organisms and their communities. Habitat refers not only to the place occupied by an organism or a community of organisms but also to the environment they create in conjunction with other abiotic factors.

A biogeographical approach has been used to define and classify the habitats prevailing in Nepal. This allows the recognition of homogeneous parcels (units) created by physical, biological, and human factors. The concept of the "isopotential ecological zone," defined by P. Ozenda as early as 1963 and used by Dobremez (1972) in Nepal to create a series of ecological maps, has been broadly recognised in the process of habitat classification. Land use classification has been broadly adopted from the LRMP (1986) types.

Nepal is centrally located in the Himalayas and occupies about a third (800 km) of its entire length (2,500 km) from the Indus Trench below Nanga Parbat to the Yarlung-Tsangpo-Brahmaputra gorge below Namche Barwa. It is located between India and China at 80°04' to 88°12' E and 26°22' to 30°27' N. It has an area of 147,181 sq km, and is of a rectangular shape, extending about 800 km lengthwise from east to west and is 140 km to 280 km in breadth.

Nepal stretches from west to east with three mountain ranges, i.e., the Himalaya, the Mahabharat, and the Siwalik ranges lying parallel along its length. These three ranges lie within the 200 km width of Nepal. Thus a north-south cross-section of Nepal reveals a range of altitudinal variation from over 7,000m towards the north to less than 1,000m towards the south. Various authors have used different terminologies to define Nepal's physiographic units (Figure 1). Most government documents dealing with natural resources are based on the Land Resources Mapping Project (1986) classification, viz. High Himalaya, High Mountains, Middle Mountains, Siwalik, and Tarai. Land use types, on the other hand, are classified into three broad categories, i.e., agricultural land, forest land, and other lands, including wetlands, shrublands, rocks, scree, shale, and permanent snow-covered land.

a) Bioclimatic Classification

The different types of climate found in Nepal have been classified into five major global types: (i) cold (Arctic/Nival), (ii) cold temperate, (iii) warm temperate, (iv) subtropical, and (v) tropical. These climatic zones, which are defined on the basis of latitudinal gradient are mirrored in altitudinal gradients along the mountain slopes.

Nepal lies in the subtropical region (latitude 26° 22' N to 30° 27' N). The foothills and low lying valleys, however, show biological tropicality, while the high mountain region is alpine in character. Biologists, therefore, recognise four major bioclimatic zones, i.e., tropical, temperate, alpine, and arctic, with further sub-divisions. There are certain variations which various authors have proposed for their own specific purposes. Altitudinal limits to define various climatic zones vary among authors even for the same geographical region, such as in East Nepal (Figure 2). Shrestha (1989) proposed six zones to compare vegetation patterns in the Nepal Himalaya (Figure 3). The alpine zone lying above 4,000m and below 5,000m and the tropical zone lying below 1,000m show a more or less uniform pattern of vegetation distribution in an east to west sequence, but the temperate and sub-tropical zones are more diverse in climatic conditions, as exhibited by their forest types.

b) Phytogeographic Classification

Phytogeographically, Nepal lies at the "crossroads" of six floristic provinces of Asia: (i) Sino-Japanese, (ii) South-East Asian, (iii) Indian, (iv) African-Asian desert, (v) Irano-Turanian, and (vi) Central Asiatic provinces. Two major realms of the earth – palearctic and oriental – have their boundaries running through Nepal. The verticality of the mountains further diversifies the bioclimatic features of Nepal. Eleven types of bioclimatic zones (Dobremez, 1972) have been identified here, ranging from the tropical to the nival zone juxtaposed along the slopes of the mountains. Thus, biogeographic delineation and habitat classification face serious problems of inter-penetration and mutual overlaps.

Altogether, six floristic provinces of Asia merge in Nepal. However, it is the Sino-Japanese province whose features dominate Nepal. The humid east Himalayan flora dominated by oaks,

rhododendrons, magnolias, and laurel, and the drier west Himalayan flora dominated by cedars, cypress, spruce, and other conifers show considerable interpenetration. Stearn (1966) classifies Nepal into three units: Western Nepal (west of longitude 83°E) which is dominated by western Himalayan flora; Eastern Nepal (east of 86° 30' E) dominated by eastern Himalaya flora; and Central

Nepal (between 83°E and 86° 30' E) which represents a zone of interpenetration for the two differing flora. Therefore, the Annapurna Conservation Area (ACA) exhibits great diversity in its flora and fauna. Even endemic species of flowering plants are highest in number (55 species) in the ACA compared to other protected areas (Shrestha and Joshi, 1996).

Figure 1 Nepal: Physical division with diagrammatic profile from north to south

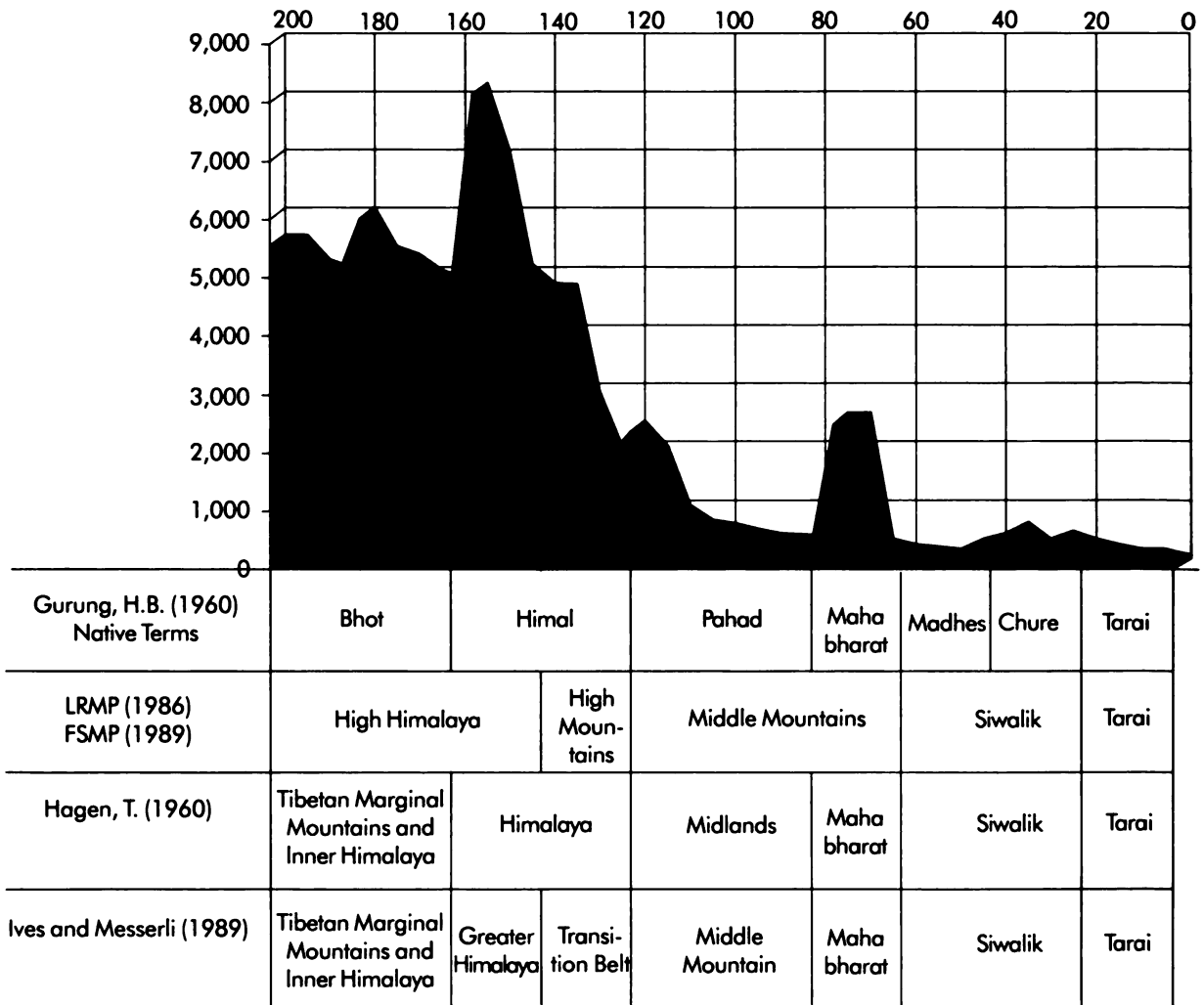
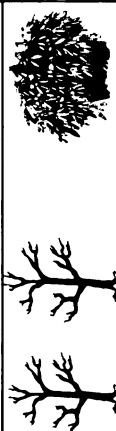
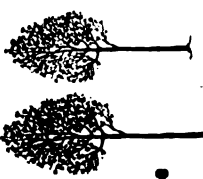


Figure 3 Vegetation pattern in the Nepal Himalaya

Metres	Feet	West Nepal	Central Nepal	East Nepal	Remarks
5000	(16500)				
4000	Alpine	Grasses/Herbs			More or less uniform all along the Nepal Himalaya
		Juniper thickets			
		Rhododendron bushes			
3000	Sub- alpine				
		Birch and Rhododendron			
		Fir and Birch			
2000	Temperate	Coniferous			1. Rich in tree species 2. High degree of diversity 3. Intense human interaction with vegetation 4. Diverse land use 5. Vulnerable to mountain degradation
		Oaks			
		Deciduous			
1000	Sub- Tropical				More or less uniform all along Nepal Tarai/foot-hills.
		Chir Pine			
		Sal Forest			

c) Zoogeographic Classification

Udvardy (1975) classified the world into 8 biogeographical realms, of which the Indo-Malayan and the Palearctic realm inter-penetrate along the mountain crest of the Himalaya. The Indo-Malayan realm is further subdivided into four regions, namely, Wallacean, Sundaic, Indo-Chinese, and Indian (Mackinnon and Mackinnon, 1986). Western Nepal largely falls in the Indian region while eastern Nepal is more of an overlap between the Indian and the Indo-Chinese regions.

The inter-penetration of two biogeographical realms is marked in the occurrence of avifauna. Palearctic species such as the golden eagle, Tibetan partridge, snow cock, snow finch, etc. are found at high altitudes above 3,000m, and during the winter a great many Palearctic birds such as the black stork, mallard, red-crested pochard, common teal, and demoiselle crane descend from Europe and Northern Asia into Nepal. Similarly, thousands of birds pass over Nepal during spring and autumn on their way to or from India and Central Asia (Fleming, 1973). The lowlands of Nepal, i.e., the Tarai and the Siwalik regions are home to a large number of Indo-Malayan species such as the giant hornbill, the pied hornbill, the hill mynah, the coral-billed scimitar babbler, and Nepal cutia. Nepal's wealth of large mammals also exhibits this

inter-penetration. The Bengal Tiger and the rhinoceros of Royal Chitwan National Park are less than 100 km away from the snow leopard and the blue sheep of the northern Manaslu area.

d) Habitat Classification: Land use Types

Vegetation classification is a convenient tool for identifying ecological land units in Nepal. However, the first level of classification may be based upon land use types, e.g., agricultural land, forest land, and other lands. The wetlands and grasslands could well be identified under separate categories. In this treatment, the wetlands are classified under "other lands" and the grasslands are classified under "agricultural land."

Natural vegetation types are very diverse in the Nepal Himalaya. Hagen (1961) identified 12 vegetation types while Dobremez (1972) laid down a schematic classification of 118 vegetation types along the 11 bioclimatic zones of Nepal. He also described 75 types of vegetation and prepared 20 ecological maps of Nepal on this basis in collaboration with other authors. His approach of preparing ecological maps was based upon Sweinfurth's

Habitats of diverse biota soon become converted into agricultural land to feed the human population. A girl ploughing a field. However abnormal it may look, it is certainly contributing to feeding her family.



vegetation map of the Himalaya which appeared in 1957.

Various authors have attempted to classify forest types, but forest botanists in Nepal mostly follow the forest types described by Stainton (1972). His classification broadly follows Champion's classification of the forest types of British India and Burma (Champion, 1936). In this treatment, an attempt is made to synthesise Stainton's forest types, Dobremez's vegetation types, and LRMP's land use types to arrive at a general classification of habitats in Nepal.

The classification scheme of land units is presented in a hierarchical fashion. Plant names and forest types are used to define particular habitats as occupied by the forest or as indicated by the species in its natural distribution (Shah and Shrestha, 1996).

i) Agricultural Land

These land units are made up of mixed, smaller areas of both level and sloping terrace. They also include minor areas of adjacent open land, i.e., bunds, houses, and paths.

Cultivated Land

Tarai cultivation – Characterised by extensive, rather flat areas of alluvium.

Wetlands – These lands are associated with poorly drained soils with a fine, loamy soil texture and slope angles of less than 1°.

Most wetlands support at least one crop of rice during the monsoon and either produce a winter crop or remain fallow during the dry season. All wetlands have reasonably small fields with high bunds.

Upper Wetlands – Field size is generally a little larger than wetlands and bunds are considerably lower (approximately 15 cm). Slope angles are less than 1°. Common crops on upper wetlands are rice, maize, and mustard.

Dry Lands – These are mainly associated with moderately well-drained, loamy soils with slope angles of up to 5°. The fields have no bunds and are generally much larger than the previous land use types. The dominant crops on dry land

during the monsoon are maize, often followed by mustard or wheat.

Mixed Lands – This type consists of a mixture of at least two of the above land use types. Mixed lands are commonly found near rivers or where streams form a network of meandering stream beds and oxbows.

Hill Slope Cultivation – The terrace system in the mountainous region of Nepal falls under this category. The hills show various forms of agricultural terraces.

Level Terraces – This category includes both level and so-called near-level terraces. The latter are terraces with a slope angle of 4°-5° either backward-sloping (towards the slope), or forward-sloping. Level terraces are commonly narrow (average width approximately 2 metres).

Sloping Terraces – This category consists of all convex, concave or straight sloping terraces. Slope angles range from 4° to 30°. Sloping terraces can be found on upper slopes and spurs throughout the mountainous and hill areas of Nepal.

Crop types include a mixture of wheat and mustard, millet or maize, and rainfed or upland rice varieties.

Abandoned Land – In this group both level and sloping terraces are included, although it is hard to separate abandoned land from land which has been left fallow. It is thus assumed that land left fallow for at least 4-5 years could be considered abandoned. The area of abandoned land may vary from year to year since the failure of crops could force the farmer to turn cultivated land into grazing acreage and again back into productive agricultural land.

Slash and Burn Area – Hill slopes are cleared using the slash and burn technique where farmers plant maize, millet, and potatoes. This is a type of shifting cultivation on which crops are

Climax *Castanopsis* forests in the Arun Valley are subjected to slash and burn cultivation and then left fallow for natural regeneration. The *Eupatorium* takes over the ground as a pioneer species.



rotated every 5-10 years. In parts of eastern Nepal, slash and burn agriculture is prevalent as a supplementary means of supporting the growing population. These areas are neither ploughed nor terraced.

Valley Cultivation – This cultivable area consists of a series of river terraces of different ages. Valley cultivation also includes floodplains, as river terraces are occasionally flooded.

Valley Floors, Including Tars and Foot Slopes – The valley floors consist of floodplains in combination with comparatively young river terraces. The oldest terraces, often referred to as “tars” in Nepali terminology, vary in size from a couple of hectares to hundreds of hectares. Tars are defined as relict river terraces, and are quite common throughout the midland hills of Nepal. High mountain areas include fewer valley floors than middle mountain areas.

Tars, Alluvial Fans, and Lower Foot Slopes – Alluvial fans are a common feature in many valleys due to a high erosion rate. Soils are loamy to “bouldery” in texture and are drained more rapidly than the river terraces.

Tars are river terraces which are formed due to valley damming and glacial outwash. Because tars in this category never become flooded, they have well-established agricultural communities. Soils are normally loamy and moderately well drained, with slopes of often less than 1°. When irrigation water is available, tars become very productive. Most of the airstrips of the midland regions are located on this tar land.

Lower footslopes consist of gentle slopes with broad terraces bordering the valley floor. Narrow bands of mostly level terraces adjacent to the valley floor are also included in this category.

ii) Grazing Land

These are grasslands used primarily for grazing. Such lands lack sufficient shrub or tree cover to appear in the forestry legend. They are divided into six zones.

Tropical zone – Grazing land in this zone is found at an elevation of less than 1,000m. Such land falls in the Tarai region and some of the valleys of the Siwaliks and middle mountains. In the Tarai, most grazing land is found scattered along the banks of rivers and streams.

Tall savanna type grasslands are included in the tropical grazing lands and are mainly found

along the Rapti and Narayani rivers in Royal Chitwan National Park and in the Royal Sukla Phanta Wildlife Reserve.

Cynodon dactylon is the dominant grass species on open fields. On poor soils with a low fertility *Imperata cylindrica* is widespread. Other species include *Chrysopogon aciculatus*, *Dichanthium annulatum*, and *Paspalum distichum*.

Sub-Tropical – Grazing lands of this category lie between 1,000m-2,000m. The grass composition of this vegetation zone consists of *Themeda* spp., *Eragrostis* spp., *Setaria pallidifusca*, and *Saccharum spontaneum*. Due to heavy grazing, non-palatable species such as ferns, stinging nettle, and *Eupatorium* are becoming dominant.



Lofty alpine valleys are often subjected to heavy grazing. The flora changes from ubiquitous grassland to colourful alpine flowers, especially *Primula*, *Potentilla*, *Geum*, *Taraxacum* and so on.

Temperate Zone – This zone lies at 2,000m-3,000m elevation. This is the main winter grazing area for cattle, sheep and goats. The area is heavily over-grazed due to its very high stocking rate.

Burning to improve grazing land is a common practice here, although this increases soil erosion and restricts regeneration of forests and shrubs. Species such as *Saccharum angustifolium*, *Setaria glauca*, and various *Poa* spp. are dominant in the cooler places within this zone.

Sub-Alpine Zone – This zone lies between 3,000m-4,000m. Only seasonal grazing takes place due to heavy snow coverage in winter. The composition of grass consists mainly of *Poa* spp., *Carex* spp., *Festuca* spp., and *Kobresia* spp.

Burning is common at the end of the grazing season and in early spring. Burning forest or shrub cover is practised to improve pasture land and to extend rangeland. Agricultural land is scarce at this altitude.

Alpine Zone – This zone consists of grazing land above 4,000m elevation. The alpine pasture meadow predominantly consists of *Festuca* spp., *Agropyron* spp., and *Kobresia* species.

In addition, there are several colourful herb species which are mainly found on moist and deeper soils after heavy grazing.

Alpine pastures and grazing lands are grazed only during the summer months (June-September).

iii) Forest Land

A forest is a plant community predominantly of trees and other woody vegetation, usually with a closed canopy.

According to LRMP (1986) and the Forestry Sector Master Plan, forest land must have at least a 10% crown cover, although small pockets of plantation and burned areas are also included.

Hardwood Forest

Hardwood is a conventional term, used irrespective of physical hardness, for broad-leaved trees and their timber. These are distinguished from coniferous species or softwood.

_____ Tropical Types

***Shorea robusta* (sal) forest** – *Shorea robusta* ('sal' in Nepali) is a gregarious species and rarely occurs as a component of other forest types. It is widely distributed throughout North India and Sub-Himalayan tracts including the Tarai, Bhabar, and Dun Valley of southern Nepal. *Shorea robusta* forest is found below 1,000m altitude in old, well composed laterite soil as opposed to the fresh alluviums of river shorelines. Sal forests, as a climatic climax, are not rich in other associated species. Some of the associated common species include *Terminalia myriocarpa*, *T. chebula*, *T. belerica*, and *Careya arborea* as a second layer. Lianas such as *Spatholobus roxburghii* and *Bauhinia vahlii* are well developed.

Sal forest generally occurs in the outer foothills. It often penetrates into the main river valleys which drop below 1000m altitude. Hillside sal forest occurs on dry south faces in parts of central and eastern Nepal.

***Dalbergia sissoo*-*Acacia catechu* forest** – This type of forest is composed of *Dalbergia sissoo* (sissoo) and *Acacia catechu* (khair). It is common

on new alluvium along the streams in Bhabar and Dun valleys.

Terminalia forest – This type of forest is found in the tropical and subtropical zone in the Bhabar and Dun valleys. It also occurs in the lower valleys of the midlands. The main species found in this type of forest include *Terminalia tomentosa*, *T. chebula*, *T. belerica*, and *T. myriocarpa*.

Riverine Forest of Bombax ceiba – *Bombax ceiba* forests develop on well-drained terraces with lots of boulders and sandy soil. As such, the Bhabar (southern foothills of Siwalik) zone and riverine terraces of the tropical zone have *Bombax ceiba* as a dominant species of mixed vegetation.

Riverine forest of Cedrela-Albizia – Sub-tropical foothills along large rivers such as the Arun are ideal for the occurrence of very tall trees of *Cedrela toona* in association with *Albizia* spp. Occasionally, *Duabanga sonneratioides* and *Eugenia* spp. are associated in this type of forest, which occupies damp habitats on north-facing slopes.

Schima-Castanopsis forest – This type of forest is found between 610m and 1830m. It does not form a continuous belt. *Schima wallichii* is mostly associated with *Castanopsis indica*, *C. tribuloides*, *C. hystrix*, and *Engelhardtia spicata*.

Above 1,200m, *Castanopsis tribuloides* becomes more numerous in comparison to *C. indica* but *Schima wallichii* remains abundant throughout. The forest is widespread on both the north and south faces of the Arun and Tamur valleys and in the vicinity of Pokhara.

_____ Temperate and Alpine Types

A temperate climatic condition indicates a warm summer and a definite winter season. The temperate zone in Nepal extends from 2,000m to 3,000m.

The alpine zone is characterised by a severe winter with heavy snowfall. The mean annual temperature is under 7.2°C and the mean January temperature is below 1.1°C. The alpine zone has an altitudinal range of 4,000m-5,000m. A subalpine zone from 3,000m-4,000m is clearly distinguishable in the Himalayas.

***Castanopsis tribuloides*-*C. hystrix* forest** – This type of forest is found at altitudes of 1,830m-2,130m in eastern Nepal. These two east Himalayan species may grow as high as 24m-30m in height.

***Alnus nepalensis* forest** – This forest is widespread in Nepal between 910m-2,730m along

streams and in places where water is permanent. It grows up to a height of 30m. *Alnus nepalensis* occurs most prominently in the form of small isolated woods amongst fields and on unstable ground.

This is a coloniser species in degraded hill slopes near streams, and is most useful in checking the soil erosion on fresh landslides and ravines. Most areas of forest regeneration are composed of alnus woods.

In eastern Nepal, cardamom is cultivated beneath alnus trees.

***Alnus nitida* forest** – *Alnus nitida* is confined to the riverbank of Mugu Karnali (western Nepal) at an altitude of 2,130m-2,440m. It grows up to 25m in height.

***Quercus incana*-*Q. lanuginosa* forest** – This forest is extensive in the west midlands between 1670m-2590m. It is less widespread in central and eastern Nepal, and is limited to south-facing slopes of large river valleys. *Quercus incana* does not extend towards the east beyond Dhaulagiri (83°E), whereas *Q. lanuginosa* extends as far as 87°E (Dobremez, 1972).

***Quercus lamellosa* forest** – This type is widespread in central and eastern Nepal. It forms a largely continuous belt along the ridges which flank the upper Arun and Tamur, and on the south slopes of Himalchuli and Annapurna Himal. Its westward limit is Myagdi Khola in central Nepal where it is associated with laurels.

***Quercus floribunda* (*Q. dilalata*) forest** – This type of forest occurs between 2,130m-2,800m. It attains a height of 30m and is fairly common in the west midlands. This forest is confined to the north or west faces where soil is damp. It is associated with *Quercus incana* and *Q. lanuginosa* as well as *Q. semecarpifolia*. It is also found mixed with *Aesculus indica*, *Ilex diphyrena*, *Alnus nepalensis*, *Juglans regia*, and *Acer* spp.

***Lithocarpus pachyphylla* forest** – This is an eastern Himalayan species and occurs in eastern Nepal at an altitude of 2,400m. It grows to a height of 24m-30m. In its most typical form, the upper canopy is composed almost exclusively of *Lithocarpus pachyphylla*.

***Lithocarpus spicata* (*Quercus spicata*) forest** – This forest is well developed in eastern Nepal. The prominent associate species include *Sorbus* spp., *Symplocos* spp., *Prunus cornuta*, *Vaccinium* spp., and *Acer* spp.



The temperate zone is often vegetated by blue pine. Occurrence of blue pine as secondary forest is common in the mountains of Nepal.

***Daphniphyllum himalense* forest** – *Daphniphyllum* forests are generally secondary in nature.

A dense *Daphniphyllum* forest was observed at the top of Bhandukay pass (3,100m) in eastern Nepal. This forest is 10m in height. Its evergreen crown shelters the ground and allows little undergrowth.

***Aesculus-Juglans-Acer* forest** – This forest type consists of *Aesculus indica*, *Juglans regia*, and *Acer* spp.

Quite often, deciduous forests of temperate levels are represented by an *Aesculus-Juglans-Acer* association which penetrates into coniferous forests along gullies and ravines. In autumn, this forest is colourful due to the yellowing of the leaves, which are seen at various levels of abscission. This forest is confined mostly to the west midlands.

***Rhododendron* forest** – In Nepal, rhododendrons are often numerous in fir, hemlock, birch, and upper temperate mixed broad-leaved forests as under-shrubs. At the alpine level, these are better described as shrubberies.

Forest composed purely of *R. arboreum* occur on rain-soaked, south facing slopes at 1,500m-3,000m. It often takes over fir forests after the latter is burnt or destroyed by human activities.

***Quercus semecarpifolia* forest** – This forest is widespread at altitudes of 2,290m-3,000m on the south facing slopes.

This type of forest is absent in heavy rainfall areas such as the upper Arun and Tamur, and hills lying north of Pokhara. It may be associated with spruce, blue pine, and birch.

***Populus ciliata* forest** – In Nepal, *Populus* forests develop along streams at an altitude of 2,130m-3,300m, in drier areas.

***Betula utilis* forest** – The birch forest characteristically forms the tree line in Nepal. It occurs throughout the length of Nepal, in the south of the Himalayan range between 3,350m-3,810m. Its prominent associate species is *Rhododendron campanulatum*.

Coniferous Forest

Tropical Types

***Pinus roxburghii* forest** – *Pinus roxburghii* occurs on the south-facing slopes of most of the midland zone and the Siwalik hills at 1,200m-2,200m. This pine is mostly used as a reforestation species in the hills of Nepal.

Temperate and Alpine types

***Pinus wallichiana* (*P. excelsa*) forest** – Blue pine is found in most parts of temperate Nepal. It forms almost a pure forest in the Humla-Jumla area in western Nepal. The lower limit of the blue pine forest is 1,830m while its upper limit is at the tree line correspond to approximately 3,700m.

It is not resistant to fire, unlike chir pine. Some associated species of this forest type are *Picea smithiana*, *Abies spectabilis*, *A. pindrow*, *Cedrus deodara*, *Betula utilis*, *Quercus semecarpifolia*, etc. It is an

aggressive coloniser in abandoned areas.

***Cedrus deodara* forest** – This type of forest occurs naturally in only a few places, as in the Humla-Jumla area. The valley of the upper Bheri demarcates its easternmost distribution in Nepal. Pure cedar forest occurs between 1,980m-2,800m. These include the areas such as the valleys of the Tila Khola (southwest of Jumla), the upper Bheri (between Tibrikot and Tarakot), and lower Bheri. These areas are windy, dry, and are composed of limestone rocks. The *Cedrus deodara* forest attains a height of 30m. Its associates are *Pinus wallichiana* and *Picea smithiana*.

***Cupressus torulosa* forest** – This type of forest occurs at an altitudinal range of 2,130m-2,900m, with exceptional examples reaching up to 3,300m. The tree attains a height of 20m and its foliage is dark green.

Cypress can grow on steep rocky gorges where other trees fail to stand. It possesses a pyramidal crown and is absent in eastern Nepal.

***Larix griffithiana* forest** – This is an east Himalayan species which grows sporadically and has been reported in the Kambachen valley in eastern Nepal. It occurs between 2,880m-3,940m and generally prefers old glacial moraines.

***Larix himalaica* forest** – This occurs only in the Buri Gandaki and the Langtang valleys as a component of xerophytic subalpine flora of the inner Himalaya. It prefers morainic habitats.

***Picea smithiana* forest** – This type of forest is present in the western part of Nepal at an altitude of 2,290m-3,350m, where it is to some extent sheltered from the full force of the monsoon.

Picea smithiana is a western Himalayan species. It forms a homogenous association with *Pinus wallichiana* and *Tsuga dumosa* along the river valleys of Bheri, Kali, Marsyangdi, and Budhi Gandaki.

***Tsuga dumosa* forest** – This type of forest is widespread at altitudes between 2,130m-3,340m and attains a 24m-30m height. In the eastern and central midlands and high mountain areas, it is associated with oaks and rhododendrons.

It forms a *Tsuga*-*Rhododendron* forest very similar to *Abies*-*Rhododendron* forest.

***Abies pindrow* forest** – This is a low altitude fir growing at 2,130m-3,050m and thus does not reach the tree line. It is confined to the north- and west-facing slopes in a few areas in the western part of Nepal. It is a tall tree attaining 45m height and possessing a columnar appearance.



Two species of Himalayan larch are reported in Nepal. The central Nepal larch, *Larix himalaica*, is restricted to a few valleys in central Nepal and adjoining areas of the Tibet Autonomous Region in China.

Abies pindrow is a western Himalayan species and does not occur in central and eastern Nepal.

***Abies spectabilis* forest** – This is a high altitude fir ranging between 3,000m-4,000m. Above 4,000m, it is replaced by birch towards the tree line.

Abies spectabilis forms different types of mixed forests as follows:

- *Abies spectabilis*-*Rhododendron hodgsonii* and *R. barbatum* - Eastern Nepal
- *A. spectabilis*-*Betula utilis*-*Rhododendron campanulatum* - Central Nepal
- *A. spectabilis*-*Rhododendron barbatum*-*R. cinnamomeum* - Central Nepal
- *A. spectabilis*-*Larix himalaica* - Central Nepal
- *A. spectabilis*-*R. arboreum*-*Quercus semecarpifolia* - Western Nepal.

***Juniperus Wallichiana* (J. Indica) forest** – *Juniperus indica* grows in the west midlands as a tree 13m-18m high and also as a small shrub. It occurs at 2,740m-3,350m. In places it forms pure forests.

Forest Plantation

Nepal has been endeavouring to reforest its degraded hills. A number of districts now have plantation areas. Such areas are becoming more and more important. Therefore, the habitats of new plantation forests are to be identified as a separate category. Forest plantations are found in various climatic zones, particularly in the tropical and subtropical zones. Prominent species of forest plantations are *Pinus roxburghii* on dry slopes in the subtropical zone and *Pinus wallichiana* in the temperate zone. Wet areas, especially the ravines and freshly degraded slopes, are afforested with *Alnus nepalensis*. Tarai plantations generally consist of *Dalbergia sisso*.

Mixed forest

Mixed forest is composed of two or more species of trees with at least 20% of the canopy consisting of species other than the dominant one.

Tropical Mixed Hardwoods

Tropical implies very hot without a defined winter climatic condition (Champion and Seth, 1968).

This type of forest is made up of the mixed

hardwood of the Tarai area and lower slopes of the outer foothills. Several species such as *Shorea robusta*, *Terminalia tomentosa*, *Eugenia jambolana*, *Trewia nudiflora*, *Lagerstroemia parviflora*, *Salmaal malbarica*, *Adina cordifolia*, *Cedrella toona*, and *Albizia* spp. are found in various combinations, while in the hills *Schima wallichii* and *Castanopsis* spp. become more prominent.

Tropical evergreen forest – Evergreen forests are never entirely without green foliage. Foliage persists until a new set has appeared.

This type of forest is found only in narrow strips along the water courses in gulleys. It has a marked preference for shady, north-facing sites. The tallest and most prominent trees in this type of forest are *Magnolia* or *Michelia champaca* with other associates like *Eugenia* spp., *Castanopsis* spp., *Pandanus furcatus* spp., *Murraya exotica*, palms, bamboos, and oaks.

Tropical deciduous riverine forest – This type of forest is frequently found along the streams of the Bhabar and Dun valley below 1000m. The most prominent tree species is *Bombax malabaria*, or silk cotton tree, growing up to a height of 40m. Other common tree species include *Schleichera trijuga*, *Ehretia laevis*, *Trewia nudiflora*, and *Garuga pinnata*. In the spring season, this type of forest becomes leafless.

Subtropical evergreen forest – A subtropical forest has a hot climate with a cool winter.

This type of forest is found between 900m-1,670m on the outer foothills and between the Koshi and Mechi rivers, where the rainfall is high. The common tree species in this type of forest are *Ostodes paniculata*, *Eugenia* spp., *Talauma hodgsonii*, *Drimycarpus racemosus*, *Lithocarpus spicata*, and laurel.

This forest is mostly evergreen, although a few tall deciduous trees, e.g., *Cedrela toona* and *Abizia* spp. may be present.

Subtropical semi-evergreen hill forest – This type of forest is confined to the base of large mountains, mainly in the side valleys of the Arun and Tamur and in the vicinity of Pokhara. It is found mostly on the north or west faces of the mountains or in steep, shady valley bottoms between the altitudinal range of 610m-1,670m. *Schima* and *Castanopsis* are quite common but not dominant in this forest type. Other associate species are also found in the tropical evergreen and subtropical evergreen forests. Two species

typical of this forest are *Pandanus furcatus* and *Cyathea spinulosa*, a tree fern.

Subtropical deciduous hill forest – This forest occurs in the outer foothills up to an altitude of 1,200m and penetrates into the hot, dry slopes of large river valleys in the midlands. The trees are only 12m-15m tall in comparison to the 40m tall trees of tropical deciduous riverine forests.

The state of leaflessness in the spring is one important characteristic of this forest type. In this respect, it resembles the tropical deciduous riverine forest.

Deciduous Mixed Broad-Leaved

Lower temperate, mixed broad-leaved forest – This forest is found in the wetter parts of Nepal between 1,520m-2,130m, usually on the northern or western faces. It is best seen in the side valleys of the upper Arun and Tamur and in wet areas to the south of Himalchuli and Annapurna Himal. One feature which distinguishes this forest from temperate forests at higher altitudes is the number of species which flower in autumn or early winter. The forest is, to a large extent, evergreen, and in many places trees of the *Lauraceae* family are prominent.

Upper temperate mixed broad-leaved forest – This type of forest occurs in the central and eastern midlands between 2,500m-3,500m, mostly on slopes which face north and west. It is predominantly broad-leaved. In some places the forest is 18m-25m tall with a dense undergrowth of small, moss-draped trees.

This forest is found in the upper part of all the regions of the Mahabharat and the high mountain zone. This forest type also includes *Aesculus-Juglans-Acer* forest.

iv) Shrub Land

Alpine Scrub

Alpine scrub implies a zone of vegetation where summer is short and the winter is long and severe with heavy snowfall. The mean annual temperature is below 7°C and the mean January temperature below -1°C.

Hippophae scrub

In Nepal, two species of *Hippophae* or Himalayan seabuck-thorn are found – *Hippophae tibetana* and *H. salicifolia*. The former species grows in dry inner valleys between 3,350m-4,420m altitude. It is a small shrub of 60cm in height, growing on old moraines and stony ground. This species grows west of Karnali, Dhorpatan (west midlands), in the Humla-Jumla area, Tukuche, and the Langtang valley.

Hippophae salicifolia is a shrub growing only a few centimetres in height and often occurring along river banks in dry inner valleys.

Moist alpine scrubs – This scrub occurs above the tree line in all the wetter parts of Nepal. In the inner valleys and arid areas it is replaced by dry alpine scrub. In the wet zones the alpine scrub can reach up to 4,418m. The species composition includes dense thickets of *Rhododendron anthopogon*, *R. lepidotum*, *R. setosum*, and *Juniperus recurva*.

Dry alpine scrub – This is found in the dry inner valleys of the Langtang, Mustang, and Dolpo areas.

In the Kali Gandaki valley the species composition includes *Sophora moorcroftiana*, *Lonicera hypoleuca*, *Ephedra gerardiana*, and *Caragana* spp.

The alpine steppe consists of species such as *Caragana brevispina*, *C. gerardiana*, *C. brevifolia*, *Lonicera spinosa*, and *Juniperus squamata*.

Mixed Shrub Land

Mixed shrub land is shrub vegetation which may include hardwood regeneration (LRMP, 1986).

A shrub is a woody perennial plant often less than 6 metres in height. Shrubs differ from perennial herbs in their persistent and woody stem and less definitely from trees in their low stature and habit of branching from the base.

Euphorbia royleana scrub – Gorges of large rivers such as the Karnali and Gandaki which lie at low altitudes harbour *Euphorbia* scrub on steep, rocky slopes. The presence of this scrub is an indication of the hot and dry condition of the habitat.

v) Other Land, Including Wetlands

Land other than agricultural, forest, and grazing land are denoted as non-agricultural land in the land use legend (LRMP, 1986). Wetlands are treated as a significant habitat type. Other types of land are not dealt with in this treatment.

Wetlands

Wetlands are areas of marsh, peat land or water, permanent or temporary, with water that is static or flowing, fresh, brackish or salt including areas of marine water the depth of which at low-tide does not exceed six metres.

Wetlands represent a landmass saturated with water due to the high water table through either groundwater, atmospheric precipitation or inundation. Wetlands may be natural or artificial.

Natural Wetlands

Natural wetlands are formed due to glacial lakes, tectonic lakes, ox-bow lakes, rivers, streams, and waterfalls. Three major types of wetlands may be identified in Nepal.

Riverine Wetlands – Riverine wetlands include habitats with perennial rivers and streams, including waterfalls. Temporary wetlands are formed in floodplains, river flats, and flooded grasslands.

Lacustrine Wetlands – This includes permanent freshwater lakes or ponds (> 8 ha area and 2m depth) including shores subject to seasonal or irregular inundation. Some lacustrine wetlands are formed seasonally during the rainy season.

Palustrine Wetlands – Palustrine wetlands include swamps and marshes with emergent

The wetlands of Nepal's Terai are very productive besides being critical for migratory water birds and resident mammals.



vegetation. Swamps are often dominated by *Typha* spp., or by woody vegetation in seasonally flooded forests. At high altitudes wetlands are formed in the meadows due to water from snowmelt and monsoon drizzle. Forested peat lands, including peat-swamp forest, also are classified in this category.

Man-made Wetlands

Man-made wetlands are created due to the construction of hydroelectric/irrigation dams for water storage, reservoirs, aquaculture ponds for fisheries, or seasonally flooded paddy fields.

Aquaculture – Natural, semi-natural or artificial ponds are utilised for fisheries and agriculture.

Agriculture (rice paddy) – Large areas in the floodplains and foothills are flooded for a considerable period of time giving rise to wetland habitats. This practice is carried out especially for paddy cultivation during the monsoon period (June/July).

Reservoirs – The damming of rivers or construction of reservoirs for hydroelectric/irrigation purposes creates special wetland habitats for fish, birds and wetland plants.

vi) Concluding Remarks on Habitat Classification

Habitat classification in Nepal is to be approached through biogeographic characterisation. This is done on the basis of dominant species of plants, animals, vegetation types, and altitudinal limits. The classification design should follow a hierarchy from broad classification to finer and finer classifications. This would facilitate different categories of users (planning level, implementation level, research level, etc.) to dwell upon the tier of their preference.

Nomenclature and terminology in habitat classification need to be standardised as far as is practicable. However, there should be provisions to interchange various terminologies on the basis of well-defined criteria. In the same way, international codes of nomenclature should be followed in the context of scientific research, while local vernacular names/common usage names should be logged against scientific names to exhibit the socio-cultural relevance of biological species.

Computer use in biodiversity, (which is still in its formative stage) and "learning by doing," should be the basis for developing a biodiversity database. Carrying out applicability tests of various software available around the world would be rather difficult, given the present situation where the information base is too weak.

A nationwide survey of biodiversity has to be undertaken using a prescribed format of survey methodology which is to be designed to address the needs of information users. Inevitably, various kinds of databases on thematic or topical interest will be developed. Mechanisms should be in place to network various thematic or topical systems within a national grid.

4. Agro-Ecosystem

The agro-climatic nature of Nepal is mirrored in the physiographic divisions of the Tarai (including the Siwalik), the Middle Mountains, the High Mountains, and the High Himalaya (trans-Himalayan region included) as defined by LRMP (1986). For the sake of convenience, these five divisions are generally merged into three areas, i.e., the Tarai (the Siwalik, Madhesh, and Tarai), the Hills (Middle Mountains including the Mahabharat), and the Himal which encompasses the High Himalaya with trans-Himalayan Bhot area and parts of the High Mountains.

Nepal has been primarily an agricultural country and its sustainability is based upon

subsistence agriculture. A more accurate characterisation of the importance of agriculture in the economy is shown by the fact that over 90% of the labour force is engaged in agriculture. Development performance in agricultural production is often rated as poor (APROSC and JMA Inc., 1995). More than 70% of the total cropped area in Nepal is covered by paddy, maize, and wheat. These contribute around 30% to agricultural GDP. The yields of these three major crops have declined over the last 30 years (APROSC/JMA). The major areas of these crops lie in the inner Tarai and Tarai zones of Nepal where land expansion has ceased to be a means of increasing agricultural production. The middle mountain zone of Nepal, generally known as "Pahad," primarily remains subsistence-oriented due to its inaccessibility and fragility. The Himalayan region has a farming system which is based on rangelands and livestock. The agricultural development strategy in Nepal concentrates largely on crops in the Tarai, on horticulture in the hills, and on animal husbandry in the Himalayan region. Forestry and agro-forestry remain an integral part of the farm ecosystem to provide organic integrity to the system. A farm and forest linkage has helped not only in providing food, fodder, medicine, wild fruit and vegetables and other biomass supplies, but also in nutrient cycling and regulation of moisture flow, and in maintaining the biological diversity of plants and animals.

Deep Himalayan valleys allow two crops of paddy to be grown a



The Tarai and Siwalik Agro-Ecosystem

Agro-climatically, this belt lies in the tropical zone and consists of alluvium plains towards the south. In the Siwalik foothills it consists of generally coarse-grained sand and gravel of high permeability. The Tarai is suitable for growing a large number of cereal and non-cereal crops. The major production is dominated by seven crops, i.e., rice, maize, wheat, sugarcane, oilseed (mustard), tobacco, and jute. Aromatic herbs (lemon grass, palm rosa, mentha) and medicinal plants (*Rauwolfia serpentina*) are also grown in some areas. Some cotton also is grown in western Nepal. Gram, lentils, chick peas, "mungi" (golden gram), and "arahaar" (pigeon pea) are the main pulses grown. Recently, a large number of vegetable crops have started to be cultivated in the Tarai.

Livestock farming consists mainly of cows, buffaloes, goats, pigs, and poultry. The practice of feral grazing in forests and public land and fallow grazing in farmland is now gradually changing to stall feeding. Inland fisheries in lakes and ponds is on the rise, with over 28 species of fish (exotic as well as indigenous) being commercially raised.

The agricultural system in the Tarai is changing drastically in recent years with monocultural plantations and replacement of traditional varieties by high yielding varieties. Of the known 1,800 varieties of indigenous land races of rice including the wild species (*Oryza rufipogon*, *O. nivara*, *O. officinalis*), only one variety is popularly cultivated in the Tarai. This variety, called "masuli", was released in the Tarai in 1973, become very popular and resulted in the elimination of all local cultivars of Chitwan District. The extinction patterns in other countries of South and South East Asia suggest that immediate measures are essential to conserve the indigenous varieties of rice. The extinction of 1,500 local rice varieties has been recorded in a period of just 15 years in Indonesia (McNeely, 1995).

Local breeds of sheep (kage sheep and lampuchhre sheep), goat (khari goat) a number of non-descript buffaloes including lime buffalo, pig (chwanche pig and pundi pig), and poultry (sakini and the naked-neck type) are considered to be near extinction due to the introduction of new varieties from elsewhere (N.P. Shrestha, 1996).

Farmers of the Tarai have accessed wild species for domestication, especially the wild buffalo, "arna" (*Bubalus arnii*). Conserved in the Koshi

Tappu Wildlife Reserve, it is used as a genetic resource for domestic buffalo. Similarly, wild boar (*Sus scrofa*), red jungle fowl, and mallard duck are kept in farms for domestic use. The wild cattle "gaauri" (*Bos gaurus*), conserved in the Royal Chitwan National Park, have not been in use by farmers. Wild elephants (*Elephas asiatica*) are widely domesticated and used for breeding by the native people. The diversity of crop species, livestock and fish is in great decline but there has not been any assessment of the loss of biodiversity from agroecosystems. Strategies/action plans on biodiversity should turn a sharp focus on this area.

Mountain Agro-Ecosystems

Agriculture is most complex in the mountainous region of Nepal and any simple classification remains to be made. Changes in climate, soil relief, and also in the ethnic composition of people alter the agro-ecosystem within a short geographical distance. However, there is a conventional integration in agriculture, livestock, and forestry in the mountain agro-ecosystems. Some authors feel that these systems have not only reached a productive threshold but are also beginning to disintegrate under the ravages of reckless exploitation and mis-management (Banskota, 1989). In spite of the bleak picture of environmental deterioration in the hills and mountains of Nepal, agro-ecosystems still remain a stronghold for biological diversity and economic prosperity. At present, the hills and mountains contribute to more than half of the agricultural GDP. The Nepal Agricultural Perspective Plan (June 1995) identifies a selected number of potential high-value crop commodities and practices such as citrus fruit, off-season vegetables, and vegetable seeds, (including potato seeds); apples; apiculture; and animal husbandry of yaks, sheep, and goats. For reasons of food security and risk management, crop diversity and livestock-based farming system will, however, continue to be the farmers' choice.

The loss of biodiversity in the hills and mountains is often considered to be a result of agricultural expansion (Khooshoo, 1995). On the other hand, a large number of economically important biological species are in fact conserved in farming systems because of their usefulness to farmers. The biological and economic value of agro-ecosystems has not received adequate attention from ecologists and scientists. Wild plants cultivated by farmers are numerous in the hills and

mountains of Nepal. Through experience hill farmers themselves have evolved a wide choice of crops over the years. The traditional isolation of the rural hill areas is rapidly breaking down with the development of infrastructure, urbanisation, and other socio-economic changes (Banskota, 1989). A rapid assessment of the biodiversity value of domesticated wild species and local breeds is urgently needed to take advantage of the opportunities afforded by their genetic resources.

The altitudinal limit of agricultural activity lies somewhere between 2,800m and 3,000m altitude on the south of the main Himalayan range. Agricultural practices may reach as high as 4,000m in the trans-Himalayan regions where solar radiation is not hampered by cloud cover. Thus a mixed farming system, based upon crop and livestock supported by heavy use of forest resources, is the characteristic feature of agriculture below 3,000m. The scope for improving the agro-ecosystem by the use of agro-forestry in the Hindu Kush Himalayan region is encouraging (Denholm, 1991). Indigenous trees such as *Alnus nepalensis* have provided the basis for the boom in cardamom production in the hills of eastern Nepal. Similarly, the success of community forestry in the hills of Nepal is contributing to the enhancement of biodiversity and local economies. The dependence of the mixed farming systems on the forests of the midhills has become increasingly evident and a number of studies have attempted to substantiate the point by actual quantification (Applegate and Gilmour, 1987). Reportedly, pioneer plantation of pine is gradually being replaced by *Schima castanopsis* in many parts of the central midhills.

Livestock are an integral part of mountain farming systems. The contribution of livestock in the hills and mountain is higher than in the Tarai. Their ecological contribution as a means of draft power in tilling the land and as a source of manure is critical. Introducing new breeds of cattle in the hills and mountains is seen as a means of improving rural-urban trade and marketing linkages through higher production of milk and meat.

Introducing exotic buffaloes such as "murrah" or cross-breeds for high yield would also mean replacing the breeds resistant to the harsh environment. Lulu cattle, achami cattle, lime buffalo, yak and nak, the pate breed of pig, and kage sheep have reached a critical stage and if suitable measures are not taken, they may be soon lost.

The trans-Himalayan region of Nepal, (Bhot), consists of the inner Himalayan Valley and the steppic region of the Tibetan plateau. The climate is arid, dry, cold, and windy. The growing season for crops is very long. The agricultural system is based on livestock, such as yak/chaunri, sheep, and the mountain goat "chyangra." Animals are driven between the higher altitudes in summer and the lower altitudes in winter. The main crops of this ecozone are buckwheat, naked barley and potato. The introduction of temperate fruit and vegetables is providing an opportunity for farmers to earn cash.

The overall agricultural development strategy based upon ecozone specialisation; such as the focus on cereal crops in the plains, horticultural crops like fruits and vegetables in the hills, and livestock in the mountains; was followed in all the periodic development plans of Nepal. A large number of crop varieties and animal breeds have been evolved in the Himalayas in the process of managing agro-ecosystems, but there has been no effort to develop strategies and plans or programmes to conserve the biological diversity of the agricultural ecosystem as a whole.

Lho Village (3,180m) in the foreground of Manaslu Himal. The interface between farm and forest is an essential feature of the mountain agro-ecosystem. Lho villagers use pine needles as manure after treating the forest with fire, ash and urine. The vegetation is mostly composed of shrubs and herbs.



An assemblage of half a dozen species of rhododendron in full bloom. Milke Danda in eastern Nepal is home to twenty-five rhododendron species.

A natural process of hybridisation is active in the remoteness of the Himalayas. *Rhododendron campylocarpum* (yellow flowers) and *R. thompsonii* (deep red flowers) have produced a natural hybrid in the Barun Valley of eastern Nepal.



Conservation and Sustainable Use of Flora and Fauna



The problem of conserving biological diversity in Nepal is linked directly with national development problems such as poverty alleviation, employment generation, environmental regeneration, and the advancement of women. Because Nepal is a mountainous country with an agrarian people, it will continue to be heavily dependant upon its water, land and forests to meet its development objectives. Conservation and sustainable use of natural resources is thus a development activity (Saunier and Meganck, 1995). The planning process for Nepal's development will provide lasting benefits only if it integrates the conservation and sustainable use of biological resources into national decision-making. Sustainable use of biodiversity means the use of its components in a way and at a rate that does not lead to long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of the present and future generations.

Convention on Biological Diversity, Article 6

General Measures for Conservation and Sustainable Use

Each Contracting Party shall, in accordance with its particular conditions and capabilities:

Develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity or adapt for this purpose existing strategies, plans or programmes which shall reflect, *inter alia*, the measures set out in this Convention relevant to the Contracting Party concerned; and

Integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes, and policies.

1. *Flora*

Overview

The value of Nepal's vast botanical heritage has been appreciated ever since plant specimens were formally collected for herbarium purposes during 1802-3. Botanical explorations became more intensive and wide ranging after Nepal opened its frontiers to foreign explorers and mountaineers during the early 1950s. The biophysical diversity of Nepal against the backdrop of a rich cultural diversity is highly regarded by the world community of plant scientists and conservationists. This encouraged His Majesty's Government of Nepal to first venture into the study and research of the flora of Nepal some 30 years ago. The Department of Plant Resources (formerly the Department of Medicinal Plants) is now poised to launch a programme to compile a flora of Nepal. Tribhuvan University, in Nepal, Japanese universities in Tokyo, Chiba, and Kyoto; and other specialised institutions such as the Royal Botanical Gardens at Edinburgh and Kew Gardens in London are supporting the programme.

Nepal is extremely rich in terms of floral diversity in proportion to its size. Nepal's share of the world's land is no more than 0.1% while its share of flowering plant species amounts to over 2%. Most of the Nepalese population use wild plants for fuel, as food supplements, and medicine; as chemicals, fibre, construction materials, farm nutrients, and livestock feed. In order to sustain a population which is doubling every 25 years, there must be an active plan for the sustainable harvest of botanical resources. A more stringent programme should be implemented for protecting plants of high commercial value such as medicinal herbs, and safeguarding plants of high conservation value such as endemic, rare, and threatened species.

Nepal is uniquely positioned to offer conservation benefits to the world through its diversity of 6 phytogeographical provinces, 11 bioclimatic zones, 35 forest types, and 75 vegetation types. The prerequisite for such an endeavour is a comprehensive flora of the plants of Nepal. No scientific communication on plants/plant derivatives is possible without access to botanical references. Therefore, the need for a systematic study on flora is obvious to address the problems that confront us

in biodiversity conservation and the development of biological resources.

Hara et al. (1978-1982) listed approximately 5160 species of flowering plants (dicots 4,000, monocots 1,150), belonging to 1,475 genera (dicots 1,140; monocots 335) and 207 families (dicots 175; monocots 32). The largest families in Nepal's flora include: Asteraceae (111/400), Poaceae (113/350), Orchidaceae (90/315), Fabaceae (90/300), Rosaceae (29/170), Cyperaceae (19/170), Scrophulariaceae (36/165), Lamiaceae (48/149), Ranunculaceae (19/143), Gentianaceae (14/106), and Rubiaceae (35/100). Only 4.8% of the total flora, i.e., 246 species of flowering plants, are endemic to Nepal.

At present, there is a great disparity of information about plant groups with respect to the available museum or herbarium specimens. The number and level of expertise in professional personnel also needs to be verified. It is apparent that the group of non-vascular Nepalese plants is poorly documented. Therefore, a flora of such groups would merely result in simple checklists and enumerations. This should by no means be a reason to delay or postpone broader undertakings such as the Flora of Nepal project.

Current Status

Since 1949, most parts of Nepal have been covered by various botanical expeditions. Major herbaria that house Nepalese specimens include the Kathmandu Herbarium (KATH), the British Museum Herbarium (BM), the Kew Herbarium (K), University of Tokyo Herbarium (TI), the Smithsonian Herbarium (US), the University of Grenoble Herbarium (GRE), and the Edinburgh Herbarium (E). It is estimated that the British Museum houses over 40,000 specimens accumulated since 1802, the University of Tokyo Herbarium has about 100,000 specimens collected during the period from 1963 to 1993, and the Kathmandu Herbarium houses about the same number gathered from 1961 to 1993.

Literature on the flora of Nepal is scattered in time and space from D. Don's *Prodromus Florae Nepalensis* of 1825 to Ohba and Malla's *The Himalayan Plants*, Vol. 2, of 1991. However, the three volumes of *An Enumeration of the Flowering Plants of Nepal* (1978-1982), and the *Catalogue of the Nepalese Vascular Plants* (1976) provide a good basis for preparing an inventory of species. Hooker's *Flora of British India* (1872-1897) and the local

floras of Nepal published as the Bulletin of the Department of Medicinal Plants will be useful to display the high standard attained by Nepalese scientists. Classical and old publications are not available in Nepal and special endeavours are warranted to strengthen library facilities with microfiche or photocopy materials from elsewhere.

Present botanical survey and herbarium management activities are poised to serve in the various fields of resource utilisation, development, and conservation in Nepal. The scientific basis for these activities starts with an authentic identification of plant resources and first-hand information on their field data regarding distribution, ecology, traditional uses, and local names. The specimens housed in the herbarium help communication across science and society. The DPR has been serving science and society in its own modest way but the potentialities of the department have not been fully harnessed for improved management of protected areas, national forests, watershed conditions, and non-timber forest products. Continued efforts towards achieving the goals of preparing a flora of Nepal would certainly provide a scientific base to all the activities undertaken by HMG line agencies related to plant resources and to teaching institutions dealing with plants and environments.

The Central Department of Botany at Tribhuvan University is the main institution where teaching and research on taxonomy is carried out. Half a dozen post-graduates with expertise in plant taxonomy (plant systematics) are produced every year. Dissertations on the revision of Nepalese taxa are also carried out. Encouragement must be given to students and researchers and basic facilities in the department should be strengthened to enable the Central Department of Botany to act as the main centre of taxonomic research and training of specialists.

Information Base

Plant scientists have devised a simple means to store and preserve their specimens in a well documented store-house called a "herbarium." A systematic collection of dried plant specimens goes to form a herbarium in very much the same fashion as a library is formed. A herbarium is a centre of research where scientists have the facilities to actually study plant specimens which are being collected from different places at different times. The herbarium at Godawari has a large

number of specimens collected from all over Nepal during the last 40 years. Specimens are mounted on a standard sheet of paper, and are systematically arranged. Those specimens have field notes as observed by their collectors, and bear an associated scientific name as determined by scientists. Herbarium specimens, therefore, act as a tool to identify a new specimens, and also as an open book of nature where the variety and variability of natural species are easily read and understood.

The inventory and information on plant resources should be readily available in a relational database for use in research and development. This would require a database system to be maintained on a long-term basis. The Department of Plant Resources and the Central Department of Botany of TU should seek to form a consortium of institutions and organisations that would enrich/ use the plant database. The inventory of the herbarium specimens, botanical exploration, and botanical literature should be documented in the database system. It should be compatible with the World Conservation Monitoring Centre (WCMC) and other databases.

Currently, there are three places where a computer-based database system on biodiversity is being developed. IUCN-The World Conservation Union has developed a database on wetlands, endangered and rare biological species, on protected areas, and on heritage sites. The approach to data accumulation and use has been that of addressing the needs of nature conservation and sustainable development. The Mountain Institute is running the Integrated Biodiversity Database Project. This project has developed an elaborate database system for biological species and their distribution in Nepal vis-à-vis their use and conservation. Socio-economic parameters are integrated with biological information. The King Mahendra Trust for Nature Conservation has also developed a database system for the biological resources of their project areas, especially the Annapurna Conservation Area Project.

In the present context, knowledge and information on the plant kingdom of Nepal is mostly limited to flowering plants, gymnosperms, and pteridophytes. Non-vascular plants are poorly documented and there is an urgent need to launch special efforts to make an inventory of lower plants. The Biodiversity Profiles Project (1995) has rightly encouraged documentation of some impor-

tant groups such as algae, lichens, and mushrooms. A summary of the known number of species is presented in the following table.

Table 1 Species richness and status of plants in Nepal

Plant Group	Number of spp.	Endemic spp.	Endangered	Extinct
Algae	687			
Fungi	1,500			
Lichens	465			
Mosses	463			
Angiosperms and Gymnosperms	5,188	246	101	8

Source: BPP, 1995

a) Flowering Plants

A list of the rare, endemic and endangered plants of Nepal have been compiled only recently. Shrestha and Joshi (1996) enumerate 246 species of flowering plants as endemic to Nepal, that represent 4.8% of the total species of 5,160 flowering plants. Japanese botanists (Koba, Akiyama, Endo, and Ohba, 1994) have further added 163 species of plants from Nepal, but their status remains to be evaluated.

The horizontal and vertical distribution of endemic species show that the highest concentration of endemic plants (91 spp.) occurs between 3000m-4000m altitude in Central Nepal (Table 2).



Table 2 Endemic plants of Nepal by altitude

Altitude (m)	Distribution			Total Species
	W. Nepal	C. Nepal	E. Nepal	
< 1000	4	7	10	13
1000-2000	11	25	13	38
2000-3000	37	51	24	75
3000-4000	61	91	29	118
4000-5000	52	84	31	107
>5000	15	18	2	24
Total Species	101	171	68	246

Similarly, according to an analysis of their distribution in the protected areas of Nepal, the Annapurna Conservation Area in Central Nepal claims the highest number, at 55 spp. (22.3% of the total 246 endemic species, see Table 3).

The high, dry and arid Tibetan Plateau extends to the foothills of the Himalayas.

Thorny cushions of *Caragana* characterise the Trans-Himalayan vegetation.

Endemism is strong in this area of natural interpenetration. However, because many species occur on either side of the border between Nepal and China they cannot be called endemic.



1 The bamboo orchid (*Arundina graminifolia*) was first discovered during Hamilton's visit (1802-03) to Kathmandu's Swayambhunath hill. It has now been replaced by other species in its type locality. It grows in the subtropical habitat often associated with grasses and shrubs.

2 *Paris polyphylla* (Satuwa) is a reputed medicinal herb for local healing and for export. Its ginger-like rhizomes are collected during the fall after the plant has produced seeds.

3 Acorns of the rare Nepalese oak (*Quercus fenestrata*). Most of the habitat for this oak has been subjected to slash and burn cultivation in the Arun Valley. This species is protected in the Makalu-Barun National Park.

4 *Homalium napaulense* is a small tree endemic to Nepal. It occurs in the subtropical zone along river courses. This species is not represented in the national parks of Nepal.

5 Yarsa gombu, one of the most famed Himalayan medicinal herbs. It is half-insect and half-plant. The plant part is represented by a club-shaped fructification of a mushroom (*Cordyceps sinensis*) and the animal part by the caterpillar of a certain moth. This herb is reputed to be an aphrodisiac.





1 *Rhododendron arboreum* - Nepal's national flower in full bloom at Milke-Jaljala. The Milke-Jaljala area is in the process being designated a Rhododendron Reserve through community conservation initiatives.

2 *Cypripedium cordigerum* is a native lady-slipper orchid occurring on the ground floor of temperate forests in western Nepal. This rare orchid deserves special conservation measures. It is not known to occur in any other protected area in Nepal.

3 *Swertia multicaulis* - a high-altitude herb known as "sarmaguru" has a small carrot-like root, which when applied as a paste on fresh wounds induces "instant healing."

4 *Cyathea spinulosa* - this tree fern occurs in the humid and sultry ravines and gorges of eastern Nepal. It is threatened due to excessive collection by nurserymen for the trunk's spongy, fibrous sheath which is useful for growing orchids.

5 *Saussurea gossypiphora* growing at 4000m is a curious looking plant which has caught the attention of faith healers as something with which to impress their clients.

Table 3 Endemic plant species occurring in protected area

Name of Protected Area	Ecological Zone	No. of Endemic Plants
Royal Suklaphanta Wildlife Reserve	Tarai/Siwalik	x
Royal Bardia National Park	Tarai/Siwalik	x
Royal Chitwan National Park	Tarai/Siwalik	x
Parsa Wildlife Reserve	Tarai/Siwalik	x
Koshi Tappu Wildlife Reserve	Tarai/Siwalik	1
Khaptad National Park	High Mountains/Middle Mountains	4
Rara National Park	High Mountains/Middle Mountains	16
Shivapuri Watershed and Wildlife Reserve	High Mountain/Middle Mountains	16
Dhorpatan Hunting Reserve	High Mountains/High Himalaya	36
Shey Phoksumdo National Park	High Mountains/High Himalaya	30
Annapurna Conservation Area	High Mountains/High Himalaya	55
Langtang National Park	High Mountains/High Himalaya	15
Sagarmatha National Park	High Mountains/High Himalaya	11
Makalu Barun National Park and Conservation Area	High Mountains/High Himalaya	7
Kanchanjunga Conservation Area	High Mountains/High Himalaya	x

Endemic species are almost absent in the protected areas that lie in the Tarai and Siwalik regions. It is also to be noted that 106 species of endemic plants occur outside of the protected area system. Of the 5 endemic species of *Eriocaulon*, only one species (*E. kathmanduense*) is expected to occur in the Shivpuri Watershed and Wildlife Reserve. Similarly, there are 16 endemic grasses, five of them not reported from protected areas. Among the 11 species of endemic *Aconitum*, only one (*A. amplexicaule*) occurs within the protected areas. Thus the conservation of species outside protected areas remains important in Nepal. An assessment of threats to endemic species suggests that 8 species may have become extinct, 3 appear endangered, 7 are vulnerable, and 31 are rare.

A twig of a very rare tree, *Tetracentron himalaica* growing on the Bunduke Ridge of eastern Nepal. It may be considered a living fossil. The tree grows to over 10m and forms a conspicuous element of temperate deciduous forest.



Treeline vegetation of birch and rhododendron is often found draped with hanging lichens (*Usnea* sp.). Such lichens provide food and nutrition to musk deer during winter.



Table 4 List of threatened/endemic plants indicating IUCN threat categories

Family	Scientific name	IUCN category						
		EX	E	V	R	CT	I	K
Acanthaceae	<i>Goldfussia acuminata</i>			+				
Acanthaceae	<i>Strobilanthes tamburensis</i>	+						
Anacardiaceae	<i>Rhus dhuna</i>	+						
Asclepiadaceae	<i>Caralluma staintonii</i>				+			
Asclepiadaceae	<i>Riocreuxia nepalensis</i>				+			
Begoniaceae	<i>Begonia tribenensis</i>				+			
Boraginaceae	<i>Arnebia nepalensis</i>				+			
Boraginaceae	<i>Maharanga verruculosa</i>				+			
Boraginaceae	<i>Onosma bheriense</i>				+			
Compositae	<i>Crepis porrifolia</i>	+						
Cruciferae	<i>Draba staintonii</i>				+			
Cruciferae	<i>Erysimum dolpoense</i>				+			
Cyperaceae	<i>Cyperus trisulcus</i>	+						
Cyperaceae	<i>Cyperus wallichianus</i>	+						
Cyperaceae	<i>Kobresia fissiglumis</i>				+			
Ericaceae	<i>Rhododendron lowndesii</i>				+			
Flacourtiaceae	<i>Homalium napaulense</i>			+				
Labiatae	<i>Lamium tuberosum</i>				+			
Labiatae	<i>Rabdosia dhankutanus</i>			+				
Lauraceae	<i>Persea blumei</i>	+						
Leguminosae	<i>Oxytropis fasciculiflorum</i>				+			
Leguminosae	<i>Oxytropis graminetorum</i>				+			
Lythraceae	<i>Rotala rubra</i>				+			
Oleaceae	<i>Jasminum amabile</i>			+				
Onagraceae	<i>Epilobium staintonii</i>			+				
Orchidaceae	<i>Liparis olivacea</i>	+						
Orchidaceae	<i>Malaxis tamurensis</i>			+				
Papaveraceae	<i>Corydalis brevicarata</i>				+			
Papaveraceae	<i>Corydalis staintonii</i>				+			
Polygonaceae	<i>Eskemukerjea megacarpum</i>		+					
Primulaceae	<i>Primula aureata</i>			+				
Primulaceae	<i>Primula ramzanae</i>				+			
Primulaceae	<i>Primula sharmae</i>				+			
Ranunculaceae	<i>Aconitum amplexicaule</i>				+			
Ranunculaceae	<i>Aconitum angulatum</i>				+			
Ranunculaceae	<i>Aconitum nepalense</i>				+			
Ranunculaceae	<i>Clematis alternata</i>				+			
Ranunculaceae	<i>Clematis bracteolata</i>				+			
Rubiaceae	<i>Wendlandia appendiculata</i>	+						
Salicaceae	<i>Salix plectilis</i>			+				
Saxifragaceae	<i>Saxifraga excellens</i>				+			
Saxifragaceae	<i>Saxifraga micans</i>				+			
Saxifragaceae	<i>Saxifraga mira</i>				+			
Saxifragaceae	<i>Saxifraga namdoensis</i>				+			
Saxifragaceae	<i>Saxifraga rhodopetala</i>				+			
Scrophulariaceae	<i>Lagotis nepalensis</i>				+			

EX = Extinct, E = Endangered, V = Vulnerable, R = Rare,

CT = Commercially Threatened, I = Indeterminate, K = Insufficiently Known

Source: Shrestha and Joshi, 1996.

b) Threatened Plants

The flora of Nepal is under threat from a number of factors associated with farm encroachment, slash and burn agriculture, livestock grazing, road construction, hydroelectric and irrigation dams (an emerging threat), urbanisation, and over-exploitation. The case from the Kathmandu Valley indicates that the original flora of the valley has changed tremendously. Swayambhunath hillock, which is the type locality for 27 species of Hamilton's new discovery of plants, has now transformed into an area dominated by re-introduced pines and exotic species including the weed eupatorium.



Saccharum spontaneum, a common species of grass, often colonises recent floodplains of the Terai and the inner-Terai region of Nepal. This species often grows in association with tall phragmites to provide a habitat for herbivorous mammals.

Table 5 Plants first discovered in Swayambhunath during Hamilton's collection 1802-1803

Valid Name	Basic Name	Family
<i>Arundia graminifolia</i> (D.Don) Hochr.	<i>Bletia graminifolia</i>	Orchidaceae
<i>Asparagus filicinus</i> Buch.-Ham. ex D.Don		Liliaceae
<i>Boehmeria platyphylla</i> D.Don	<i>Boehmeria rotundifolia</i>	Urticaceae
<i>Phyllanthus parvifolia</i> Buch.-Ham ex D.Don		Euphorbiaceae
• <i>Phoebe cathia</i> (Buch.-Ham.) Kosterm.	<i>Cinnamomum cathia</i>	Lauraceae
• <i>Sopubia trifida</i> Buch.-Ham. ex D.Don		Scrophulariaceae
• <i>Jasminum nepalense</i> Spring.	<i>Jasminum dichotomum</i>	Oleaceae
<i>Micromeria biflora</i> (Buch.-Ham ex D.Don) Benth.	<i>Thymus biflorus</i>	Labiatae
<i>Ophorohiza fasciculata</i> D.Don		Rubiaceae
<i>Viburnum mullaha</i> Buch.-Ham ex D.Don		Sambucaceae
<i>V. punctatum</i> Buch.-Ham. ex D.Don		Sambucaceae
<i>Anaphalis busua</i> (Buch.-Ham. ex D.Don) DC.	<i>Gnaphalium busua</i>	Compositae
<i>Inula cappa</i> (Buch.-Ham. ex D.Don) DC	<i>Conyza cappa</i>	Compositae
<i>Zizyphus incurva</i> Roxb.		Rhamnaceae
<i>Rhamnus viargatus</i> Roxb.		Rhamnaceae
<i>Thalictrum foliolosum</i> DC.		Ranunculaceae
<i>Anemone vitifolia</i> Buch.-Ham. ex DC.		Ranunculaceae
<i>Begonia hatacoa</i> Buch.-Ham. ex. D.Don		Begoniaceae
<i>Rubus betulinus</i>		Rosaceae
<i>R. Rugosus</i> Smith		Rosaceae
<i>Crotolaria alata</i> Buch.-Ham. ex D.Don		Leguminosae
<i>Indigofera dosua</i> Buch.-Ham. ex. D.Don		Leguminosae
<i>Begonia picta</i> Smith		Begoniaceae
<i>Persicaria viscosa</i> (Buch.-Ham. ex D.Don) Nakai	<i>Polygonum viscosum</i>	Polygoniaceae
<i>P. posumbu</i> (Buch.-Ham. ex D.Don) H. Gross	<i>P. posumbu</i>	Polygoniaceae
<i>Lonicera macrantha</i> (D.Don) Spreng.	<i>Caprifolium macranthum</i>	Caprifoliaceae
<i>Sanicula elata</i> Buch.-Ham. ex D.Don		Umbelliferae

Source: D. Don (1825). *Prodromus Florae Nepalensis*, London.

• Not listed in *Flora of Kathmandu* (1986).

The *Flora of Kathmandu* (1986) which includes 1,312 species of plants does not have 3 species collected from Swayambhunath in 1802-1803.

4. *Orchidaceae* sp. (orchid)
5. *Podophyllum hexandrum* (may apple)
6. *Rauwolfia serpentina* (Serpentine)
7. *Dioscorea deltoidea* (dioscorea)
8. *Taxus wallichiana* (Himalayan yew)

Appendix III

1. *Cycas pectinata*
2. *Gnetum montanum*
3. *Talauma hodgsonii*
4. *Meconopsis regia*
5. *Podocarpus neriifolius*
6. *Tetracentron sinense*

Government Protected

Under the Forest Act 1993, HMG has notified the following restrictions:

1. Ban on collection, use, sale, distribution, transportation, and export of the following medicinal herbs
 - ◆ Yarsa gomba (*Cordyceps sinensis*)
 - ◆ Panch ounle (*Dactylorhiza hatagirea*)
2. Ban on export outside the country.
 - ◆ Jatamansi (*Nardostachys grandiflora*)
 - ◆ Sarpagandha (*Rauwolfia serpentina*)
 - ◆ Sugandhakokila (*Cinnamomum glaucescens*)
 - ◆ Sugandabala (*Valeriana wallichii*)
 - ◆ Jhau (lichen)
 - ◆ Talispatra (*Taxus wallichiana*)
 - ◆ Loth Salla (*Taxus wallichiana*)
3. Ban on transportation, export, and felling
 - ◆ Champ (*Michelia* sp.)
 - ◆ Khayer (*Acacia catechu*)
 - ◆ Sal (*Shorea robusta*)

Source: Shrestha and Joshi, 1996.

d) Socio-Cultural

Aspects of Nepalese Plants

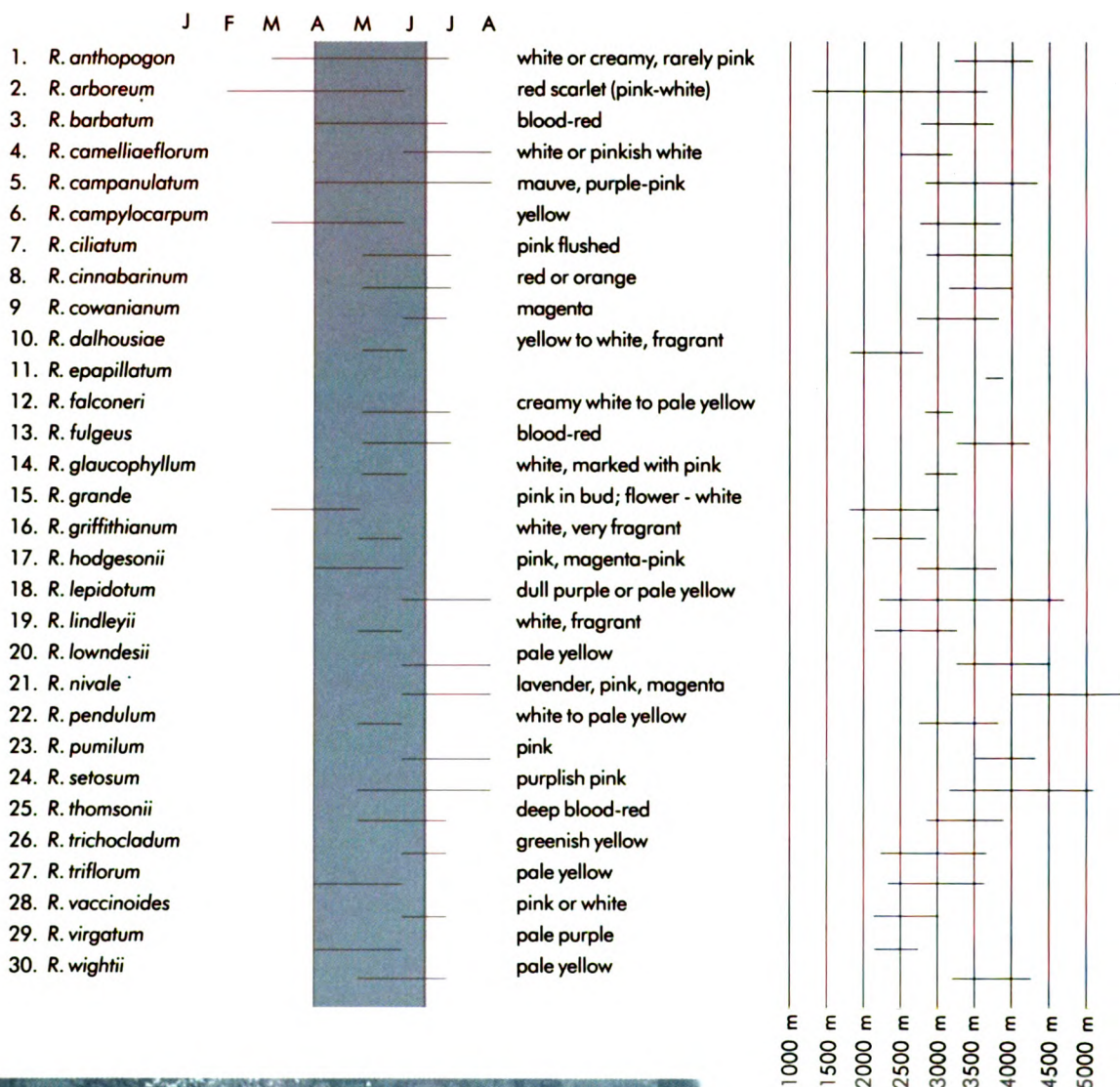
Plant species can generate public sentiment and support for conservation action from which much broader components of biodiversity would benefit. Some species such as *Ficus religiosa* (peepal) have a high religious value for both Hindus and Buddhists. Another means of harnessing national sentiment is to call for support for plants which bear the country's name, such as *Nepalensis*, *Napaulensis*, *Nepalense*, etc. There are 93 species

of such plants which bear Nepal in their name in one way or another (Shrestha and Joshi, 1996). Some of these occur throughout the Himalayas and even beyond, e.g., *Alnus nepalensis*, *Clematis napaulensis*, *Geranium nepalense*, *Hedera nepalense*, *Myriactis nepalensis*, and *Persicaria nepalensis*. At least 32 others are restricted to Nepal such as *Homalium nepaulense*, *Taraxacum nepalense*, *Rubus nepalensis*, and so on.

Plants with beautiful flowers could serve as flagship species for conservation. Rhododendrons could be one such plant. At least 30 species of rhododendron exist in Nepal. *Rhododendron arboreum* is Nepal's national flower, a species that forms fine forests all along the hills and mountains of the Nepal Himalaya. It often reaches 8m-10m in height and flowers profusely. The colour of the flower varies from magenta and scarlet red at the lower altitudes to pure white at elevations above 2,800m. The Milke-Jaljala area which separates the Arun and the Tamur Valleys offers a good site for the establishment of a rhododendron reserve. The area is presently under severe threat of encroachment and firewood collection. Urgent action is needed to protect this area as a unique tourist site and nature reserve. A list of rhododendrons is presented in Table 7.

The respect traditionally accorded to nature by the people of Nepal has allowed them to protect biodiversity in a number of ways. Biodiversity conservation through traditional beliefs and cultural practices could be used as an effective tool to help attain conservation goals. A cursory look into the cultural expression of various ethnic groups in Nepal quickly reveals that habitats are protected for sacred forests and religious sites, biological species are respected and protected as sacred plants and animals, varieties of cereal crops are present as special offerings to gods and goddesses and also as specific requirements for religio-cultural expressions from childbirth to funeral rites. Besides this, the seasonal festivals of Nepal are marked with specific requirements on the use of plants and animals.

A number of biological species of plants and animals are protected in Nepal for their cultural and religious values and for their medicinal virtues. *Ficus religiosa* is not uprooted, even those growing on shrines and buildings, because it represents the Hindu god Lord Vishnu, the god of sustenance. This particular tree is also widely worshipped as the bodhi tree under which Lord

Table 7 Rhododendron flowers and flowering periods in Nepal

Buddha attained enlightenment. Similarly, the grass *Cynodon dactylon*, basil (*Ocimum sanctum*), the sacred beads of rudrakshya (*Elaeocarpus ganitries*), the lotus (*Nelubium speciosum*), the deodar (*Cedrus deodara*), and the juniper tree (*J. recurva*), are all worshipped in some form by most Nepalese people. The list of such plants may well exceed 50 if all ethnic cultures are considered. However, since religious and cultural values are on the decline, as elsewhere, appropriate measures have to be taken to utilise the cultural strength of Nepali society for biodiversity conservation.

Rites and ceremonies associated with the cultural expression of various ethnic groups demand specific products or parts of plants and animals. The first feeding of rice to a baby of 5-8 months of age requires the head of a shrike. Among the Newars, girls below 10 years of age undergo a wedding ritual with "bel" fruit (*Aegle marmelos*), years before their wedding takes place. Elderly people, who have attained a certain age (77 years and 7 months), are offered obeisance in a ceremony when over 50 different kinds of leaves, flowers, wood, seeds and grains are used. In the same way, the use of bamboo is common in many rituals and rites. This has promoted maintenance of bamboo groves in and around many villages. Indeed, a traditional society like Nepal needs to protect a wide variety of plants to sustain its ancient culture.

2. Fauna

Species richness in Nepal's faunal wealth has so far largely been demonstrated by the collections and studies of fish, mammals, birds, butterflies and reptiles made during the early 19th century. Hamilton's collection of fish (1802-1803) followed by Brian Hodgson's more extensive collection of fish,

birds, reptiles, and mammals (1820 and 1843) provided ample clues in the species richness in Nepal's natural history. However, it was only after the advent of democracy in 1951 that Nepalese scientists could contribute to zoological and wildlife studies in Nepal. Most surveys addressed themselves to the task of exploring species richness in wildlife and discovering new species. Wildlife studies oriented towards conservation were of more recent origin, becoming prevalent only in the past three decades. The Biodiversity Profiles Project (1995) made a rapid compilation of the information available on species diversity in Nepal's fauna as shown in Table 8.

a) Insects

Of the 1.4 million living species of all kinds of organisms known to modern science, over 53%, i.e. 750,000 species are insects. In Nepal itself the number of reported insect species amounts only to about 5,000. The role that insects play in the human environment as beneficial or harmful creatures is well recognised in all societies. However, the gap in scientific knowledge regarding insects remains very wide, and the scope for new discoveries and useful knowledge in this arena is high. Zoological explorations describe more new insects than other higher organisms. For example, Riozo Yosii described 56 new species out of his collection of 125 species in the order Collembola. Among the known species, Nepal has one of the largest honey bees (*Apis laboriosa*) of the world, the world's largest moth (the atlas moth) and a relict dragonfly (*Epiophlebia laidlawi*) as a living fossil.

Knowledge about Nepal's insects before the year 1950 was limited to the collections of Major

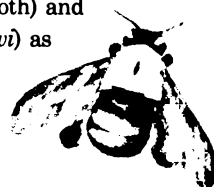


Table 8 Species richness in Nepalese biodiversity

Fauna	Global number	Nepal	Percentage	Nepal endemics
*Insects	750,000	5,000		
Butterflies	15,000	656	4.2	29
Freshwater fishes	> 8,500	185	2.2	8
Amphibians	>4,500	43	1.1	9
Reptiles	>6,500	100	1.5	2
Birds	9,883	844	8.5	2
Mammals	4,327	181	4.2	1

General Hardwicke. After 1950, Nepal was opened to foreigners and a number of expeditions contributed to the knowledge about insects from the Nepal Himalayas. Most of the taxonomic work has been carried out on butterflies (Lepidoptera), dragonflies and damselflies (Odonata), beetles (Coleoptera), true flies (Diptera), and moths (Lepidoptera). A summary of Nepalese collections of insects is presented in Table 9.

The Japanese publication *Fauna and Flora of Nepal* (1955) edited by H. Kihara was a result of the collection made during expeditions in 1952-53. The Germans have published *Khumbu Himal*, made up of a number of articles on insects. Prof. J. Martens (1987) of Germany edited *Beiträge zur Fauna Faunengenese und Zoogeographie des Nepal - Himalaya Arthropoda* comprising 20 articles on the arthropods of Nepal.

It is remarkable that of the 5,052 known species of insects, 1,131 species representing over 22% were first discovered and described from Nepalese specimens. A detailed study should be conducted to examine the extent of their endemism. Thus, knowledge and information on insect diversity is still very meagre, and local expertise has not yet developed for want of financial and technical support and encouragement.

Butterflies serve as a flagship species for ecosystem conservation, and they have attracted considerable attention from naturalists. Nepal's butterflies are documented in the book *The Butterflies of Nepal* (Colin Smith, 1989) which lists 614 species. V.K. Thapa (1997) listed 656 species under 268 genera. The BPP (1995) identifies 29 species as endemic or possibly endemic to Nepal (see Table 10).



Table 9 Summary of insects collected from Nepal

Insect order	Number of species reported from Nepal	Number of genera described from Nepal collection	Number of species described from Nepal collection
Protura	4	-	3
Collembola (springtails and snowfleas)	125	2	56
Thysanoptera (thrips)	25	-	6
Plecoptera (stoneflies)	4	-	3
Mallophaga (biting lice)	10	-	-
Psocoptera (book lice and allies)	31	-	15
Ephemeroptera (mayflies and allies)	26	-	12
Neuroptera (alderflies and allies)	29	1	21
Isoptera (white ants or termites)	5	-	-
Trichoptera (caddis flies and allies)	2	-	2
Siphunculata	1	-	-
Siphonoptera (fleas)	37	1	13
Dermaptera (earwigs)	49	-	13
Phasmida (stick and leaf insects)	2	-	-
Orthoptera (crickets and grasshoppers)	31	1	9
Dictyoptera (cockroaches and mantids)	8	1	2
Odonata (dragonflies and damselflies)	147	1	2
Lepidoptera (butterflies)	656	1	11
Lepidoptera (moths)	789	8	11
Hemiptera (bugs)	499	16	120
Hymenoptera (bees and wasps)	174	-	13
Coleoptera (beetles)	approx. 1,489	23	630
Diptera (true flies)	909	6	267
Total	approx. 5,052	60	1,131

Source: Thapa, 1997.

Table 10 Total list of all twenty-nine possible endemic butterfly species and sub-species in Nepal

Species	Common Name
PAPILIONIDAE:	
<i>Parnassius epaphus boschmai</i>	Common red apollo
<i>P. epaphus capdevillei</i>	
<i>P. epaphus chiddii</i>	
<i>P. epaphus robertsi</i>	
<i>Parnassius acdestis-laurenti</i>	Banded apollo
<i>P. acdestis marki</i>	
<i>Papilio machaon emihippocrates</i>	Common yellow-swallowtail
<i>P. machaon rinpoche</i>	
PIERIDAE:	
<i>Colias stoliczhana cathleenae</i>	Orange clouded yellow
LYCAENIDAE:	
<i>Neozenkyras surora yakioe</i>	Cerulean hairstreak
<i>Chrysocephyrus kirbariensis shakunage</i>	Kirbari hairstreak
<i>Chaetoprocta odata kurumi</i>	Walnut blue
<i>Amblopala avidiena nepalica</i>	Chiense hairstreak
<i>Oreolyce vardhana nepalica</i>	Dusky blue
<i>Polyommatus nepalensis</i>	Nepal meadow blue
<i>Albulina orbitulus lobbichleri</i>	Greenish mountain blue
NYMPHALIDAE:	
<i>Mesoacidalia clara shieldsi</i>	Silverstreak fritillary
<i>Neptis yerburyi tamur</i>	Tamur sailer
<i>Phaedyra aspasia kathmandia</i>	Great hockeystick-sailer
SATYRIDAE:	
<i>Lethe latiaris hige</i>	Pale forester
<i>Neope pulahoides tamur</i>	Tamur labyrinth
<i>Crebeta lehmanni</i>	
<i>Dallacha hyagriva nepalica</i>	Brown argus
<i>Paralasa nepalica</i>	Nepal argus
<i>Coenonympha amaryllis forsteri</i>	Mustang heath
<i>Aulocere swaha lobbichleri</i>	Common saty
<i>A. swaha schaeferi</i>	
HESPERIIDAE:	
<i>Pyrgus nepalensis</i>	Nepal skipper
<i>Parhara apostela debdasi</i>	Debdas swift

Source: BPP, 1995.



Table 11 List of butterflies meriting protected status

Scientific name	Common name
<i>Meandrusa gyas</i>	Brown gorgon
<i>Teionpalpus imperialis</i>	Kaiser-i-Hind
<i>Papilio krishna</i>	Krishna peacock
<i>Chrysozephyrus disparatus</i>	Sikkim hairstreak
<i>Maneca bhotea</i>	Slate royal
<i>Neptis manasa</i>	Pale hockeystick sailor
<i>Phaedyma aspasia kathmandia</i>	Great hockeystick sailor
<i>Euthalia duda</i>	Blue duchess
<i>Diagora nicevillei</i>	Scarce siren
<i>Lethe latiaris hige</i>	Pale forester
<i>Crebeta lehmani</i>	
<i>Capila lidderdalei</i>	Lidderdale's dawnfly

Source: BPP, 1995.

b) Fish

Overview

Knowledge on the fish of Nepal dates back to the early 19th century. Hamilton was the first author to provide valuable information about the fish of Nepal. He described some fish from Nepal in his admirable work *Fishes of the Ganges* in the year 1822. Hodgson (1820-1834) collected fish from Nepal and deposited the specimens in the British Museum. Later, Gunther (1859-1870) and Day (1878) completed epoch-making studies on the fish of the Asian subcontinent and made elaborate references to the fish of Nepal in their work.

Boullenger et al. (1907) also examined some of the fish from Nepal. Hora (1921-1952) has conducted research work on the Himalayan fish of Nepal and India. Edward Migdalski, ichthyologist in Ripley's expedition team, collected fish from the Koshi and Karnali rivers and deposited the specimens in the Indian Museum, Calcutta. Swan (1954) collected many fish during the course of his California Himalayan expedition. Taft (1955) prepared a checklist of the fish known from Nepal, which contained 95 species representing 13 families. Further, De Witt (1960) elaborated Taft's checklist by adding some new species. His list included 102 species representing 21 families. Jeevan Shrestha published the book *Fishes of Nepal* (1981). Edds (1986) studied the fishes of the Kali Gandaki river and highlighted the needs and

opportunities of conservation here. Jayaram (1981), Datta Munshi, and Shrivastava (1988); and Talwar and Jhingran (1991) have also added considerably to the literature on the fish of the Indian subcontinent, which also makes references to Nepal's fish. Shrestha compiled a book in 1990 on the *Resource Ecology of the Himalayan Waters* explaining the conservation status of the rare fish of the Himalayan waters of Nepal. T.K. Shrestha gave an account of the native freshwater fish of the Himalayas in 1994 with particular emphasis on ornamental species (Shrestha, T.K., 1995; 1996).

Species Richness

The Nepal Himalaya is well-known for its freshwater fish, amounting to 185 species. There are 8 fish endemic to Nepal. Among these, 3 occur in Rara Lake (Table 12). The high potential for fisheries in the headwaters of Nepal calls for concerted efforts for the development of commercial fishery.

Conservation Status

To date, there are no fish species officially listed or protected by HMG, Nepal. Many species are reported to be threatened with extinction in the scientific literature published in India and elsewhere. Shrestha (1990) gives a list of several species that are in danger of extinction, threatened or restricted in range. He also reports that the causes for population decline include impact of water development projects, pollution, improper

Table 12 List of the endemic fishes of Nepal

Name of fish	Common name	Distribution
<i>Schizothorax nepalensis</i>	Asla	Rara Lake
<i>Schizothorax macrophthalmus</i>	Asla	Rara Lake
<i>Schizothorax rarensis</i>	Asla	Rara Lake
<i>Schizothorax annandalei</i>	Chuche Asla	Trishuli, Sunkoshi, Indrawati, Pharping
<i>Raimas guttatus</i>	Jalkapoor	Koshi, Indrawati
<i>Psilorhynchus pseudochenets</i>	Titoe	Dudh Koshi, Sunkoshi, Tadi
<i>Lepidocephalichthys nepalensis</i>	Lota	Phewa, Narayani, Koshi, Gandaki, Kamali
<i>Pseudeutropius muris batraensis</i>	Jalkapoor	Koshi, Kamali, Trisuli

harvest methods such as dynamite and the use of various toxins, the absence of fishery laws, and poor enforcement of the existing laws. Tandon, Johal and Kaur (1993) report a serious decline of golden mahseer (*Tor putitora*) in India due to water development projects and the negative impact on water quality caused by paper mills.

In Nepal, game fish such as mahseer (*Tor tor*, *T. putitora*) and katle (*Acrossocheilus hexagonolepis*) are being affected by the barrier

effect of water development projects. Further study of the effect on other migratory fish is required.

The introduction of exotic fish such as tilapia, mosquito fish and gourami in the inland waters of Nepal poses several problems. To avoid the high risks associated with exotic fish species, cultivation of indigenous food fish must be encouraged. Any scheme for the introduction of alien species in Nepal should be backed by thoughtful experimentation.

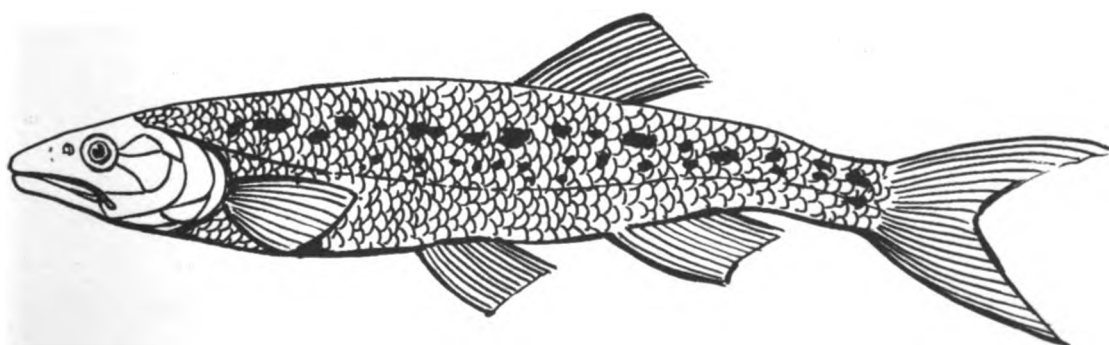


Table 13 Rare fishes of Himalayan waters

Family and Species	Common name	Status	Preferred habitat	Distribution in rivers
Cyprinidae: <i>Tor puti tora</i> (Hamilton)	Golden mahseer (C,G)	ED	Pool/run areas, swift gorges	Mainstreams of Koshi, Gandaki, Karnali, and Mahakali
<i>T.tor</i> (Hamilton)	Deep-bodied mahseer (C,G)	ED	Eddy/run interfaces	Mainstreams of Koshi, Gandaki, Karnali, and Mahakali
<i>Acrossocheilus hexagonolepis</i> (McClelland)	Copper mahseer (C,G)	CR	Small streams and creeks	Tamur, Arun, Sunkoshi, and Trisuli
<i>Schizothorax richardsonii</i> (Gray)	Spotted snow trout (C,G)	TH	Rhithron streams	Upper reaches and feeder streams of Koshi, Gandaki, and Mahakali
<i>Schizopyge</i> (<i>Schizothoracichthys</i>) <i>esocinus</i> (Heckel)	Mountain trout (C,G)	TH	Sandy and gravel-bottomed rivers	Headwater streams of Koshi, Karnali, and Mahakali; Himalayan lakes
<i>S. progastus</i> (McClelland)	Point-snouted snow trout (C,G)	TH	Deep in backwaters	Mainstreams and tributaries of Koshi, Gandaki, Karnali, and Mahakali
<i>Diptychus maculatus</i> (Steindachner)	River trout (C,G)	ED	Rhithron streams	Mainstreams of Sunkoshi, Bagmati, Kulekhani; Himalayan lakes
<i>Garra gotyla</i> (Gray)	Sucker head (F,O)	CR	Rhithron streams	Tamur, Arun, Sunkoshi, and Trisuli
<i>G. annandeli</i> (Hora)	Stone roller (F,O)	WS	Pool/rim areas of swift streams	Mainstreams of Koshi, Gandaki, Karnali, and Mahakali
Cobitidae: <i>Nemacheilus botia</i> (Hamilton)	Sand loach (F,O)	WS	Rocky pools of rhithron streams	Tributaries of Koshi, Gandaki, and Karnali
<i>N. rupicola</i> (McClelland)	Stone loach (O)	CR	Shallow water riffles and spring pools	Hill streams and creeks
<i>N. beavani</i> Gunther	Creek loach (O)	WS	Pools/riffle areas of creek	Tributaries of Koshi, Gandaki, and Karnali
<i>Botia lohachata</i> (Chaudhari)	Painted loach (O)	CR	Rocky and gravel bed creeks	Bagmati, Trisuli, and Rapti
<i>B. almorhae</i> (Day)	Tiger loach (O)	CR	Rocky and gravel bed pools of streams	Mountain rivers and creeks
Amblycipitidae: <i>Amblyceps mangois</i> (Hamilton)	Catfish (C,F,O)	ED	Rhithron streams	Mainstreams and tributaries of Koshi, Gandaki, and Karnali
Psilorhynchidae: <i>Psilorhynchus pseudocheneis</i> (Menon and Datta)	Stone carp (O)		Pool/run areas of rhithron streams	Dudh Koshi and feeder streams
<i>P. homaloptera</i> (Hora and Mukerjee)	Torrent stone carp (O)	CR	Small headwater stream cienagas	Tributaries of Koshi, Gandaki, Karnali and Mahakali

Family and Species	Common name	Status	Preferred habitat	Distribution in rivers
<i>P. sucatio</i> (McClelland)	River stone carp (O)	WS	Pool/run areas of mountain streams	Tamur, Arun, Kali Gandaki, and Rapti
Homalopteridae: <i>Balitora brucei</i> (Gray)	Rock carp (O)		Backwaters and quiet eddies	Mainstreams and tributaries of Koshi, Gandaki, and Karnali
Sisoridae: <i>Pseudecheneis sulcatus</i> (McClelland)	Sucker throat catfish (O)	CR	Deep riffles and runs over gravel, cobble substrata	Mountain rivers and creeks
<i>Echiloglanis hodgarti</i> (Tora & Silas)	Torrent catfish (O)	TH	Rhithron stream gravel riffles in small creeks and springs	Snow-fed mountain rivers and creeks
<i>Myersglanis blythi</i> (Day)	Stone cat (O)	CR	Pool/run areas of rhithron streams	Bagmati and tributaries
<i>Corglanis kishinouyei</i> (Kimura)	Catfish (O)	ED	Rocky and gravel bed pools rhithron streams	Mountain rivers and creeks draining Kulekhani area
<i>Laguvia ribeiroi</i> (Hora)	Painted catfish (O)	TH	Pool/run areas of swift streams	Tributaries of Koshi, Gandaki, and Karnali
<i>Glyptosternum pectinopterus</i> (McClelland)	River cat (O)	CR	Pool/run areas of rhithron streams	Tributaries of Koshi, Gandaki, and Karnali
<i>Glyptothorax trilineatus</i> (Blyth)	Three-lined catfish (O)	CR	Pool and riffle areas of streams	Tributaries of Koshi, Gandaki, and Karnali
<i>G. cavia</i> (Hamilton)	Catfish (G,O)		Sandy or rock-bottomed springs	Mainstreams and tributaries of Koshi, Gandaki, and Karnali
<i>G. horai</i> (Shaw and Shebbeare)	Catfish	TH	Backwaters of quiet eddies	Mainstreams and tributaries of Koshi, Gandaki, and Karnali
<i>G. gracilis</i> (Crlora)	Catfish	CR	Pool run areas of mountain streams	Tributaries of Koshi, Gandaki, Karnali and Mahakali
Bagaridae: <i>Rita rita</i> (Hamilton)	Striped catfish (O)	TH	Backwater of quiet eddies	Tributaries of Koshi, Gandaki, Karnali, and Mahakali
Anguillidae: <i>Anguilla bengalensis</i> Gray	Freshwater eel (C,G)	TH	Sandy or rock-bottomed crevices of rivers	Mechi, Tamur, Arun, and Seti

Note: The table above shows the rare fish of Himalayan waters, the preferred habitat and the distribution in the major rivers of Nepal. The status of each species is suggested as follows. 1) In danger of extinction (ED); 2) threatened (TH); 3) restricted (CR); 4) wide-spread (WS). Economic and social values are indicated in parentheses after the common names of species thus, C – preserved in temple ponds due to cultural taboos, worshipped as Fish Goddess; F – used in folk medicine; G – game fish for angling; O – ornamental fishes used by Buddhists (after T.K. Shrestha, 1997).

Fishing Communities

Traditional ethnic communities, who make their livelihood through fishing are Bote, Majhi, Chepang, Darai, Satar, Tharu, Majhi, Kewat, and Kumale. The fishing communities of Nepal appear to be poor and simple and their fishing methods and implements are primitive and crude (Table 14). They use spears, bows, arrows, cast nets, long lines, drift lines, gill nets, land drift nets, and so on. Occasionally they use Gangetic dolphin oil on a baited hookline to capture large game fish (Shrestha 1989, 1993).

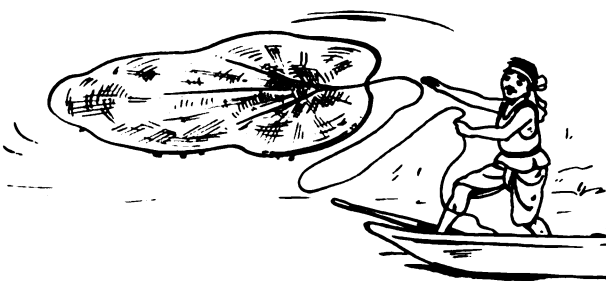


Table 14 Fisher communities and their major catches

Fisher communities	Geographical area	Major catches	Fishing gear
Bote/Majhi	Midland, hills, and plains	Mahseer, katle	Cast net
Tharu	Tarai	Eel	Hook line, spear
Mushar	Tarai	Jalkapoor	Gill net, drift net
Kumale	Hills and Tarai	Snow trout	Nets and traps
Darai	Tarai and hills	Tenger (mystus)	Nets and traps, hookline
Chepang/Tamang	Hills and plains	Puntius, garra, xenentodon	Bow and arrow, spear, cast net
Chhetri/Gharti	Midland hills	Stone caw, stone eel	Gradient fish trap, cast net
Fode	Midland hills	Minor carps (puntiis), carp	Cast net, lift net
Sunaha	Hills and Tarai of Western Nepal	Minnow, mahseer, river carp and catfish	Cast net, gill net, traps, Fish poison
Bodi	Western Nepal	Mohseer, eels, catfish	Hookline, spear, lines
Magar/Gurung	Midland hills	Snow trout, katle	Fish snaring, trapping, lift nets, cover pots

Commercial Fishing

Figures on fish production indicate that 7,700 MT, i.e. nearly 45% of the total fish production (16,549 MT) in Nepal during 1993/94, was based upon the catch in natural water resources of rivers, lakes, and reservoirs (HMG, 1993/94). Thus the sustainable harvesting of fish can be considered a major issue in fish conservation. The use of dynamite, electric currents, and fish poisons from cheap pesticides is reported to be a recently introduced practice in many parts of the country.

The commercial fish stocks of Nepal include river carp (*Labeo rohita*, *Cirrhina mirgala*, *Catla catla*), catfish, eel, and knife fish (Table 15). The fisherfolk of Nepal provide fish protein to the community through their daily fish catch. Although fish is an important food item in the Nepalese diet, its production is not sufficient to meet the needs of

a growing population. Current statistics show that only 10716.86 tonnes of fish are available, giving a annual per capita supply of fish of just 610 grammes.



Table 15 Commercially important fishes of Nepal caught for food, game, and recreation

Local name of fish	Scientific name	Maximum weight recorded (kg)
Raj ram	<i>Anguilla bengalensis</i>	10.0
Gounch	<i>Bagarius bagarius</i>	80.0
Sahar (kalo sahar)	<i>Tor tor</i>	60.0
Sahar (mahseer, pahelo sahar), ratar	<i>Tor putitora</i>	48.0
Gardi	<i>Labeo angara</i>	3.0
Kursa	<i>Labeo gonius</i>	3.0
Banga	<i>Labeo dero</i>	3.9
Bata	<i>Labeo bata</i>	3.0
Kamoch or bishari	<i>Labeo calbasu</i>	3.0
Mrigal, nami	<i>Cirrhina mirgala</i>	5.0
Catla	<i>Catla catla</i>	6.0
Saur or saul, or bhoura	<i>Channa maurilus</i>	15.0
Buhari	<i>Wallago attu</i>	5.0
Dhunge bam or gaichi	<i>Macrogathus aculeamm</i>	5.0
Gaichi	<i>Macrogathus aculeatus</i>	1.0
Banai	<i>Mastacembellus armatus</i>	1.0
Tenger	<i>Mystus tengera</i>	3.0
Jalkapoor or pottasi	<i>Clupisoma gaura</i>	3.0
Jalkapoor	<i>Pseudotropius goonawaree</i>	5.0
Moi	<i>Notopterus chitala</i>	20.0
Chunche bam or kauwa	<i>Xenentoden cancila</i>	0.5
Mugri	<i>Clarias batrachus</i>	2.0
Singhi	<i>Heteropneus fossilis</i>	1.0
Bachawa	<i>Eutropichtys vacha</i>	2.0
Pabata	<i>Pangasius pangasius</i>	2.0
Tenger, kanti	<i>Mystus seenghala</i>	10.0
Voktari	<i>Ompok bimaculatus</i>	0.5
Rewa	<i>Chagunio chagunio</i>	0.5

Source: various.

Fishing in the rivers of Nepal has lagged behind partly due to a lack of transport and communication facilities. This persistent problem combined with the perishable nature of fish products and the geographical remoteness of fishermen from the consumers prevents good use of the catch. The seasonal glut of fish landing in rural areas is generally salted, sundried, and smoked by using crude traditional methods of fish preservation. Due to their rough packing, these products often undergo quick microbial infestation and thus have a short keeping quality. All these factors result in the product failing to fetch a good market price. Further, in the absence of adequate expertise and knowledge about breeding, migration and behaviour, the development of inland fisheries in Nepal has been slow.

A strategy needs to be developed for the optimal utilisation of freshwater fishes in the lakes and reservoirs of Nepal. Many carnivorous fish species such as murrel (*Channa marulius*), catfish (*Wallago attu*), tenges catfish (*Mystus seenghala*), freshwater eel (*Anguilla bengalensis*), and jalkapoor (*Clupisoma gaura*, *Pseudotropius antherinoids*, *Silonia silondia*, *Pangasius pangasius*) live and breed fast in reservoirs. Therefore, efforts should be directed towards the optimal utilisation of these carnivores. These fish can be best caught on hooklines, longlines, and in drift nets in reservoirs. These species are most easily caught during dusk and dawn using baited gear rather than by laying driftnets and gillnets.

For the past two decades, captive breeding of exotic carp has been highly successful in the

government fish farms of Nepal. The fisheries section of HMG is also preparing a trial of large-scale captive breeding of snow trout (*Schizothorax richardsonii*) and mahseer (*Tor tor*).

Threats to Survival

The pristine waterways of Nepal have undergone irreversible changes as a result of modern development. During the past decades, dams, barrages, and irrigation channels have altered the face of many rivers and their physical and biological condition. Now, slowly but surely, these changes are affecting the aquatic habitat and fish fauna. We still have time to rectify past mistakes by utilising the principles of eco-development and conservation.

Water pollution affects all kinds of fish and freshwater organisms. It is often caused by an accumulation of domestic, industrial, and agricultural waste in water bodies. Evidence of heavy metal pollution is found in certain rivers of Nepal. Such pollution should be measured and mitigative measures put in place. Some freshwater fishes such as hill stream trout (*S. plagiostomus*), Nepalese katle (*Acrossocheilus hexagonolepis*), and stone loach (*Noemacheilus*) have now vanished entirely from the valley section of the Bagmati river.

Dams in the Trisuli and the Sunkoshi rivers have, to some extent, obstructed the seasonal migration of fish from the Tarai. For example, before the creation of dams in these rivers, schools of gouch (*Bagarius bagarius*), used to visit the area. Now their teeming abundance in the rainy season (May and June) has decreased.

During the past two decades, the number of fish in Nepal has declined steeply due to pollution, harmful fishing practices, habitat modification, environmental degradation, and the effect of dams. Many gamefish such as mahseer (*Tor tor*, *T. putitora*) and katle (*Acrossocheilus hexagonolepis*) are declining due to the barrier effects of dams, water quality changes, erratic fluctuations in water levels, and destruction of spawning beds. To stop the extinction of these species, artificial breeding and propagation are being developed. Migratory fish such as the bagarid catfish (*Bagarius bagarius*), the eel (*Anguilla bengalensis*), and the jalkapoor (*Pseudeutropis gaura*) have not been studied in detail. The impact of dams or other physical barriers on cold water catfish is not known. Better methodology and propagation

techniques are yet to be developed for these species in the reservoir.

The use of DDT and other agricultural insecticides have affected clear water hill stream fish such as *Exostoma blythi*, *Amblyceps mangois*, *Balitora brucei*, and *Glyptothorax annandeli*.

Measures for Mitigation

Conservation of fish in Nepal needs to be given proper attention. To facilitate seasonal migration of fish, dolphin, crocodiles, turtles, and other aquatic animals, fish ladders or fish lifts should be constructed along hydroelectric dams. There ought to be reciprocity between biologists and engineers in formulating policies for power and water use. In addition, harmful fishing practices such as poisoning, dynamiting and striking fish with rocks should be stopped totally. Some sections of rivers and reservoirs, where the fish congregate for breeding and rearing fry, must be closed to fishing or declared as a fish sanctuary.

For the conservation and management of fish resources in the rivers of Nepal, long-term research and planning are necessary. In this context, the following measures are suggested.

- The natural environment of the major watersheds of the rivers of Nepal has been greatly changed by deforestation, erosion, and silting of the river bed. To restore the ecological balance of watersheds, intensive monitoring and management must be practised.
- Habitat improvement is an essential factor for fishery improvement. To avoid seasonal changes in the water level, suitable pools should be created by constructing natural rock or boulder dams. Such a practice will improve the quality of fish habitats and avoid winter desiccation.
- Water requirements for fish and river wildlife in the rivers of Nepal should be determined by constant monitoring. The water quality and volume should be well-regulated to boost the quality of the habitat.
- Fish ladders, fish lifts, and fish guiding systems should be developed along the dams to allow fish, river dolphins, crocodiles, and turtles to pass up- and downstream.
- Protective and catch-restrictive fishing regulations should be based on the periodic assessments of fish stocks. The critical stages in the life histories of the fish should be

adequately studied. It is high time that fishing laws were enforced and restrictions on the use of nets below 2 cm mesh size applied.

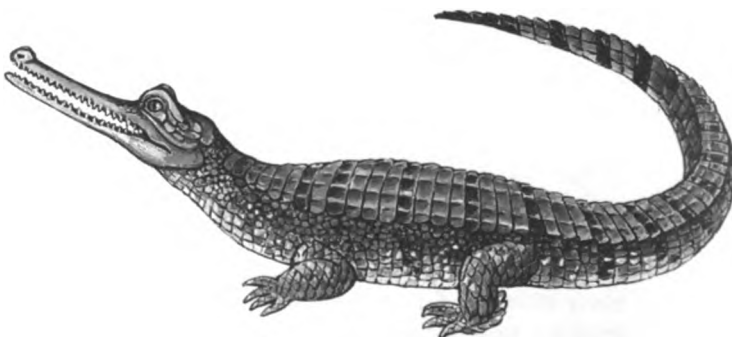
- Gill net and drift net fishing practices have always had adverse effects on fish, dolphins and crocodiles. Unregulated drift net fishing should be banned.
- In the upland section of the rivers, the practice of electro-fishing and the tossing of dynamite into the water is in vogue. Such destructive activity should be stopped.
- In the rivers of Nepal, spawning and migration of fish usually takes place in May and June. These months should be declared closed seasons by law.
- To reduce pollution in the rivers, adequate provision should be made through legislation to check the pollution caused by effluent from paper factories, beer factories, and other industries.
- Mahseer or Himalayan salmon is a highly prized game fish whose population is in decline. Therefore, for the conservation of this fish, a 'mahseer fish farm' may be developed near the crocodile farm of the Royal Chitwan National Park. As mahseer is the principal food of dolphins and crocodiles, its propagation will help conserve these endangered river wildlife.
- The snow trout population is in decline owing to high fishing pressure in waters of the Himalayan region. The breeding of snow trouts in a hatchery and the releasing of spawn or fry in natural waters will help stabilise the snow trout population.
- The deep water pools of rivers and their feeder streams should be declared fish sanctuaries. Such sanctuaries will help protect spawners. The value of natural schemes has not been realised as yet.
- Collection of fish fry from rivers, reservoirs, and the waters of dams and spillage should be stopped. Such commercial exploitation will deplete the fish stock and restrictions should be imposed.
- For the conservation of endemic snow trout, a gene bank conservation programme should be developed.
- The HMG fish and aquatic life conservation act should be enforced.

c) Herpetofauna

Overview

Herpetofauna refers to amphibians and reptiles, the study of which is called herpetology. Amphibians include newts, toads and frogs; while the reptiles include crocodiles, turtles, tortoises, agamas, geckoes, skinks, lizards and snakes. Brian J. Hodgson is the pioneer naturalist in this field followed by Hodgart and Stevens (Boulenger, 1907). Twenty-one species of herpetofauna were first described from Nepal (Shah, 1995).

There was a long gap between the initial study and the current exploration of the herpetofauna of Nepal. During the early sixties a systematic zoo geographical study of Nepalese herpetofauna was carried out by Swan and Levington (Shah, 1995). Subsequently, a number of naturalists explored different parts of the country contributing to the knowledge of the herpetology of Nepal. Most of the herpetological explorations were concentrated around the Arun Valley, the Chitwan Valley, the Annapurna-Dhaulagiri region, and the Kathmandu Valley. Western Nepal has not been studied in detail and still awaits exploration. Wild fauna including herpetofauna have been described in the Suklaphanta Wildlife Reserve (Bhatta and Shrestha, 1977), the Royal Chitwan National Park (Gurung, 1977); the Annapurna Conservation Area (Inskipp, 1989); Sagarmatha National Park (Sherpa, 1986); the Arun Basin (Jackson et al., 1990; Giri et al., 1991; Cronin, 1979); the Makalu Barun National Park and Conservation Area (Jackson et al., 1990a, b); and the Koshi Tappu Wildlife Reserve (Shakya, 1995). Our report refers to the recent enumeration of the reptiles and amphibians of Nepal by K. Shah (1995).



Species richness

Herpetofauna belong to six orders in Nepal. These are Caudata, Anura, Crocodylia, Testudines, Sauria, and Serpentes (salamanders, frogs and toads, crocodiles, turtles, lizards, and snakes). Altogether, 100 species of reptiles and 43 species of amphibians have been found to occur in Nepal. The tropical climate of the Tarai and Siwaliks supports a large number of herpetofauna as can be expected, given their cold-blooded nature. The herpetofauna of the Tarai and Siwaliks is composed mainly of Indo-Malayan elements. Crocodiles are confined to the wetlands of the Tarai and Inner Tarai, whereas the newt is reported only from the eastern midhills. Snakes, frogs, and toads are represented in higher diversity whereas the crocodiles and newts are represented by single genera only.

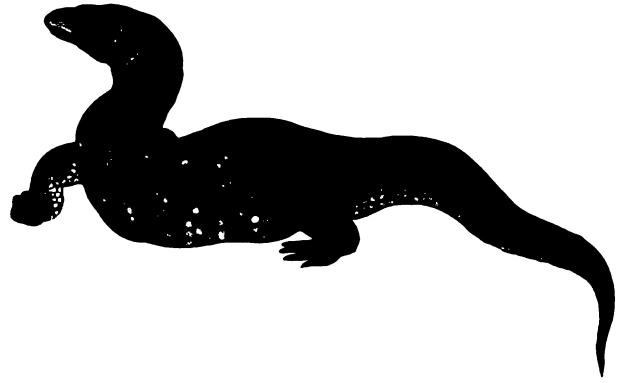


Table 16 Distribution of herpetofauna by physiographic zone

Order	Nepal	Tarai and Siwaliks	Midhills	Highlands
Caudata (salamander)	1	0	1	0
Anura (frogs and toads)	42	22	28	9
Crocodylia (crocodiles)	2	2	0	0
Testudines (turtles)	14	13	2	0
Sauria (lizards)	24	11	17	7
Serpentes (snakes)	60	42	37	6
Total number of orders	6	5	5	3
Total number of species	143	90 (63%)	85 (59%)	22 (15%)
Confined species	Endemic species 10	43	26	5

Source: BPP, 1995d.

In a global context Nepal supports 1.1% of the amphibians and 1.5% of the reptilian species described up to 1992 (WCMC, 1992). The Tarai and Siwaliks support a larger percentage of herpetofauna (63%), followed by the midhills (59%). The least of number of species –15% – are found in the highlands (Table 16). The tropical climate, rich vegetation, and the wetlands of the Tarai and Siwaliks contribute to higher herpetofauna diversity. The climate, terrain and river rapids have probably acted as a barrier to the distribution of crocodiles and turtles in the mountains. Crocodiles and turtles predominantly inhabit the lowlands (Tarai and Inner Tarai). Gharials are also found in the lower stretches of the Kali Gandaki river, a major tributary of the Narayani. The diversity of frogs and toads is higher in the midhills. So far,

however, no turtles have been reported from the Highlands.

Crocodiles are the largest species among the herpetofauna found in Nepal. Gharial crocodile have been recorded as measuring 6.75m and the marsh crocodile 3.75m. *Kachuga dhongoka* (three-striped turtle) may weigh upto 30 kg. The bullfrog (*Rana liebigii*), known as “paha” in Nepali which is a delicacy for some ethnic groups, weighs about a kilogramme. Glacier skink (*Scincella ladacensis ladacensis*) has been recorded from the Balangra Pass (Dolpo District) at 5,490m, which is the highest ever altitude for a species of herpetofauna in Nepal. The longest and heaviest snake found in Nepal is the Asiatic rock python (*Python molurus molurus*). It may measure seven metres in length and weigh nearly 100 kg. The most venomous

snake found in Nepal is the banded krait (*Bungarus fasciatus*) which secretes neurotoxic venom. The king cobra, though rare, is the most aggressive snake found in Nepal. The blind worm snakes are non-venomous and are the smallest snakes found in Nepal.

Endemic Herpetofauna of Nepal

Nepal has nine endemic species of amphibians and one endemic species of skink (Table 17). Further investigation may prove that *Rana pierrei*, *R. teraiensis*, and *Tomopterna swani* could have a distribution range extending further east to India. The midhill physiographic zone, with its unique position as a transition between the palaearctic and Indo-Malayan region, may support several more endemic species.

Protected Herpetofauna

The National Parks and Wildlife Conservation Act of 1973 accorded protected status to three threatened and rare species of herpetofauna which includes the gharial crocodile (*Gavialis gangeticus*), the yellow monitor lizard (*Varanus flavescens*), and the Asiatic rock python (*Python molurus*). All three species are predominantly found in the Tarai and the Siwaliks. Gharials are found in large rivers systems, the yellow monitor lizard in grasslands and open forest, and the pythons live in moist forests.

Gharial are categorised as an endangered species by IUCN and listed in CITES Appendix I. Gharial crocodiles occur in the major river systems of protected areas in the Tarai. The population of Koshi Tappu Wildlife Reserve consists of reintroduced specimens from the captive stock raised by the Gharial Project. They also occur in the lower stretches of the Kali Gandaki river which is not a protected area. During 1974 the global population of Gharial was thought to be less than 150 individuals, with the major population occurring in India and Nepal and scattered populations in Pakistan and Bangladesh (Andrew and McEachern, 1994).

Yellow monitor lizards are found in the Tarai and Siwaliks. They live in burrows in grassland and open forest and are occasionally found on cultivated land. For some of ethnic groups of the Tarai this animal is a delicacy. Yellow monitor lizards are threatened due to the commercial value of their skin which is used to make various items. They have been categorised as indeterminate by IUCN, and are listed in CITES, Appendix I.

The Asiatic rock python prefers to live in wetlands adjacent to forests. Their docile nature coupled with their need for a pristine habitat, plenty of prey species, and the fact that they live in a safe area have been the major factors for their survival. Today, the market for their skin is the reason for their dwindling population. The annual burning of grasslands and forest fires has also

Table 17 Endemic species of herpetofauna of Nepal

Scientific name	Distribution according to region and physiographic zones	
	Region	Physiographic zone
Amphibians		
<i>Scutiger nepalensis</i>	Western and Central	Midhills
<i>Rana ercepea</i>	Western	Midhills
<i>R. minica</i>	Western	Midhills
<i>R. nepalensis</i>	Western and Eastern	Midhills
<i>R. pierrei</i>	Central and Eastern	Tarai and Siwaliks
<i>R. rara</i>	Central Midhills and Western	High Himal
<i>R. rostandi</i>	Central and /Eastern	Midhills/High Himal
<i>R. teraiensis</i>	Eastern	Tarai and Siwaliks
<i>Tomopterna swani</i>	Eastern	Siwaliks
Lizard		
<i>Scincella capitanea</i>	Central	Midhills

Source: BPP, 1995.

killed some of their population. The Asiatic rock python has been categorised as a vulnerable species by IUCN and is listed by CITES in Appendix I (BPP, 1995).

The mugger crocodile (*Crocodylus palustris*), although not directly protected by the NPWC Act 1973, has been listed as a banned species for hunting by the Department of National Parks and Wildlife Conservation (DNPWC). This species is categorised as vulnerable by IUCN and listed in CITES Appendix I. Formerly the mugger crocodile occurred in all the wetland areas found in the Tarai and the Inner Tarai. They co-exist with gharials in large river systems. Currently, they are confined mostly to the wetlands of protected area systems, such as Royal Suklaphanta Wildlife Reserve, Royal Bardia National Park, and Royal Chitwan National Park with the exception of the semi-protected wetlands of Bees Hazar Tal, and the buffer zone of Royal Chitwan National Park.

Threatened Herpetofauna

A review carried out in 1995 by BPP to assess the status of Nepalese vertebrates for the Department of National Parks and Wildlife Conservation recommended that 31 species of herpetofauna should be put under legal protection. The list includes 9 amphibians, 14 turtles, 1 crocodile, 2 lizards, and 5 snake species (BPP, 1995). Most of the recommended species of reptiles are found in the Tarai and Siwaliks, and frogs in the midhills. All the frogs and toads recommended for protection are endemic to Nepal.

Once the malarial mosquito, the natural barrier of the lowlands, was controlled, the human population from the north and south came to settle in the fertile lands of the Tarai. Habitat loss due to human pressure and direct human persecution has been the major causes for the decline of the marsh crocodile and the gharials. Currently, more than 40% of the nation's human population lives in the Tarai.

Crocodiles are predominantly hunted for their pelts. The medicinal and mystical value of gharial nostrils have led the local people to kill them. Eggs, collected to eat, are also believed to be of medicinal value. The construction of dams has prevented the crocodiles from returning to their natal areas. Once the gharials or marsh muggers are swept down the dam, they have little chance of surviving in the hostile, unprotected areas. The over-harvesting of fish by traditional fishermen is a major cause of food scarcity. Gharials are specifically fish eaters (piscivorous) and river dwellers. Their specialised dietary and habitat requirements have threatened their survival. The flow of untreated effluent into upstream water from rubber and paper factories in their current habitat has destroyed the chemical, physical, and biological balance of the river water and has unbalanced the life support system of the gharial as well as the mugger crocodile.

Turtles are delicacy to some ethnic groups of the Tarai. There is a growing demand for live turtles in the Tibetan town bordering Nepal. Truckloads of live turtles being smuggled across the border have been confiscated by authorities. Some 186 turtles were confiscated last year

Table 18 Threatened herpetofauna occurrence by physiographic zone

Group	Status	 Nepal	Tarai and Siwaliks	Midhills	Highlands
Frogs and toads	Susceptible (all endemic)	9	3	6	2
Crocodiles	Vulnerable	1	1	-	-
	Endangered (HMG/P)	1	1	-	-
Turtles	Vulnerable	3	3	1	-
	Susceptible	11	11	1	-
Lizards and skinks	Susceptible	3	2	3	-
	(including one endemic and one HMG/P)				
Snakes	Vulnerable (one HMG/P)	3	3	2	-
	Susceptible*	3	3	1	-
	Total	34	27	14	2

Source: BPP, 1995.

Note: * = including one endemic and one HMG/P

(Kantipur, March 11, 1997). Turtle shells are traded for their use in the handicraft market. Monitor lizards are also considered a delicacy by some ethnic groups of the Tarai with their skin bearing a certain value in the commercial market.

Conservation Measures

The Gharial Conservation Project at Kasara, Royal Chitwan National Park (RCNP) was launched by the Government of Nepal in affiliation with the Frankfurt Zoological Society in 1978 to revive the population of gharials in the wild. The project collects the eggs from the wild and brings them to a safe hatching place. The hatchlings are reared in the nursery for about three years until they are 1.5m in length and are later released into a safe and suitable natural habitat.

The first release of the captive raised population took place in 1981. This hatching facility was extended to Royal Bardia National Park (RBNP) in 1982 and the same procedure applied for marsh muggers at a facility in Kasara. To date, some 432 gharials and 300 marsh muggers have been released into different rivers of Nepal. The current gharial population in the wild is estimated to be between 100 and 150 while those in captivity number 140. Reintroduced gharials from the 1978 batch of hatchlings released in 1981 have started breeding in the wild. The gharial hatchlings of the 1978 batch bred in captivity during 1994 and laid seven fertilised eggs. The fate of the released marsh muggers is not known, as they were not monitored while selected gharials are constantly monitored. The marsh mugger has not been able to breed in captivity due to the lack of a captive mate (Andrew and McEachern, 1994).

d) Birds

Overview

Modern ornithology in Nepal may be said to have started two centuries ago when Col. W. J. Kirkpatrick described some game birds of Nepal during his tenure in 1793 AD. The first detailed study on the birds of Nepal was carried out by a British expatriate, Brian J. Hodgson, between 1818-1843 AD. He collected approximately 9,500 bird skins belonging to 665 bird species, of which over 120 species were new to science. Surgeon John

Scully (1876-1877) collected some 2,000 bird skins belonging to 300 species. His research was concentrated around the Kathmandu Valley. Herbert Stevens (1911 and 1914) studied the birds of the upper Mai Valley. Lt. Col. F. M. Bailey (1935-1938) collected approximately 2,146 bird skins belonging to 381 species from central and northwest Nepal. Dr. Dillon Ripley (1947-1949) explored the far east and far west of Nepal and collected 1,600 specimens belonging to 300 species. Desirée Proud published several papers between 1948 and 1961 relating to bird observation in the Gandak-Koshi watershed and the Kathmandu Valley. Oleg Polunin (1952) recorded bird distribution in the west while accompanying the British Museum (Natural History) botanical expedition. Dr. Biswamoy Biswas and Dr. Walter Koelz collected 3,500 bird specimens belonging to 350 species between Raxaul and Kathmandu. Between 1960 and 1968 they published a summary of the Nepalese birds recorded up to that date, including their own findings. Dr. Diesselhorst contributed to the knowledge of altitudinal distribution of 315 species collected during his 1962 expedition. The Hemming father-and-son team made an extensive study and published a field guide of the birds of Nepal in 1976. The senior Flemming's first expedition to Nepal was in 1949. Flemming Jr. still visits remote areas of Nepal to study birds.

The blood pheasant (*Ithaginis cruentus*) is a prize catch for local hunters. The bird occurs towards the alpine and sub-alpine regions of the eastern Himalaya, where it is becoming rare. It is an east Himalayan bird and does not occur west of the Kali Gandaki



Mr. Hari Saran Nepali, popularly known as 'Kazi' and a legendary figure in Nepalese ornithology, travelled extensively throughout Nepal in search of birds. His collection of more than 600 bird species is on display at the Natural History Museum in Kathmandu. Carol and Tim Inskipp, a husband and wife team of Oriental Bird Club, UK, have made a significant contribution by compiling all the available documents on Nepalese birds. Since bird watching is a popular hobby in the west, many amateurs and professionals have contributed to the knowledge of the birds of Nepal. Additional information on birds is available in the studies on biodiversity in the Suklaphanta Wildlife Reserve (Bhatta and Shrestha 1977); the Royal Chitwan National Park (Gurung, 1977); the Annapurna Conservation Area (Inskipp, 1989); Sagarmatha National Park (Sherpa, 1986); the Arun Basin (Jackson et al., 1990; Giri et al., 1991; Cronin, 1979), and the Makalu Barun National Park and Conservation Area (Jackson et al., 1990a, b). More recently, a report on the biodiversity of Koshi

Tappu Wildlife Reserve compiled by P.R. Shakya (Final Report, 1995) provided some information on the birds present in the reserve.

Bird Diversity

To date, 844 bird species have been recorded for Nepal, which totals 8.5% of global species. It is estimated that more than 600 bird species breed in Nepal (Inskipp, 1989). The order Passeriformes has the highest representation in Nepal with 465 species. Other major bird orders represented are Charadriiformes with 68 species; Falconiformes at 59 species; Piciformes and Anseriformes with 33 species each; Ciconiformes at 27 species; Galliformes with 21 species and Gruiformes, Columbiformes, and Strigiformes with 20 species each. Coraciiformes have 19 species, Cuculiformes 18 species and Apodiformes 10 species. The minor bird orders are Psittaciformes with six species, Pelecaniformes with five species, Caprimulgiformes with four species, Gaviformes with three species,

Table 19 Distribution of birds species by physiographic zone

Order	Nepal	Tarai and Siwaliks	Midhills	Highlands
Gaviformes (grebes)	3	3	3	3
Pelecaniformes (pelicans)	5	4	5	1
Ciconiformes (storks, ibises, egrets and herons)	27	27	21	4
Anseriformes (ducks and geese)	33	26	26	18
Falconiformes (birds of prey)	59	52	56	48
Galliformes (game birds)	21	8	15	13
Gruiformes (cranes and rails)	20	20	15	4
Charadriiformes (plovers)	68	64	56	29
Columbiformes (doves and pigeons)	20	15	17	11
Psittaciformes (parakeets)	6	6	5	1
Cuculiformes (cuckoos)	18	17	18	7
Strigiformes (owls)	20	13	18	9
Caprimulgiformes (nightjars)	4	4	3	1
Apodiformes (swifts)	10	10	8	5
Trogoniformes (trogons)	1	1	1	0
Coraciiformes (rollers and kingfishers)	19	18	14	5
Piciformes (woodpeckers)	33	28	25	8
Passeriformes (perching birds)	465	333	386	246
Total number of orders	18	18	18	17
Total number of species	833**	648	691	413
Confined species	2 endemic species	111	29	24

Source: BPP/BDP 1995.

Note: ** = excludes 11 extinct species.

and Trogoniformes with only one species. These birds species include resident, migratory, passage migrants, and vagrant species. The major resident forms of birds include perching birds, woodpeckers, game birds, storks, ibis and egrets, cranes and rails, doves and pigeons, owls, rollers, and kingfishers. The major migratory birds (fall and spring migratory and passage migratory) include passerines, plovers, birds of prey, ducks, and geese. The major breeding summer migrants include cuckoos.

Species Richness

Nepal has one of the highest densities of bird species comparative to its areas among the mainland countries of Asia. This diversity can be attributed to Nepal's varied physiographic zones. The Tarai and Siwaliks provide extensive habitats for resident and migratory wetland and grassland bird species. Similarly, the midhill physiographic zone provides the highest altitudinal differences, greater habitat diversity, optimum living conditions, and relatively larger surface area than the Tarai and Siwaliks due to the pyramidal effects of the mountains. The highland zone covers 43% of the land mass of the country, but supports fewer species. About 77 species have been recorded here, above 4,270 metres (Inskipp and Inskipp, 1985). The altitude above 5,000 metres is under perpetual snow, and it supports an even smaller bird diversity. However, it is not surprising to see birds (geese, cranes, eagles, and vultures) flying higher than Mt. Everest and other major peaks during their fall and spring migration. Eastern Nepal (east of the Kali Gandaki river) supports greater bird diversity (774 species) than the west (589 species). Nepal is the distributional limit for 122 eastern and 22 western bird species.



The Tarai, Siwaliks and Midhills

The important forest birds of the Tarai and Siwaliks include the blue peafowl (*Pavo cristatus*), the giant hornbill (*Buceros bicornis*), pied hornbill (*Anthraceros albirostris*), great slaty woodpecker (*Mulleripicus pulverulentus*), stork-billed kingfisher (*Pelargopsis capensis*), long-tailed broadbill (*Psarisomus dalhousiae*), and the hill mynah (*Gracula religiosa*). The important breeding birds of prey include the crested serpent eagle (*Spilornis cheela*), the grey-headed fishing eagle

(*Ichthyophaga ichthyaetus*), lesser fishing eagle (*Ichthyophaga humilis*), lesser spotted eagle (*Aquila rapax*), and the grass owl (*Tyto capensis*).

The globally threatened swamp partridge (*Francolinus gularis*) breeds in the savannah of the Koshi Tappu and Suklaphanta Wildlife Reserve. Bengal floricans (*Houbaropsis benghalensis*) are found in the grasslands of the Tarai and the Siwaliks.

The river bodies and the oxbow lakes of the Koshi, Narayani, and Karnali and the wetlands of Bees Hazar Tal, Banganga reservoir and Ghodaghodi lake provide important breeding habitats for some bird species, including the lesser adjutant stork (*Leptoptilus javanicus*), black-necked stork (*Ephippiorhynchus asiaticus*), the open-billed stork (*Anastomus oscitans*), and the great stone plover (*Esacus recurvirostris*). These wetlands are also visited by a number of waders and waterfowl species during the fall migration to spend the winter season these include the black stork (*Ciconia nigra*), the Eurasian curlew (*Numenius arquata*), the mallard (*Anas platyrhynchos*), the red-crested pochard (*Netta rufina*), the northern pintail (*Anas acuta*), and the common teal (*Anas crecca*).

Some of the important forest birds of the midhills include the blue-naped pitta (*Pitta nipalensis*), the broad-billed warbler (*Tickellia*

▲ The rufous piculet (*Sasia ochracea*) is one of the smallest woodpeckers in the world. It is often found in the forests of the Barun Valley which are least disturbed by human activities.

hodgsoni), the chestnut bunting (*Emberiza rutila*) the reed bunting (*Emberiza schoeniclus*), the coral-billed scimitar babbler (*Pomatorhinus ferruginosus*), the spotted wren babbler (*Spelaeornis formosus*), the white-naped yuhina (*Yuhina bakgri*) the Eurasian siskin (*Carduelis spinus*), the golden babbler (*Stachyris chrysea*), the cutia (*Cutia nipalensis*), the grey-sided laughing thrush (*Garrulax caerulatus*), the blue-winged laughing thrush (*Garrulax squamatus*), the black-headed shrike babbler (*Pteruthius rufiventer*), the rusty-fronted barwing (*Actinodura egeroni*), and the greater yellow-naped woodpecker (*Picus flavinucha*). The rivers and streams of the mountains support brown dipper (*Cinclus pallasii*). Endemic bird species such as the spiny babbler (*Turdoides nipalensis*) and the Nepal wren babbler (*Pnoepyga immaculata*) are predominantly found in the midhills.

The peregrine falcon (*Falco peregrinus*), the common barn owl (*Tyto alba*), and the long-eared owl (*Asio otus*) are also important species of the midhills. The important game birds of the midhills include the rufous-throated hill partridge (*Arborophila rufogularis*), the kaliz pheasant (*Lophura leucomelana*), the koklass pheasant (*Pucrasia macrolopha*), and the globally threatened cheer pheasant (*Catreus wallichii*).

High Himalaya

The golden eagle (*Aquila chrysaetos*) and the booted eagle (*Hieraaetus pennatus*) are the important highland birds of prey. Game birds include the Tibetan partridge (*Perdix hodgsoniae*), the snow partridge (*Lerwa lerwa*), the Tibetan snow cock (*Tetraogallus tibetanus*), the Himalayan snow cock (*Tetraogallus himalayensis*), the globally threatened satyr tragopan (*Tragopan satyra*), and Nepal's national bird the impeyan pheasant, or danfe (*Lophophorus impeyanus*). Other important birds include Hume's ground pecker (*Pseuopodoces humilis*), the raven (*Corvus corax*), the white-breasted dipper (*Cinclus cinclus*), the red-fronted rosefinch (*Carpodacus puniceus*), and the species belonging to genus *Prunella* spp. and *Montifringilla* spp.

Important breeding species of the highlands include ibisbill (*Ibidorhyncha struthersii*), the horned lark (*Eremophila alpestris*), the red-billed chough (*Pyrrhocorax pyrrhocorax*), the alpine chough (*Pyrrhocorax graculus*), grandala (*Grandala*

coelicolor), Guldenstadt's redstart (*Phoenicurus erythrogaster*), the Eurasian goldfinch (*Carduelis carduelis*), lammergier (*Gypaetus barbatus*), and the Himalayan griffon (*Gyps himalayensis*).

Migratory Birds

The movement of birds in Nepal is dynamic and governed by altitudinal range and seasonality. Birds living in the mountain region exhibit the typical phenomena of diurnal and altitudinal migration. A bird roosting at 2,000 metres altitude may reach the upper limits of a mountain at 3,500 metres for foraging or go down to the base of the hill depending upon the season and food availability. Passerines such as thrush, babblers, warblers, and minivets follow this types of movement and often forage in mixed flocks in the different strata of the forest. The breeding passerines of the high mountains descend to the midhills and to the Tarai and Siwaliks in winter. Large scavengers of the high altitudes use gravity to glide down to low elevations in the morning hours to forage. They use the thermals of the daytime to soar back up to their roosting sites. Long-distance migrants of palaeartic species include passerines, plovers, birds of prey, ducks and geese. Summer migrants arriving in Nepal from the Indo-Malayan region include cuckoos, pittas, bee-eaters and swallows.

The great Himalayan range is a barrier for the high altitude trans-Himalayan migrants, e.g., cranes, ducks, and other birds of prey to reach the Indian subcontinent and or to proceed to Africa. The harsh weather conditions and the jet stream (wind speed measuring 70-90 knots or more) pose an obstacle for high altitude migratory birds. Yet, mountaineers have noted geese flying higher than Mt. Everest (8,848m) and cranes flying higher than Manaslu (8,163m).

Similarly, small birds take the land route through the mountain passes and gorges. After crossing the main range of the Himalaya it is the forests, lakes, and cultivated land that provide the vital staging areas to rest and forage. By far the most important land route lies through the deepest gorge of the world formed by the Kali Gandaki river between the peaks of Mount Annapurna and Dhaulagiri, rising to more than 8,000 metres.

Rara lake in western Nepal, and Phewa and Begnas lakes of central Nepal, as well as the marshes of Kathmandu provide regular staging areas for migratory waders and waterfowl. Winter-

ing wetland birds spread out over the rivers, floodplains, rainwater basins, and marshes of the Tarai and Inner Tarai. The floodplains and marshes of the Koshi, Bagmati, Narayani, Rapti, and Karnali rivers provide extensive habitats for wetland birds. The biggest river of Nepal, the Koshi, and its marsh are the largest wetland habitats of the country and support the largest and most diverse population of waders and waterfowl. Koshi Tappu Wildlife Reserve was designated as a Ramsar Site in 1987. Bees Hazar Tal of Chitwan, the Banganga reservoir of Kapilvastu, and the Ghodaghodi lake system of Kailali district provide important wetland habitats and have been considered for protection and management.

Ducks and Geese – A number of ducks and geese are either passage migrants or wintering species. Bar-headed geese have been sighted flying over Mt. Everest. The chief wintering ducks in the wetlands of the Tarai include the Northern pintail which may amount to over 50,000 in the Koshi river alone. Other common wintering species include the common pochard, the common teal, the ruddy shelduck, the Northern shoveler, etc. Most of the ducks start arriving from the trans-Himalaya (Tibet, northern China, Mongolia, and Siberia) from the end of monsoon until the autumn. Their return flight starts from early March.

Raptors – A large numbers of eagles, chiefly steppe eagles, migrate over the Trishuli Valley, Naudanda (north of Pokhara), and the Arun Valley during late October and early November. Return flights from Naudanda and Namche have been noted during March. Similarly buteos (chiefly the common buteo) migrate in large flocks and roost in the forests of Shivpuri Watershed and Wildlife Reserve, and other forests of the midhills. Smaller raptors (harriers, kestrels) also take the same route but they arrive earlier and fly in loose flocks. Hundreds of harriers (chiefly hen, pied, and marsh harriers) have been observed roosting in the grasslands of the Lumbini Area. Red-footed falcons migrate in flocks of hundreds and have been observed frequently in the Kathmandu and Pokhara valleys in the course of their fall migration.

Cranes – One of the most fascinating migratory phenomena that occur in the high Himalayas is the migration of cranes, chiefly the common and the demoiselle cranes. Common cranes usually fly higher than 8,000m and are not easily visible. Demoiselle cranes flying over the Kali Gandaki Valley, the Manaslu Pass, and the Kathmandu

Valley have attracted the attention of local admirers and hunters. They start arriving over Jomsom at the end of September, and the last flock departs at the end of October. During adverse weather conditions they have to occasionally stop and feed in the fields of the Kali Gandaki Valley.

Storks – The black stork is the chief migratory stork species, and arrives from Western European countries. Their small flock spends the winter in the wetlands and the cultivated land of the Tarai and Inner Tarai. There are vagrant records of white stork occurring in the Tarai during winter. The globally endangered greater adjutant stork exhibits nomadic migration and has seldom been reported from the eastern Tarai.

Swallows – Barn swallows are migratory birds that build nests inside houses in urban areas. They start arriving in March to breed. Their post-nuptial migration starts in the fall. They contribute to the control of flying insects. Nowadays, many of these birds overwinter in Kathmandu, indicating the rise in the average temperature and availability of food during the winter. A certain shop at Kopundole near the Bagmati Bridge, where hundreds of barn swallows breed, has been dedicated to these birds and named "House of Swallows."

Endemic Birds

The spiny babbler (*Turdoides nipalensis*) and the Nepal wren babbler (*Pnoepyga immaculata*) are the two endemic bird species recorded in Nepal. The spiny babbler is found between the upper Siwaliks and the midhills and is widely distributed from the eastern to the western border of Nepal. This species may well occur in India. The Nepal wren babbler (*Pnoepyga immaculata*) has been reported recently from the Kali Gandaki region by Jochen Marten. This species is also found in the central and eastern regions of the midhills.

Protected Species

The National Parks and Wildlife Conservation Act (1973) lists nine bird species as protected. It includes three resident pheasant species, two species each of stork, and florican, and one each of hornbill and crane. Cheer pheasant and Bengal florican are listed under the IUCN "endangered" category. Similarly, impeyan pheasant, cheer pheasant, and Bengal florican are listed in CITES I Appendices and crimson horned pheasant has been recommended for

Table 20 Bird species protected by DNPWC Act 1973

Scientific name	Common name	Nepali name
<i>Ciconia nigra</i>	Black stork	Kalo bhundifor
<i>Ciconia ciconia</i>	White stork	Seto bhundifor
<i>Lophophorus impejanus</i>	Impeyan pheasant	Danfe (national bird of Nepal)
<i>Tragopan satyra</i>	Crimson-horned pheasant	Monal
<i>Catreus wallichi</i>	Cheer pheasant	Cheer kalij
<i>Houbaropsis benghalensis</i>	Bengal florican	Khar mayur
<i>Sypheotoides indica</i>	Lesser florican	Sano khar mayur
<i>Grus grus</i>	Common crane	Saras
<i>Buseros bicornis</i>	Giant hornbill	Raj dhanesh

a trade ban by Nepal. Black stork, white stork and lesser florican are included in CITES Appendix II. Protected species include one critically endangered species (lesser florican), one susceptible species (impeyan pheasant), and the remaining seven species as endangered. Impeyan pheasant is the national bird of Nepal.

Threatened Species

A review of bird status carried out by BPP 1995 for the Department of National Parks and Wildlife Conservation (DNPWC) recommended 88 species as meriting legal protection. The basis for selection was their small, fragmented population, the extent of the population being killed by humans for food, and being killed or captured for commercial trade, and their role in the control of pests species (insects and rodents). The bird species recommended for protection include birds of prey (37 species), owls (16 species), storks (6 species), and pheasants and cranes (2 species each). The bird species recommended for protection include 3 critically endangered, 19 endangered, 21 vulnerable, and 45 susceptible species. There are about 85 species that have been categorised as vagrants and are under-recorded. It is probable that most of these birds arrive in Nepal due to unnatural conditions such as bad weather, jet streams, etc.; and most are found on the outer limits of their distribution range.

Inskipp (1989) recommended 103 species of Nepal's forest birds for conservation. The bird species belonging to Accipiter, the falcon family, and an additional 17 birds occurring in Nepal are listed under the Indian Wildlife Act Schedule (I) (Majupuria, 1990). Sixty-one bird species fall under one of the Appendices of CITES that includes 10 species in Appendix I, 48 species in Appendix II,

and 3 in Appendix III as of 1992. Birdlife International lists 91 species as threatened or probably threatened, that includes 19 globally threatened, 55 regionally threatened, and 17 nationally threatened species (BLI, 1995). According to IUCN categorisation (Groombridge, 1992), 17 bird species are listed as threatened that includes four endangered, five vulnerable, two indeterminate, and three insufficiently known species. The IUCN 1996 updated version (Baillie and Groombridge, 1996) lists 27 birds species as threatened, an increase by 10 species. Bird Conservation Nepal (Baral et al., 1996) lists 139 bird species as threatened that includes 31 as critical, 44 as endangered, 54 as vulnerable, 1 as data deficient, and 9 as species to watch.

Threats to the survival of avifauna include direct and indirect persecution. Birds are threatened by deliberate and/or inadvertent acts of human beings.

Direct persecution includes hunting, trapping, egg collection, and nest robbery. Guns, snares, traps, and poison are used to kill birds. "Flash light lure" shooting of kalij pheasants could wipe out the local population (Inskipp, 1989). The population of ducks and geese has decreased tremendously due to the use of pesticide poison as bait. Sarus cranes are declining in number due to hunting, egg stealing, chick capturing, and loss of habitat. Birds of prey are killed when their food is contaminated with the poison meant to kill the large predatory mammals. Large numbers of passerines are trapped in the lowlands (Tarai and Siwaliks floodplains) to be sold in the local market or to be exported to other countries for the pet trade. Some local pubs of the Tarai and Kathmandu specialise in serving passerines (bagedi in Nepali) trapped in the Tarai region.

Table 21 : Extinct bird species of Nepal

Scientific name	Common Name	Recorded from (region/physiographic zone)
<i>Ardea imperialis</i>	Imperial heron	Central Tarai/ Siwaliks
<i>Rhodonessa caryophyllacea</i> #	Pink-headed duck	Central/ Midhills
<i>Perdica asiatica</i>	Jungle bush quail	Unknown, Tarai/Siwaliks
<i>Hierococcyx fugax</i>	Hodgson's hawk-cuckoo	Eastern Tarai/Siwaliks
<i>Aceros nipalensis</i>	Rufous-necked hornbill	Eastern Tarai/ Siwaliks
<i>Serilophus lunatus</i>	Silver-breasted broadbill	Eastern/ Tarai/Siwaliks and Midhills
<i>Brachypteryx hyperythra</i>	Rusty-bellied shortwing	Unknown locality
<i>Cochoa viridis</i>	Green cochoa	Unknown/Tarai /Siwaliks
<i>Paradoxornis flavirostris</i>	Black-breasted parrotbill	Eastern/ Tarai /Siwaliks and Midhills
<i>Liocichla phoenicea</i>	Red-faced liocichla	Eastern/ Tarai/ Siwaliks and Midhills
<i>Heterophasia sibia</i>	Long-tailed sibia	Central/ Tarai /Siwaliks

Source: BPP, 1995i.

Legend: # Globally extinct species.

More than 40% of the forest of the Tarai was lost between 1960 and the 1990s (Joshi et al., 1995). Malaria eradication during the early 1960s allowed the government to undertake settlement scheme on this productive land. Currently, 60% of its land is under agriculture and more than 40% of the populace lives in this physiographic zone. The population is still increasing.

The bird trade threatens ducks and geese of the Koshi Tappu Area where they are trapped using nets or poisoned baits in order to supply meat for the local market. Small passerines (buntings, munias, pipits, etc.), are exploited as a delicacy for human consumption. Hill myna, the best human imitator, and parakeets are popular as pets. Traditional Buddhists believe that releasing birds wins spiritual merit for their deceased ancestors and for themselves. This has encouraged the bird trade in Nepal. In addition, birds of prey such as the saker falcon have been confiscated at Kathmandu International Airport on their way to be sold in Arab countries.

Extinct Species

Eleven bird species are believed to be extinct in Nepal. The last specimens were collected a century ago by Hodgson. The pink-headed duck, once recorded from the Kathmandu Valley, is believed to have become globally extinct. The sighting record of Hodgson's hawk cuckoo from the Koshi Tappu area needs further corroboration. Most of the bird

species that have become extinct were recorded from the eastern region of Nepal.

Important Bird Habitats Outside Protected Areas

The Tarai and Siwaliks

Eastern region – The Lower Mai Valley for moist tropical forest (Southeast Lowlands). Koshi Marshes outside the KTWR for waders and waterfowls. The forest of Chatara for eastern deciduous forest birds.

Central region – The Siwalik range of Dang Deukhuri for central Siwalik deciduous forest-dependent species (an understudied area). Banganga reservoir for resident, staging and wintering waders and the forest of Goru Singhe.

Western region – Ghodaghodi lake system.

Midhills

Eastern region – Upper Mai Valley of Ilam District. Gairi Bans Santapur of Ilam District (adjacent to Singalila Range, the National Park of West Bengal, India). Milke-Jaljala ridge of rhododendron forests.

Central region – Forest of Thodung and Tanbe Danda of Ramechhap District (lies south of Rolwaling Himal and along the Everest trekking route). Watersheds and lakes of Phewa, Begnas, and Rupa tal and other major lakes of the midhills and their watersheds.

Western region (Rara Ringmo Finger) –

Ghanteswor Lekh of Doti Dadeldhura (scenic, far from settlement; but close to highway, with a high biodiversity and socio-religious value). Binayak Gurel Lekh of Bajhang (dense mixed broad-leaved and conifer forest with diverse habitat condition. Abounds in herbs and is an important wildlife corridor). Bhateli Gwani Lekh (conifer forest covering several hills, riverine to morainic habitat conditions). Badi Malika (oak, rhododendrons, hemlock - juniper shrubbery). Amarmani Lekh of Bajura (oak- rhododendrons).

High Mountains

Eastern region – Kanchanjunga conservation area.

Central region – Manaslu ecotourism development area.

Western region – Tinkar Valley (unexplored area)

Traditional Bird Trapping Techniques

Many ethnic groups and tribes of Nepal practice harvesting of wild animals for food and sport. The nomadic forest dwellers of the western midhills are Raute and Kusunda. The Kusundas are thought to have settled and adapted to modern society, whereas the Rautes still prefer to lead a nomadic life in the forests of the western midhills. Frequently, they visit villages to barter wooden vessels for food. Chepangs have not changed their traditional lifestyles, and still live in caves, eating wild fruit, vegetables, and tubers and undertaking activities such as fishing, hunting, and bird trapping.

Many ethnic groups of the lowland and Inner Tarai harvest wild flora and fauna to sustain their livelihood. The chief among such ethnic groups are Tharus, Bantars, and the nomadic Natuwas and Satars. Most of these ethnic groups use traditional weapons and methods to capture animals. Nowadays, pesticides are often used on bait to stun or kill the animals.

The people of Tibrikot train falcons to catch wild birds. For weeks young falcons in training have their eye-lids sewn shut. They are then exported to Indian markets for their journey onward to the Arabian market, where people use falcons to catch birds for meat.

a. Gum traps ("liso")

Resins are used to trap birds on their perch. Usually a known roost site is selected and gum is spread over the branch. When the bird sets its claws on the branch, both the claws and the fluttering wings get stuck. Gum is also used on the forks of the branch to capture roosting birds. Generally a long forked pole is used to trap smaller birds such as passerines.

b. Snare traps ("paso")

Snares made of nylon and silk strings are used to make bird snares. These may be placed vertically touching the ground, about two feet in height. This method is applied in the case of game birds that live in bushy or dense forests. Once stuck, the bird tries to move, and the snare becomes tightened.

c. Mist net ("jal")

Mist nets made of thin silk threads are the most popular and effective way to trap birds. Generally, advanced mist nets are used for scientific collection. Grasslands, wetlands, floodplains, and sugarcane farms are suitable habitats for bird trappers. Mist nets are placed horizontally over the reeds and birds are trapped when they come to roost in the evening. Such birds include small passerines such as munias, pipits, and buntings. Most of the birds that enter the market to be sold as meat are caught in this way.

d. Pesticides (BHC, Metacid, Aldrin, Dieldrin)

By far the most popular but most dangerous method of harvesting birds is the use of pesticides mixed with rice or other grains. The target species are geese and ducks. The birds are often sold in the market. This method is commonly applied in the fields and rivers adjacent to protected areas such as Koshi Tappu and Chitwan.

e. Vessel technique

A large earthen vessel is used to disguise the hunter's head while wading in a shallow river or lake. Holding it by the leg, the trapper drags the bird into the water. This method is generally applied when hunting ducks, especially the Brahmini duck.

f. Fishing hooks

A small fish or invertebrate is stuck in the fishing hook as a bait to trap geese and kingfishers.

g. Bamboo spears ("suiro")

A thin bamboo, five feet long is fitted with a sharp spear on the top. The end of the pole is hollow to fit another similar bamboo spear. Four to five bamboos are thus joined together to reach the bird. This method is mostly used by Natuwas, Satars, and other tribes of the Tarai.

h. Catapult ("guleli")

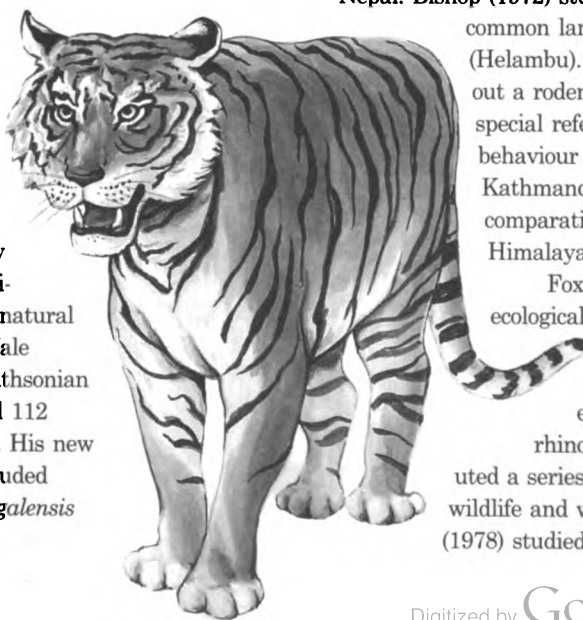
A catapult is used as a sport and to chase pest species invading the fields rather than for harvesting. The catapult is a common weapon in use throughout Nepal.

e) Mammals

Overview

The first authentic taxonomic record of the mammals of Nepal was made by Hodgson (1826-1854). Baptist (1921) made a systematic collection of the mammals of Nepal. Hinton (1922), Thomas and Hinton (1922) and Thomas (1924) collected 52 mammal specimens belonging to 10 species. Hinton and Fry (1923) listed a collection of 34 genera and 44 species of mammals from Nepal. Brander (1923) referred to many important mammals of Nepal in his book on the mammals of central India.

In 1948-49, Ripley conducted a field expedition in Nepal to collect natural history specimens for Yale University and the Smithsonian Institution. He collected 112 specimens of mammals. His new records from Nepal included *Tupaia glis*, *Vulpes bengalensis* and *Lepus grahmi*.



Biswas and Khajuria (1955, 1957) collected mammals from the Khumbu region of eastern Nepal. The collection included two species and two sub-species of rodents and pikas which were described for the first time. A German-Nepal Himalayan expedition team investigated the insectivora and rodentia of east Nepal in 1965 and listed 10 genera and 14 species. Kawamichi (1968) studied the Himalayan pikas extensively. Caughley (1969) studied wildlife and recreation in the Trisuli watershed. He gave an account of the eco-geographic distribution of the principal wildlife forms. Similarly, Grueber (1969) studied the zoogeography, ecology and bionomics of the small mammals of east Nepal. In the first part of his report, he has presented 17 characteristic biotopes. Furthermore, he described six species of *Sorex*: *Sorex cylindricauda nepalensis*, *Sorex nigraescens centralis*, *Soriculus caudatus*, *Oracles lucoys*, *Soriculus gruberi*, and *Suncus murinus soccatus*. He also discussed the taxonomy and biology of pikas. Fry (1976) carried out a mammal survey in Nepal. In this collection two ungulates (*Ovis ammon* and *Tragulus meminna*) and three insectivora (*Crocidura attenuata*) were included. Worth and Saha (1969) collected 469 skins of mammals from Nepal consisting of 18 genera and 28 species. Abe (1971) investigated small mammals in 22 localities of central Nepal during a three month period from April to July 1968. He collected seven species of insectivores, eight species of bats, three species of rodents, and three species of pikas. Sharma (1971) gave a short account of the vanishing mammals of Nepal. Bishop (1972) studied the biology of the

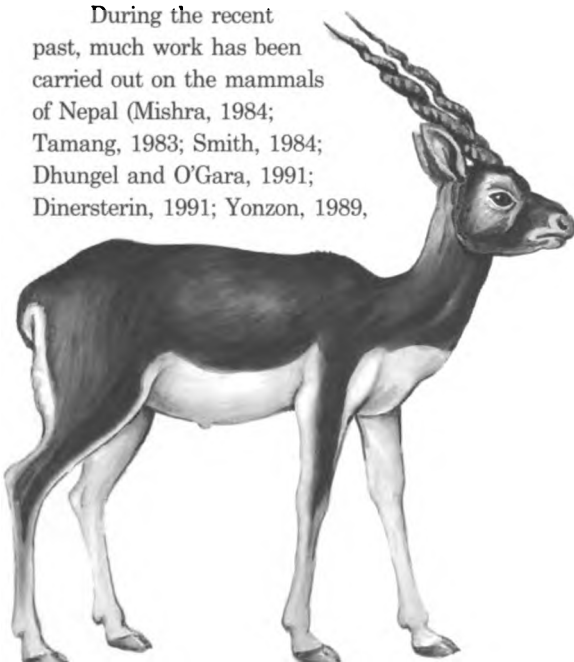
common langur in Melamchi (Helambu). Frantz (1973-74) carried out a rodent research project, with special reference to rodent ecology, behaviour and control in the Kathmandu Valley and with comparative studies in Tarai and Himalayan regions.

Fox (1974) carried out an ecological survey of Langtang National Park. Laurie (1974) studied the ecology and behaviour of rhinos. Weber (1974) contributed a series of useful papers on the wildlife and wilderness of Nepal. Schaaaf (1978) studied the swamp deer, Tamang

(1982) tiger ecology, and Jackson (1977) the snow leopard. Boulton (1976) drew a management plan of the major national parks and reserves of Nepal. Mishra and Mierow (1976) published a book on the mammals of Nepal. Michael (1978) studied the Himalayan musk deer of Nepal. Mariott (1978) published her report on the feeding behaviour of the rhesus monkey (*Macaca mulatta*) in Kathmandu. Dahmer (1978) worked on the ecology of wild Asian buffalo (*Babulus bubalis*). Green (1978) gave an account of the Himalayan musk deer. He studied some aspects of the ecology of the trans-Himalayan animal and provided suggestions for park management. Wegge (1976) studied the major Himalayan reserves of Nepal. He provided an interesting account of trophy mammals and management of the Himalayan resources, furnishing important data on blue sheep.

Johnson et al. (1980) gave authentic records of doubtful mammals of Nepal. Shrestha (1980) published a note on the pygmy shrew in Kathmandu. Shrestha (1981) added a volume of information on the mammals of Nepal in his book *Wildlife of Nepal*. He provided a consolidated account of the peripheral, principal and river wildlife of Nepal. Mishra (1982) studied deer and tiger ecology in Royal Chitwan National Park. Green (1981) prepared a check-list and some notes on the mammals of Langtang National Park and gave the altitudinal range of the various mammals in the park. Ghosh and Saha (1981) reviewed the taxonomy of Hodgson's giant flying squirrel (*Petaurista magnificus*) and described a new species *Petaurista magnificus hodgsoni*.

During the recent past, much work has been carried out on the mammals of Nepal (Mishra, 1984; Tamang, 1983; Smith, 1984; Dhungel and O'Gara, 1991; Dinersterin, 1991; Yonzon, 1989,



1994; Janwali and Wegg, 1993; Shrestha, 1991, 1992, 1993). Important landmarks in the study of the ecology of mammals in Nepal, Bangladesh, Sri Lanka and India were achieved by Johnsing and Joshua (1994) and Shrestha (1995, 1997).

Although descriptions of Nepalese mammals are available in standard literature, there are many mammals whose status is not clear. There is also a lack of distributional, behavioural and ecological information. The distributional pattern of many species is changing rapidly with man-made changes in their habitats. A state of the art report on Nepalese mammals is now required.

The conservation and management of the small mammals of Nepal has been neglected. Therefore, a thorough country-wide, long-term survey is needed to determine their conservation status and to undertake the management of small mammal species in the wild.

Species Richness

In Nepal, a total of 181 mammal species have been recorded. Of these, the Himalayan field mouse (*Apodemus gorkha*) is endemic to Nepal. It is found in central Nepal at an altitude of 2,200m-3,600m, primarily in coniferous forests. The Red Data Book lists the pygmy hog (*Sus salvanius*) as extinct in Nepal. Once pygmy hog roamed all over the grassland zone from Nepal to Assam. Its distribution is now limited due to habitat fragmentation. In recent years, it has been reported in Assam, India.

Indian chevrotain ranges from Peninsular India, northwest to Rajasthan. The cheetah became extinct in India in the 1940s (Corbet and Hill, 1992). The record of Indian chevrotain from Nepal by Mitchell (1975) needs confirmation. There is some record of the occurrence of takin (*Budorcas taxicolor*) on the southern slopes of Kanchanjunga. The occurrence of Tibetan wild ass (*Equus kiang*), as reported by the local people in upper Mustang also needs further confirmation.

Status of Mammal Species

Fifty-six mammal species have been proposed for the National Red Data Book (BPP, 1995). Twenty-seven mammal species are legally protected by HMG. Of these, the pygmy hog is believed to be extinct. Endangered species of wild animals in the major habitats of the Himalaya are the wolf, red panda, lynx, snow leopard, Himalayan brown bear,

Tibetan sheep, Tibetan antelope, musk deer, and wild yak. Some of the endangered species of the southern tropical areas include tiger, rhinoceros, elephant, gaur bison, and the Gangetic dolphin. Other threatened species of the Tarai are the wild buffalo, swamp deer, four-horned antelope, black buck, and hispid hare.

Altogether, 26 mammals have been classified as protected species. The national parks and protected areas are fairly well managed and provide protection to wild fauna and flora. However, the majority of habitats outside national parks and the protected area system are vulnerable. Aquatic mammals such as the dolphin do not

receive any protection as they live in open rivers outside protected areas.

Every possible method of killing musk deer is used when poaching these animals. Hunting them with dogs, shooting them with guns, snaring, and setting poisoned bamboo splints across pathways are some of the techniques used for poaching musk deer and other deer species. Netting, spearing or putting explosives in food are common methods for killing wild pigs and blue bull. Set guns, deadfalls, bait poisoning, and guns are used for leopards. Pits are used for rhinoceros and poisoned carcasses are laid for tigers. The strangest technique, however, is the driving of ghoral, serow, and blue sheep over precipitous rocks.

Table 22 List of mammals included in the National Red Data Book

SN	Scientific Name	Common Name
1.	<i>Macaca mulata</i>	Rhesus macaque
2.	<i>Semnopithecus entellus</i>	Hanuman langur
3.	<i>Vulpes vulpes</i>	Red fox
4.	<i>Vulpes bengalensis</i>	Bangal fox
5.	<i>Vulpes ferrilata</i>	Tibetan sand fox
6.	<i>Cuon alpinus</i>	Asiatic wild dog (dhole)
7.	<i>Ursus ursinus</i>	Sloth bear
8.	<i>Ursus thibetanus</i>	Asiatic black bear
9.	<i>Mustela strigidorsa</i>	Black-striped weasel
10.	<i>Arctonyx collaris</i>	Hog badger
11.	<i>Mellivora capensis</i>	Honey badger (ratel)
12.	<i>Lutra lutra</i>	Common otter
13.	<i>Lutrogale perspicillata</i>	Smooth coated otter
14.	<i>Aonyx cinera</i>	Oriental small-clawed otter
15.	<i>Herpesticus urva</i>	Crab-eating mongoose
16.	<i>Felis chaus</i>	Jungle cat
17.	<i>Prionailurus viverrinus</i>	Fishing cat
18.	<i>Catopuma temminckii</i>	Golden cat
19.	<i>Pardofelis marmorata</i>	Marbled cat
20.	<i>Panthera pardus</i>	Snow leopard
21.	<i>Moschus fuscus</i>	Black musk deer
22.	<i>Cervus unicolor</i>	Sambar deer
23.	<i>Axis porcinus</i>	Hog deer
24.	<i>Boselaphus tragocamelus</i>	Nilgai (blue bull)
25.	<i>Hemitragus jemlahicus</i>	Himalayan thar
26.	<i>Naemorhedus goral</i>	Himalayan goral
27.	<i>Naemorhedus sumatraensis</i>	Mainland serow
28.	<i>Pseudois nayaus</i>	Bharal (blue sheep)
29.	<i>Ratufa bicolor</i>	Black giant squirrel
30.	<i>Ochotona nubrica</i>	Nubrica pika

Source: BPP

Table 23 IUCN list of mammals

SN	Scientific Name	Common Name	Appendix
1.	<i>Ailurus fulgens</i>	Red panda	I
2.	<i>Bos gaurus</i>	Gaur bison	I
3.	<i>Bos grunniens</i>	Yak	I
4.	<i>Canis lupus</i>	Wolf	I
5.	<i>Capra falconeri</i>	Markhor	I
6.	<i>Caprolagus hispidus</i>	Hispid hare	I
7.	<i>Cervus duvaucelii</i>	Swamp deer	I
8.	<i>Elephas maximus</i>	Elephant	I
9.	<i>Felis bengalensis</i>	Leopard cat	I
10.	<i>Felis marmorata</i>	Marbled cat	I
11.	<i>Felis temmincke</i>	Golden cat	I
12.	<i>Lutra lutra</i>	Otter	I
13.	<i>Melursus ursinus</i>	Sloth bear	I
14.	<i>Moschus spp.</i>	Musk deer	I
15.	<i>Naemorhedus goral</i>	Ghoral	I
16.	<i>Naemorhedus sumatraensis</i>	Himalayan serow	I
17.	<i>Neofelis nebulosa</i>	Clouded leopard	I
18.	<i>Ovis ammon hodgsonii</i>	Argali	I
19.	<i>Panthera tigris</i>	Tiger	I
20.	<i>Panthera pardus</i>	Common leopard	I
21.	<i>Panthera uncia</i>	Snow leopard	I
22.	<i>Pantholops hodgsoni</i>	Chiru	I
23.	<i>Platanista spp.</i>	Dolphin	I
24.	<i>Presbytis entellus</i>	Langur	I
25.	<i>Prionodon pardicolor</i>	Linsang	I
26.	<i>Rhinocerotidae spp.</i>	Rhinoceros	I
27.	<i>Selenarctos thibetanus</i>	Himalayan black bear	I
28.	<i>Sus salvanus</i>	Pygmy hog	I
29.	<i>Ursus arctos</i>	Brown bear	I
30.	<i>Cuon aplainus</i>	Wild dog	II
31.	<i>Equus hemionus</i>	Wild ass	II
32.	<i>Manis spp.</i>	Pangolin	II
33.	<i>Primates spp.</i>	Monkey	II
34.	<i>Pteropus spp.</i>	Flying fox	II
35.	<i>Ratufa spp.</i>	Squirrel	II
36.	<i>Tupaia glis</i>	Common tree shrew	II
37.	<i>Antelope cervicapra</i>	Black buck	III
38.	<i>Arctictis binturong</i>	Bear cat	III
39.	<i>Bubalus bubalis</i>	Wild buffalo	III
40.	<i>Canis aureus</i>	Jackal	III
41.	<i>Herpestes edwardsi</i>	Common mongoose	III
42.	<i>Herpestes fuscus</i>	Brown mongoose	III
43.	<i>Herpestes urva</i>	Crab-eating mongoose	III
44.	<i>Marmota himalayana</i>	Himalayan marmot	III
45.	<i>Martes flavigula</i>	Yellow-throated marten	III
46.	<i>Martes foina intermedia</i>	Stone marten	III
47.	<i>Mellivora capensis</i>	Honey badger	III
48.	<i>Mustela altaica</i>	Pale weasel	III

49.	<i>Mustela kathia</i>	Yellow-bellied weasel	III
50.	<i>Mustela sibirica</i>	Distri Himalayan weasel	III
51.	<i>Paguma larvata</i>	Himalayan palm civet	III
52.	<i>Paradoxurus hermaphrodi</i>	Common palm civet	III
53.	<i>Paradoxurus jerdoni</i>	Brown palm civet	III
54.	<i>Tetracerus quadricornis</i>	Four-horned antelope	III
55.	<i>Viverra zibetha</i>	Large Indian civet	III
56.	<i>Viverricula indica</i>	Small Indian civet	III
57.	<i>Vulpes bengalensis</i>	Indian fox	III
58.	<i>Vulpes montana</i>	Mountain fox	III

Source: IUCN (1994). *Endangered Wildlife: Nepal's threatened animals in the IUCN Red List, 1994*

Endangered Mammals

IUCN Nepal has prepared a list of endangered flora and fauna in Nepal on the basis of the CITES list. Currently, there are 58 mammals which appear in various appendices. Twenty-nine species fall under Appendix I, 7 in Appendix II and 22 in Appendix III.

Distribution of Mammals in National Parks and Wildlife Reserves

His Majesty's Government of Nepal (HMG) has set up National Parks and Wildlife Reserves in different ecological zones to protect Nepalese wildlife.

In 1970, His Majesty the Late King Mahendra approved in principle the establishment of Royal Chitwan National Park and Langtang National Park. The conservation movement in Nepal was effectively initiated from that year. In 1973, Royal Chitwan National Park was officially established through the National Parks and Wildlife Conservation Act. That same year, His Royal Highness Prince Gyanendra announced at the Third International Congress of the World Wildlife Fund the creation of Sagarmatha National Park. At present, there are 8 national parks, 4 wildlife reserves and 3 conservation areas in Nepal. In total, these parks, reserves and conservation areas cover more than 15 % of Nepal's land area.

The floodplain of the Koshi river in the east, the Tarai Bhabar region of Parsa and Bardia, and the riverine open grassland of Suklaphanta are important for mammals living in land and water-interchange areas.

Sagarmatha National Park and Royal Chitwan National Park have been included in the

World Heritage List. These areas are important for the preservation of large mammals.

The buffer zone initiatives of HMG/N may bring positive results to local mammal protection, since local people will be directly involved in designing and implementing the conservation activities in the surrounding areas. The initiative is also an effective model for minimising park-people conflict. Since it involves the local people, who are both the victims and beneficiaries of national parks. In addition, local people will be aware of their special role and added responsibility in wildlife conservation. From this perspective, the buffer zone management initiative in the surrounding areas of the protected area system will be a challenge for wildlife managers who traditionally practice the implementation of conservation activities within the protected areas. The initiative has become an opportunity for the local people to become active participants in Nepal's wildlife management process, which is a new direction in sustainable development.



3. Forest Resources

"The wealth of Nepal," it was said until recently, "is its green forests." And, indeed, the export of tropical hardwood timber to India was the prime source of income for the national treasury of Rana rulers who were in power for over a century, from 1846 to 1951 AD. However, along with the eradication of malaria during the 1960s the Tarai forests began to diminish rapidly. The forests of the Tarai were a ready victim for all sorts of political upheavals, including that of the referendum in 1980 and the political change of 1990. Rehabilitation programmes for refugees from Myanmar and Bhutan, for army vetrans from India and landless peasants from the Nepalese hills and mountains have been taking place on government forest land. The Forestry Sector Master Plan (1988) acknowledges that over the last two decades, more than half a million ha of forest has been lost, and about 0.2 million ha of Tarai and Siwalik forest land cleared through planned settlement and illegal felling between 1980 and 1985 (Master Plan for Forestry Sector).

The Master Plan estimates that Nepal's forest cover comprises around 37% of its land surface. This estimate is based on the 1979 aerial photo data generated by the Land Resource Mapping Project (LRMP), in which a forest is defined on the basis of 10% crown cover. Dense forests with over 70% crown cover amount to only 5.61%. Therefore, the prospects of harvesting forests or reducing forest cover do not have any justification. What is more promising is the use of genetic resources from the diversity of species in terms of the first layer of canopy trees and the subsequent shrub layer, the ground cover of herbs, and the epiphytic plants such as mosses, lichens, ferns, and orchids. Genetic evaluation of these forest resources would certainly lead to better utilisation of these species through cultivation and propagation. Afforestation, reforestation, agro-forestry and other forms of silviculture should certainly be based upon indigenous wild plant resources.

Various sources of data on the vegetative cover of Nepal indicate that about 54% of its land surface (147,181 sq km in total) is under some sort of vegetation cover (forest area 37%, shrubland and degraded forest 5%, and grasslands 12% - HMG Master Plan for the Forestry Sector, 1988). Nepal's vegetation has been categorised into 75 types

(Dobremez, 1972) ranging from tropical monsoon forests and savannah grasslands to sub-alpine birch-coniferous forests and grassy meadows with temperate forests dominated by rhododendrons, oaks, and conifers. The steppic cushion vegetation of Dolpa and Mustang is similar to the Tibetan plateau type, while the steppic shrubby vegetation of the upper Bheri Valley (southern Dolpa District) is reminiscent of the Mediterranean variety.

Stainton (1972) identifies 35 forest types in Nepal. The tropical and sub-tropical zones house 10 forest types and the temperate zone 11 forest types in the broad-leaved category; 8 in the coniferous category and 5 forest types in minor associations of various kinds of scrub vegetation, such as moist alpine scrub and so on.

Nepal's 20 million people mostly live in rural conditions. The use and conservation of natural resources of plants and plant products is rooted in Nepalese culture. A large number of trees such as the peepal (*Ficus religiosa*), rudrakshya (*Elaeocarpus ganitris*), bael (*Aegle marmelos*), and khari (*Celtis australis*) are deemed sacred. All cultural groups of Nepal pay a special homage to crops, particularly rice and barley. Wild flowers and grasses are essential in all ceremonies. Some plants of versatile use such as bamboo carry a high cultural value. Various species of bamboo have specified uses during social occasions ranging from birth and weddings to funerals. Some herbs bear a certain sacred aura. For instance, tulsi (*Ocimum sanctum*) is worshipped as it is believed to facilitate a dying person's journey to heaven. The diversities in Nepal's traditions and cultures usually converge on issues relating to the use of plants. Thus, traditional knowledge holds the prospect of developing genetic resources from wild plants.

Various faculties of Tribhuvan University such as the Institute of Science and Technology, the Institute of Forestry, the Institute of Agriculture and Animal Sciences, and the Natural History Museum are directly involved in study, research, and manpower development concerning plant resources. The Research Centre for Applied Science and Technology (RECAST) and the Royal Nepal Academy of Science and Technology (RONAST) have given emphasis to the research and development of plant resources.

The Forestry Research and Survey Centre under the Ministry of Forests and Soil Conserva-

tion is engaged in the research and development of forests and forest products. A regular journal *Ban ko Jankari* highlights important findings in forestry research in Nepal.

Altogether two national parks and three wildlife reserves lie in the Tarai and Siwalik region of Nepal and five national parks are situated in the High Himalayan region. The representation of the Middle Mountains is rather poor. The Khaptad National Park, the Dhorpatan Hunting Reserve, and the Shivpuri Conservation and Wildlife Reserve encompass some areas of the Middle Mountains. It has been estimated that of the 35 forest types of Nepal, more than 25 types are represented in the protected area system (Shrestha, 1985).

The floral wealth of Nepal's protected areas has only been studied in a few places mostly in the Makalu Barun National Park and in the Annapurna Conservation Area. The study related to the flora of Langtang (1976) was published before the establishment of the park. Similarly, the botanical wealth of Shey Phoksumdo National Park was also studied (Shrestha, 1985) before the park's establishment. Both the parks house a large number of medicinal herbs, fibre plants and a great number of alpine garden plants such as primroses, gentians, edelweiss, blue poppies, saxifragas, and rhododendrons. They also house a number of endemic plants including *Homalium nepaulense* (a small tree), *Larix himalaica* (Langtang larch), *Primula aureata*, *P. sharmae*, and *Clematis phlebantha*. The mountain parks of Nepal are renowned as collection sites for medicinal herbs. Local communities have been badly affected due to park regulations and conflict has tended to increase. However, domestication and cultivation of these herbs for community development has not yet been successful.

a) Forest Management

His Majesty's Government of Nepal nationalised all forest land in 1957. This one-stroke decision transferred the ownership of most of the Tarai forest from individuals to the government. It also resulted in the alienation people from forest management. The resource users, especially at the community level, resented the state's appropriation of the rights they had exercised until then. In the new context, people gave up their responsibility of

conserving forest resources while continuing to use them more aggressively. The act was amended in 1977 to empower the people in the management of forest resources through social forestry or community forestry. The Master Plan for the Forestry Sector (MPFS) in Nepal included (i) community and private forestry, (ii) national and leasehold forestry, (iii) wood-based industries, (iv) medicinal and aromatic plants and other minor forest products, (v) soil conservation and watershed management, and (vi) conservation of ecosystems and genetic resources.

In 1993, His Majesty's Government elaborated the concept of the "Forest Users' Group" under the Forest Act 1993 and the Forest Regulations of 1995 (MOFSC, 1996). Accordingly, the national forest has been further divided into five sub-categories: (i) Community Forest, (ii) Leasehold Forest, (iii) Government-managed Forest, (iv) Religious Forest, and (v) Protected Forest.

Community Forest

The idea of the community forest was to develop and manage forest resources through the active participation of people and communities in order to meet their basic needs.

Groups of peasants and farmers organise themselves into a Forest Users' Group (FUG). The FUGs have clearly demonstrated that they have the capacity to protect, rehabilitate and manage their forest and forest resources in a more effective way. A large number of success stories abound in the Tarai and midhills of Nepal (Gilmour and Fisher, 1991; Jackson and Ingles, 1994; Chhetri and Pandey, 1992). There has been a succession of policy reforms to actually empower the community. However, it must be noted that the actual ownership of land remains with the government. People are reaping the benefits of forests and more and more national forests are being handed over to the community. By December of 1994, the area under community forest was just over 112,000 ha. As of 15 December 1996, the database record on FUGs has shown that the government has recognised 4,565 FUGs, which belong to 460,470 households. They are managing about 290,000 ha of land under community forestry.

The biodiversity value of community forestry has not yet been assessed in terms of ecosystem diversity, species diversity, and genetic diversity.

The midhills (middle mountain region) have been transformed by cultivation and grazing and most of the forest land is now under regular human use and its attendant pressures. Possible sites for a national park or protected area are not available. However, there exists a complex mosaic of fragmented ecosystems consisting of forested land, shrublands, grasslands, and barren lands. They constitute potential areas for the recovery of biodiversity and conservation. Forest regeneration patterns in central and eastern Nepal are very encouraging in the sense that coniferous plantation is being gradually converted into broad-leaved forests. Shrublands revert into forested land when they are fenced from cattle and people. There are increasing incidences of livestock killings and crop depredation in adjoining farmland. These problems need to be addressed immediately before negative feelings take root in the community, thus hampering community forestry. There is an urgent need to develop conservation strategies in order to enhance the value of biodiversity. This is possible through a

process of community participation in the restoration and protection of land masses through community forestry.

The experiences of one Nepal Australian Community Forestry Project have positively indicated the potential of changing degraded forests back into natural forests if FUGs manage them (Jackson and Ingles, 1994). Although community forestry primarily aims at supporting subsistence-oriented farms and rural household needs, there exists a potential for enhancing resort tourism and enriching NTFPs.

Community forestry, coupled with agro-ecosystems and agro-forestry, offers a great opportunity to create new economic incentives for peasants and farmers. There are success stories of alder-cardamom agroforestry in Sankhuwasabha and Ilam districts and rejuvenation of degraded forests in the midland areas (Pande, 1997). Community forestry in the buffer zone areas of Royal Chitwan National Park is already showing promising results.

Kumrose Community Forestry

Kumrose VDC is decreasing the pressure on forest biomass by adopting biogas schemes. The initiative of the NGOs' Environmental Management Programme of IUCN Nepal has encouraged farmers to invest in biogas plants. As a result, the stall feeding of cattle and livestock has become the usual practice rather than the exception in this VDC that adjoins RCNP.

Mr. Dan Bahadur Dahal of Kumrose Village Development Committee is the chairperson of the Forest Users' Group which covers over 1,200 ha of land adjoining Royal Chitwan National Park. Once flooded and sand-covered, the area is now afforested enough to attract a large number of tourists on elephant back. They observe a rich assemblage of bird species and a number of one-horned rhinoceros among the newly developed grasslands and forested areas. Mr. Dahal's FUG also earns money from elephant-grazers who face shortages of grass elsewhere in the district. He aims to develop his area as a "Village Park" in order to harvest biomass to meet the community needs and earn more money from tourist visits.

Mr. Dahal's continued enthusiasm and the collective realisation of this community have set an example, showing that conservation is key to their survival. Initial support from the Small Farmers Development Project, CARE Nepal, and the King Mahendra Trust for Nature Conservation were vital in his successful reversion of sand dunes into forests and fleeing farmers into prosperous peasants.

Government Managed Forest

This is a national forest managed by HMG/N. The government must grant a license for the utilisation, removal, sale and distribution, and the export or transportation of forest products from national forests. Meanwhile, any part of a national forest may also be declared a protected forest on the basis of its special environmental, scientific or cultural importance. Opportunities to protect pocket forests of high biodiversity value such as the mixed broad-leaved forest of Prok VDC in northern Gorkha, the rhododendron forest between Bimtang and Bhute southwest of Larke La (McEachern et al., 1995), and a number of other similar sites all over Nepal are imminent.

National forests at high altitudes in the upper temperate and sub-alpine zone between 2,800m and 4,200m are rich areas for biodiversity conservation. They belong mostly to national forests that have yet to be allocated to any of the five management categories (W.J. Jackson, M.C. Nurse and R.B. Chhetri in Banko Jankari Vol. 4, No. 1, March 1993). Forest degradation and loss of species have been reported from many parts of Nepal (Jackson et al., *ibid*). Conservation plans are thus badly needed for the high altitude forests all over the country.

Sacred Forest/Religious Forest

The literature of both the Hindu and Buddhist faith attest to the long tradition of the Nepalese people in worshipping a tree, forest or sacred

landscape consisting of trees and shrubs. Panchakuti Vana, Brindra Vana, Shleshmantak Vana, Lumbini Vana, and a host of other locations are associated with epics, mythology, and history. Tigers, deers, birds, serpents, and other wildlife species are closely linked to such forests. The antiquity of sacred forests can also be seen in most cultures in isolated, community-managed patches of forests or small groves of trees all over Nepal. Such forests and groves occur in the cultures of the Tharus, Dhimal, and Santhals of the Tarai; the Chepangs, Tamangs, Magars, Gurungs, Newars, and Thakuris of the midhills; and the Sherpas, and Bhotas of the high Himalayas. A number of authors have referred to the occurrence of fine examples of matured forest in the context of managing them as sacred forest. Ingles (1990) refers to several authors who have located specific areas of sacred forests under the active protection of monks, priests, guthi, and the local community. The NCS (1988) has put the emphasis on religious forests managed under guthi tenure. Two of these are in the Kathmandu Valley – one at Swayambhunath and another at Pashupatinath – and are World Heritage Sites. The forest of Swayambhunath is actually the type locality of 27 flowering plants. Sacred sites such as Bajrabarahi and Dakshinkali have become a popular destination for worship and picnics. The biodiversity value of Bajrabarahi forest has been investigated by IUCN Nepal and the prospect of using the matured forest as a seed bank for indigenous trees will be fruitful for the local community.

Bajrabarahi Nature Conservation Project

Near the ancient town of Chapagaun lies the temple of Bajrabarahi, surrounded by forest. Bajra means lightning and Barahi means wild boar. Bajrabarahi is one of the four deities guarding the inhabitants of the Kathmandu Valley. Devotees come to worship with the milk given by cows, buffalo or goats after the birth of their offspring and pour it over the sitting he-buffalo made of stone. This could be the only place in the country where the buffalo is worshipped. Generally, they are one of the five species used primarily for sacrifice and meat. There is a common belief that it is a sin to collect twigs and leaf litter from this forest. Cutting trees is forbidden. Locals believe that the cutting of trees brings bad luck. In the ancient texts, jackals and white snakes have been mentioned as occurring in and around this forest. The betel nut trees of this forest are considered sacred. The flora and fauna enjoy the protection provided by the local people.

With the passage of time, some of the ancient towns of the Kathmandu Valley have emerged as metropolises. The villages surrounding Bajrabarahi have also experienced

change. A new breed of visitors have started visiting this sacred forest besides the devotees. The traditional values are being undermined; the pleas of the deity's patrons, i.e., "the old peoples" go unheeded; and the exploitation of the forest continues. The urban people have chosen this site as a destination for picnics during the weekends. A few local people have resorted to collecting wood in order to sustain their fuel supply and economy. Saplings have been crushed by four-wheel vehicles and motorcycles. The weekenders set up their makeshift kitchens at the base of trees and litter the forest with garbage. Accompanied by livestock encroachment and cultivation, these activities kill the saplings and trees. All this has slackened the process of regeneration of the forest.

The forest of Bajrabarahi is one of the last remaining natural climax forests found on the valley floor. Dominant tree species are chestnut (*Castanopsis indica*), chilaune (*Schima wallichii*), oak (*Quercus glauca*), and *Albizia* spp. There are over 6,000 standing trees belonging to 30 species in this 18 hectare forest. The maximum height reached by chilaune (*Schima Wallichii*) and khari (*Celtis australis*) is 38m. Realising the significance of the forest, a group of young people from Chapagaun, the members of Jyoti Daya Sangh, have come to the rescue of the forest. They have proposed a Bajrabarahi Nature Conservation Project (August, 1995) after approval by the local people and the temple priest. The group approached IUCN Nepal and Environmental Camps for Conservation Awareness (ECCA) for their help in protection and management of the forest. IUCN Nepal and NGOs Environmental Management Programme (NEMP) supported by USAID provided financial and technical support. As an immediate relief package for the forest, the young people have organised a clean-up campaign, environmental awareness raising and as education programme for students. Part of the forest was fenced, vehicular traffic was banned from entering the forest, dustbins were placed in picnic areas, and saplings were planted. A pay-parking area was designated on the outskirts of the forest. A forest guard and parking fee collector were also appointed. The natural history of this forest was highlighted by placing billboards with the names of the representative bird and plant species.

The initial campaign has been successful and the local people also have appreciated the effort. For the long-term management of this forest, two types of programmes were identified, namely conservation and development projects. The conservation projects include the establishment of an indigenous plant nursery where indigenous plants will be grown to replenish the vanishing forest and to sell the sapling to visitors as "prasada." To encourage natural regeneration of flora, part of the forest will be fenced to create an "island" forest. Nursery and dead trees will be included in the island to provide a habitat for the flora and fauna depending upon it for sustenance. An orchid garden will be established for the display of indigenous species and a wild garden will be developed within it. The garden will have a small water pool, sand bath, and nest boxes to encourage bird species to visit and nest. Trees along the access trail to the temple will be tagged as part of the "know your trees" campaign. Similarly, the names and pictures of large vertebrates will be printed on billboards to encourage the idea of dissemination of awareness through programmes such as "know your animals." A guided trail system has been planned for exploring the forest and a bamboo check-dam will be constructed to control soil erosion by the stream. Local students will be trained for wildlife monitoring. Deer and native ornamental bird species provide additional attractions for visitors. The development project also includes programmes such as forest fencing, stone paving of the access trail up to the temple, and shelter renovation. Future plans include the provision of water tanks, dustbins, waste disposal pits, makeshift kitchens in the picnic area, and the placing of billboards with do's and don'ts and other messages in the forest area. The old water holes are the perennial source of water; they will be renovated to provide an additional supply of water to the visitors. Local participation is anticipated for the protection of the forest.

The presence of religious forests in heavily modified landscapes provides a refuge to species which may otherwise have become locally extinct (Ingles, 1994). Religious forests which are remnants of climax forest types also serve the purpose of research sites for measuring or monitoring the environment and biodiversity. Opportunities for conservation and management of religious forests have been widened with the legal recognition of religious forests as a category of community forest. However, any action plan undertaken without a clear-cut strategy to conserve religious or sacred forest will remain incomplete and unfulfilled.

b) Non-Timber Forest Products

Non-timber forest products (NTFPs), is a new name for Minor Forest Products (MFPs), which was used in Nepalese forestry for over half a century. Another term used especially in FAO literature is Non-wood Forest Products (NWFPs). Among these terms, the common factor is the forest product which is not wood/timber.

Forest Products from Non-Timber Forests

A forest ecosystem consists of trees, shrubs, herbs, epiphytes, parasites, saprophytes, and micro-organisms. Harvesting various components of the ecosystem except the wood means harvesting NTFPs: these include medicinal and aromatic herbs, spices and condiments; bast fibres and grasses for paper pulp or textile fibre; wild edibles like ferns, rhizomes, mushrooms, vegetables and fruits; fodder grasses, leaf litter and manure. Other important products are rattens, canes, bamboos and lianas. Gathering NTFPs should be viewed as a way of harvesting the ecosystem to help it maintain an optimal level of regeneration. It is a sort of "milking" of the forest ecosystem.

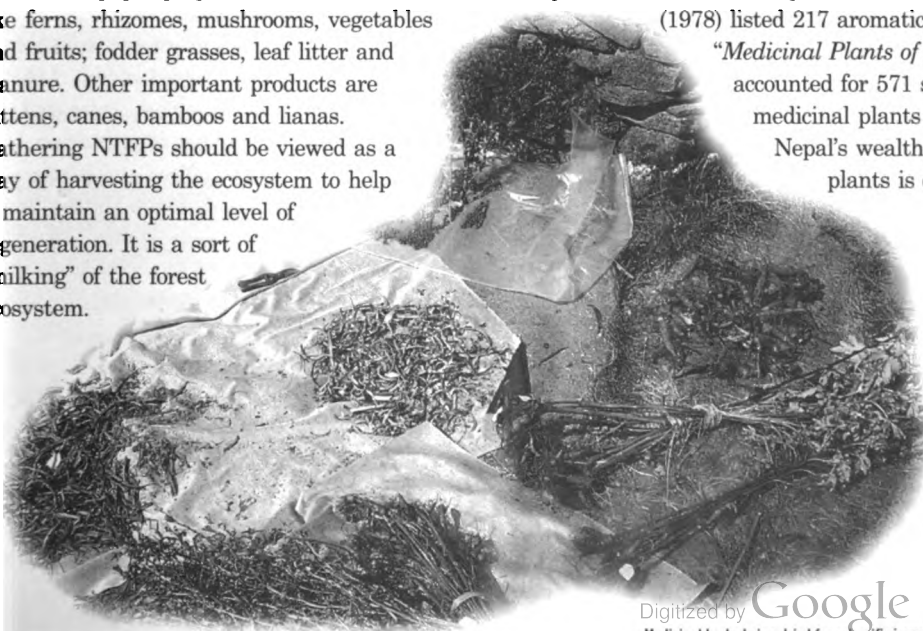
Non-Timber Use of Forest Trees

A tree is just not a mass of wood. It is an ecosystem by itself. Harvesting a tree without harming it is also a significant part of the NTFP concept. A large number of forest seeds and fruits such as sal seeds (*Shorea robusta*), rudraksha (*Elaeocarpus ganitris*), lapsi (*Choerospondias axillaris*), kafal (*Myrica esculentum*), bael (*Aegle marmelos*), and ritha (*Sapindus mukorosi*) are of high economic value. Harvesting sal leaves is a long tradition in Nepalese culture. Similarly, leaves for fodder, thatch, animal bedding, and farm manure are collected mostly from forests. Trees are also the producers of industrial raw materials such as rosin and turpentine, tannin (katha etc.), vegetable oils, fats, and a large number of aromatic and chemical substances.

NTFPs in the Ecosystem

Promoting NTFPs for the growth of the rural economy should also have a positive impact on the environmental health of Nepal. However, there is a need for a change of policy so that (i) local groups are trusted as guardians of their natural resources, (ii) herb dealers and middle-men are brought in as business partners for NTFP promotion, and (iii) scientists and researchers are respected forces guiding the process of conservation and development.

Malla and Shaky (1984/85 in Majupuria) enumerated 510 species of medical and aromatic plants (MAPs) from Nepal. Adhikari and Shaky (1978) listed 217 aromatic plants. The "Medicinal Plants of Nepal" (1993) accounted for 571 species of medicinal plants from Nepal. Nepal's wealth of medicinal plants is contained in its



natural ecosystem. The loss of natural vegetative cover contributes to the loss of medicinal plants. Deforestation and degradation of Tarai forests has resulted in the decline of *Rauwolfia serpentina* (sarpagandha); the decline of *Dioscorea deltoidea* (bhyakur) is attributed to the deforestation of the midhills; and the loss of orchids from eastern Nepal's midhills is a direct consequence of the expanding tea gardens and agricultural encroachment on natural forests. It is reasonable to assume that if there is a strategy to market the ecosystem through the sustainable use of NTFPs, their ecological balance will be ensured. It can also be argued that bird and wildlife ranching and agro-forestry practices should provide added incentives to the rural people to conserve natural forests and to practice reforestation.

Non-timber or non-wood use of trees and forests is generally friendly to the environment, but appropriate harvesting guidelines are necessary. Harvesting exodus (rosin, turpentine), roots and rhizomes (rhubarbs, aconites, jatamansi, etc.), bark (cinnamonum, taxus, berberis, etc.), wood (katha, cedar oil, etc.), leaves (lemon grass), live plants (orchids, ferns, etc.), and other products like mushrooms, lichens, mosses and micro-organisms requires the development and adoption of appropriate technology, including biotechnology. The collectors of these NTFPs are often rural people who rely on their traditional skills and local technology. Scientists and researchers must provide them with improved technology, and the government should fix the rights and responsibilities in order that these resources are properly managed.

Several of the non-timber forest products have entered into domestic and international markets. Although of those products are plant-based, there is also a great potential to harvest wildlife species such as pheasant, deer, and wild boar. Current treatment would, however, be limited to the following plants and plant products:

1. Medicinal and aromatic plants
2. Lokta paper (bast fibres)
3. Allo (nettle fibres)
4. Canes, rattans, and bamboos

Medicinal and Aromatic Plants (MAPs)

Plants with medicinal and aromatic properties occur throughout the plant kingdom. Nepal's bioclimatic diversity, which ranges from tropical jungles to alpine meadows, offers enormous

opportunity to harvest such NTFPs. Indigenous people use plants for medicine, food, and vitamin supplements. The plants have many domestic uses, such as fibres, vessels, baskets, and pots and as thatching materials. However, contributions to cash income generally come from the sale of MAPs to middle-men. Over 50 items of crude herbs and aromatic plants are known to be sold from Nepal to India and China. This has been happening since time immemorial.

Medicinal and aromatic plants, as a valuable component of Nepal's biodiversity, need to be examined with a view to the returns they could bring to the village collectors. The role of various government, quasi-government, and non-governmental organisations with supporting international organisations deserves to be discussed in the light of sustainable harvesting.

Role of Concerned Agencies in MAP Development and Conservation

Issues relating to the utilisation, marketing, research, and development of MAPs fall into the realm of a large number of organisations, both governmental and non-governmental. They range from groups of local collectors and cultivators to custom officers and policemen at borders. These agencies may be categorised into four broad groups as follows:

Direct Beneficiary Agencies – Herb collection from the wild is a group endeavour. Local groups are organised for the collection and sale of their commodity. These local groups are supported by NGOs through issues related to conservation and general awareness. Revenue collection from MAPs is carried out by district forest offices. Sales and export is done through a number of marketing mechanisms. Border customs offices and border police posts are the main check points for revenue collection and security management. While the forest offices execute their authority by issuing permits for the exploitation of MAPs, the customs office and police check posts oversee national interests and legal provisions. Industrial concerns such as Herbs Production and Processing Company Limited (HPPLC), Royal Drugs Limited, and other pharmaceutical industries such as Gorkha Ayurved Company and Singha Durbar Vaidhya Khana benefit from processing and manufacturing. All this results in disparity in benefit sharing among herb

collectors, herb dealers, and manufacturing companies.

Research and Development Agencies – The Department of Plant Resources (formerly created as the Department of Medicinal Plants) devoted over 30 years to enhancing national capabilities for resource identification, chemical evaluation, scientific extraction methods, and drug development. The department has also endeavoured to organise herbal farms in various ecological zones. Its linkages with the marketing network and the law enforcement network have not developed sufficiently to provide it with any strength in MAP conservation and development. The Forest Survey and Research Office under the Department of Forest provides scientific and socio-economic inputs to NTFP development and conservation. At Tribhuvan University, RECAST (Research Centre for Applied Science and Technology) devotes itself to developing technology for the extraction of chemical substances from MAPs.

Law Enforcement Agencies – The Department of Forest is the sole implementor of forest laws encompassing NTFPs. Its authority to issue collection permits and collect government royalties could well be effectively utilised for the sustainable harvest of NTFPs. The figures from the Middle and Western Development Regions suggest that large quantities of NTFPs (61.4% in MDR and 77.1% in WDR) are categorised as “other” items, i.e., not known precisely (Table 24). There remains a great scope for improvement.

The protection of the endangered species of flora and fauna under the Convention of Interna-

tional Trade on Endangered Species (CITES) falls under the jurisdiction of the Department of National Parks and Wildlife Conservation. There is no specialised section to deal with the endangered plants of Nepal. The authority to issue export certificates for plants rests with the Department of Plant Resources. However, border customs offices and border police checkpoints are not equipped with the information required to deal with NTFPs, which includes their identification.

Institutional Capabilities and Development Trends

The traditional institutions for herbal medicines can be traced back to community institutions such as *gurukul* for Ayurved, *gompas* (monastery) for Tibetan medicine and community priests, witchdoctors and *sudinis* for rural remedies.

The role of physicians in the Rana palaces was prominent as early as 1850 AD when the first Rana Prime Minister, Jung Bahadur, was accompanied by his personal physician during his voyage to England. The present Singha Durbar Vaidya Khana is said to have been established during his regime (Shrestha, 1979). It is still the only government unit for manufacturing herbal medicine in Nepal. Over 67 products are distributed through the Department of Ayurved into various parts of the country. The Department of Ayurved under the Ministry of Health has a 50-bed hospital in Naradevi, Kathmandu, and a hospital in Dang with 15 beds has recently been established. There were 85 dispensaries by 1979, this number has increased to 141 in 1995. Of the 75 districts in Nepal, only 15 have Ayurved health centres. The

Table 24 NTFP collection data: 2049/50

Development Region	% Volume		% Revenue	% Total Quantity	Average Revenue Rs/Kg
	Known species	Others			
Eastern	97.5	2.5	11.34	12.3	1.8
Central	38.6	61.4	11.12	6.78	3.3
Western	22.9	77.1	14.05	23.54	1.2
Mid-Western	89.8	10.2	44.87	35.75	2.5
Far Western	90.5	9.5	18.59	21.38	1.7

Source: Department of Forest, 1994.

Total Quantity: 5,678,513 kg

Total Revenue: Rs. 11,329,641

government has planned to add 5 centres each year. Some private companies such as Gorkha Ayurved Co., Dabur Nepal, and private dispensaries like Piyushvarsi Aushadhalaya and Krishna Aushadhalaya produce and dispense herbal medicines.

The Nepalese government made efforts to improve the export of herbs as early as 1937 AD. However, the idea of an organised department did not come to fruition until 1960 AD. The Department of Medicinal Plants, currently renamed the Department of Plant Resources, has oriented itself towards the scientific validation of and research into Nepalese medicinal plants. Major achievements of the Department include the establishment of the Royal Drug Research Laboratory, (now called the Natural Products Development Division), the Royal Botanical Gardens, the National Herbarium, experimental herbal farms, and extraction units. At present, the Herbarium houses about 100,000 specimens and has an ethnobotanical museum attached.

The Natural Products Development Division is organised to undertake pharmacognostical and phytochemical studies along with biological research work and technology development. The Division also runs a pilot plant to help enhance the processing technology of medicinal and aromatic plants. A pharmacognostical museum with dried crude drugs and preserved plant materials provides services to herb dealers for the identification of crude herbs. The government has also established Herbs Production and Processing Co. Ltd. to process medicinal and aromatic plants for domestic use and for overseas export.

Government efforts to institutionalise Tibetan medicine have not yet materialised in Nepal. The Ministry of Local Development with its programme under the Remote Area Development Committee has been promoting Tibetan medicine in the remote areas that border Tibet.

The Japan Chapter of the King Mahendra Trust for Nature Conservation is promoting research work on Tibetan medicine in Mustang District. IUCN is assisting teaching institutions at Tengboche Monastery near Mount Everest to incorporate Tibetan medical curricula into their teaching process and to cultivate indigenous herbs in the vicinity. Research centres like the Tibetan Medical and Astro Institution in Dharmashala, India; Chagpori Tibetan Medical Institute in Darjeeling, India; and the National Institute of

Traditional Medicine in Thimpu, Bhutan are active in promoting Tibetan medicine.

It is to be noted that institutions for herbal medicine in Nepal made their advancements parallel to each other, and there has been no concerted effort towards integrated development. Plant research takes place within the Ministry of Forest and Soil Conservation; Ayurvedic services are undertaken by the Ministry of Health; and Tibetan medicine is promoted by the Ministry of Local Development.

NTEFPs in Development Plans

The Forestry Sector Master Plan (1988) defined MAPs and other forest products other than wood as minor forest products. FSMP focused on seven such products: (1) medicinal and aromatic plants; (2) Lokta paper; (3) pine resin; (4) sal seeds; (5) katha; (6) sabai grass; and (7) canes and bamboos.

The Eighth Five-year Plan 1992-1997 set the following two objectives with regard to NTEFPs:

- to increase income and employment opportunities for small farmers and marginalised people in the forestry sector, and
- to conserve the ecosystem and biodiversity of Nepal.

The Forestry Sector Master Plan encourages the private sector to undertake the development of forestry-based industry. Such industries would be motivated to develop and manage leasehold forests.

The NCS (National Conservation Strategy 1988) has duly emphasised the conservation and development of medicinal plants. This has been done not only to help alleviate the poverty in the villages but also to increase national income. NEPAP (Nepal Environment Policy and Action Plan 1988) recommended reorientation of forestry research by developing programmes to provide information (including utilisation of the so far unused or lesser known forest species) for users' groups, forest industries, and private individuals.

'Agenda 21' of UNCED emphasises alternative livelihood opportunities for people, especially in the context of sustainable mountain development. It explicitly mentions that the government should undertake income generating activities such as the cultivation and processing of medicinal and aromatic plants.

Medicinal and aromatic plants at present have their market at a location too far from their place of origin. Medicinal herbs and crude drugs

make a long journey from their mountain homeland to manufacturing companies. The marketing network, dubbed "The Jadibuti Trail" by Manisha Aryal (1993), has been in operation for a very long time. Even during the early 1960s, the mountain people were heavily exploited. They still do not get their fair share from the herbal trade and the story has not changed. "... *mountain peasants get to see only a tiny fraction of the profit. It is a historically secretive trade and little is known about who collects, who trades, who profits and whether there is over-harvesting. Clearly, though, the economic future seems to lie not in timber, but in minor forest products, including herbs.*" (Aryal 1993). All those years from 1960 to 1990 and onwards, the governments' efforts were a threat to traders and middlemen. Even the establishment of Herbs Production and Processing Company Limited (HPPCL) is viewed as a competitor to existing private trading companies. A shift in policy is thus required, whereby the government does not try to replace but to replenish private companies with a full but legitimate participation in the herbal trade.

Important NTFPs Found in Nepal

Fibre Plants

A large number of plants in Nepal provide fibre which is used in the production of cordage, net, cloth, paper, and matting. Traditionally, the hemp fibre (*Cannabis sativa*) and the nettle fibre "allo" (*Girardinia diversifolia*) are widely used by mountain communities. Recently allo has emerged as a new product for cottage industries and in the manufacture of handicrafts. The entrepreneurial capacity of the people of the conservation area buffering the Makalu Barun National Park is being expanded to help them diversify the use of this mountain nettle. Experiments have been conducted adding wool yarn or cotton and using broader looms to produce marketable items. Earlier, the Koshi Hill Area Rural Development Programme explored various prospects of developing allo in terms of its harvesting and spinning methods (Susi Dunsmore, 1993). "Allo" fibre is found to be among the longest botanical fibres and is smooth and lustrous.

The allo plant occurs at 1,200m to 3,000m in the moist temperate regions of Nepal, especially

under the shade of mixed deciduous forests of oak, maple, magnolia, and cherry.

Hemp (*Cannabis sativa*) is a traditional source of fibre used to weave a coarse cloth "bhangra" and "gado". The white bast fibre is known to be one of the finest fibres for high-value textiles. However, the narcotic value of this plant is detrimental to the promotion of its cultivation and commercialisation. In Nepal, it grows as a farm weed and covers waste land. Its wide range of distribution from below 500m to about 3,000m allows selection of the optimum quality of various products, i.e., seeds for cooking oils, young leaves and latex for medicinals and narcotics, and stems for fibres.

Lokta

Lokta paper is one of the most well known NTFPs in Nepal. It is obtained from the bast fibre of the shrubs *Daphne bholua* and *D. papyracea*. The plant grows as an under-storey shrub in oak-rhododendron forest or in mixed coniferous forests at 1,500m to 3,000m, under generally humid conditions. Bark is stripped from the stem of living plants, which ultimately leads to the destruction of the plant. The emerging concern over sustainability is gradually being understood by local collectors and coppicing above ground is now being practised by the villagers. The new method of treating pulp with chemicals such as caustic soda has also contributed in minimising the use of wood ash as an alkaline material. Lokta plants are dependant on the support of mature forests. The sustainable harvesting of lokta plants would therefore be the function of forest conservation.

Wild Edibles and Fodder Plants

Over 90% of Nepalese people live at the interface of farms and forests. A large number of plants and plant products are still used as food supplements in the rural areas. In times of drought and famine, people depend upon wild yam, fruit, and vegetables from nearby forests. Ethnobotanical knowledge among various communities is strong but there is a rapid decline of knowledge in the younger generation who tend to migrate elsewhere for jobs. Knowledge about the local uses of plants has not yet been systematically recorded. Manandhar (1980) has recorded over 100 species of plants used for food in Nepal. The Department of Medicinal

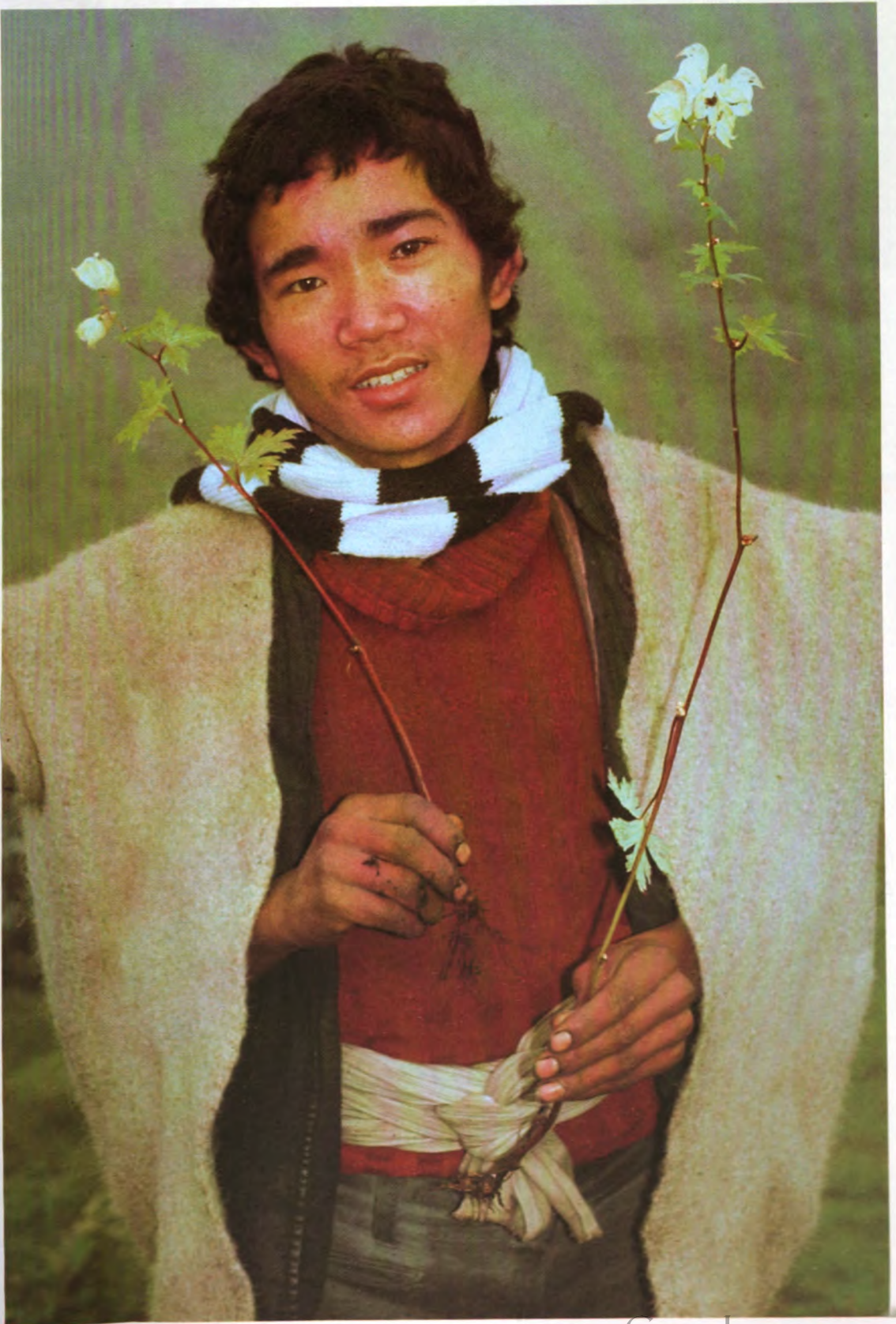
Plants has produced an illustrated inventory of 133 plants which are used as edibles in Nepal (Nepali Khadya Kandamoolharu, 1982).

The list includes the tubers of *Aspargaus racemosus* from 150m in the Tarai region to the tubers of *Arisaema flavum* at 4,000m in the sub-alpine region. In general, the shepherds and herders are knowledgeable in the use of wild plants. How their knowledge can be harnessed for the development of biological resources and how ethnobotanical research can be linked with community development is something that needs to be addressed in the context of implementing the Convention on Biological Diversity.

There is now a general consensus that local people should benefit from any study and research that seeks to discover the secrets of the forest, assess its economic value and conserve it (Gary J. Martin, 1995). There is a general tendency among villagers in Nepal to preserve useful plants such as fodder trees and fruit trees on their own farms. Over 55 species of fodder trees are found in the Arun Basin (Shrestha, 1989) and a number of these are cultivated in and around farmlands (*Saurauja napaulensis*, *Ficus racemosa*, *F. semicordata*, *Garuga pinnata*, and *Bauhinia purpurea*). However, these species are very rare in the forested areas outside villages and farmland (K.K. Pande, 1982).

High altitude shepherds are excellent collectors of medicinal herbs. Their indigenous knowledge regarding identification and use of crude herbs is to be appreciated.





The Himalaya is not only the abode of snow and the so-called abominable snowman, but is also an abode rich in livestock animals such as the yak. Hybridisation between high altitude animals such as the yak (male) and nak (female) with low altitude cattle (cow and ox) is a specialised skill developed by the Sherpas of Nepal.



Efforts to Protect Biodiversity



1. International Conservation Tools

Convention on Wetlands of International Importance, Especially as Waterfowl Habitat, 1971 (Ramsar Convention)

In view of the fundamental ecological function of wetlands as regulators of water regimes and as habitats supporting characteristic fauna, especially waterfowl; the broad objectives of the Ramsar Convention are to reduce the loss of wetlands and to ensure their conservation. It is one of the most important legal instruments of international wildlife law (Lyster, 1985).

Each party to the convention is obliged to designate suitable wetlands within its territory for inclusion in the List of Wetlands of International Importance. At least one wetland must be included in the list when the convention is signed, or when an instrument of ratification or accession is deposited. Parties to the Ramsar Convention are obliged to formulate and implement planning measures to promote the conservation of wetlands included on the list and to use wetlands in their territory as wisely as possible. While the Convention does not specify whether this obligation is limited to the wetlands included on the list or extends to the wetlands that are not inscribed on the list, Simon Lyster suggests that according to Article 3 (1) the parties to the Ramsar Convention are required to formulate and implement planning to promote the wise use of wetlands in their territory, whether or not the wetlands are included in the list (Lyster, 1985).

Article 4 (3) requires parties to encourage research and promote the exchange of data and publications regarding wetlands and their flora and fauna. Similarly, under Article 4 (5), parties are required to promote the training of personnel competent in the fields of wetland research, management, and wardening.

Nepal acceded to the Ramsar Convention on 17 April 1988 (Koester, 1989). The government has not yet recognised that the current legislation in Nepal precludes optimal fulfilment of the convention's obligations (Belbase, 1993). There is limited legislation, which provides only a modicum of wetlands conservation and has

glaring deficiencies. Nepalese legislation lacks a definition for the term 'wetland' and the reclamation of wetlands is not prohibited by law. The government has not yet developed a management plan for the conservation of its only wetland included in the Ramsar List, i.e., Koshi Tappu Wildlife Reserve. Unless the government formulates and implements a well-defined wetland policy and management plan, it cannot fulfil its obligations to the convention.

Convention Concerning the Protection of World Cultural and Natural Heritage, 1972

The World Heritage Convention imposes various obligations on its members. These range from the identification and conservation of cultural and natural heritage to handing down such heritage to future generations. Under Article 4, each party to the Convention has a duty to identify, protect, conserve, present, and transmit to future generations the country's cultural and natural heritage to the best of its ability.

In order to ensure the effective protection, conservation and presentation of cultural and natural heritage, Article 5 of the Convention provides that each party is required, in so far as it is possible, to:

- adopt a general policy which aims to give the cultural and natural heritage a function in the life of the community and to integrate the protection of that heritage into a comprehensive planning programme;
- set up within its territories, where such services do not exist, one or more services for the protection, conservation, and presentation of the cultural and natural heritage with an appropriate staff possessing the means to discharge their functions;
- develop scientific and technical studies and research; and to work out such operating methods as will make the state capable of counteracting the dangers that threaten its cultural or natural heritage;
- take the appropriate legal, scientific, technical, administrative, and financial measures necessary for the identification, protection, conservation, presentation, and rehabilitation of this heritage; and
- foster the establishment or development of national or regional centres for training in

the protection, conservation, and presentation of the cultural and natural heritage and to encourage scientific research in this field.

Protection of world heritage sites is an international obligation shared by all countries. Further, each state party is obliged not to take any deliberate measures which might damage, directly or indirectly, the cultural and natural heritage situated on the territory of other states which are parties to this Convention. The broad prohibition of indirect harm could apply to development-assistance programmes which affect the environment or to local activities causing trans-boundary pollution that result in harm to a site (Kiss and Shelton, 1991).

Nepal became a party to the World Heritage Convention in June 1978. Nepal's eight cultural heritage sites including the birthplace of Buddha, Lumbini; and two natural heritage sites are inscribed in the World Heritage List. Nepal has taken various legislative and policy measures for the conservation of its national heritage.

The National Conservation Strategy for Nepal, the Nepal Environmental Policy and Action Plan, and the Ninth Plan provide the policy basis for conservation of cultural as well as natural heritage. Similarly, the Town Development Act, 1985; the National Parks and Wildlife Conservation Act, 1973 and the Ancient Monuments Protection Act, 1956 provide a legal basis for the conservation of Nepal's heritage.

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

Illegal trade in endangered flora, wildlife, and derivatives (trophies) occurs throughout the world, which is presently witnessing the extinction of animal and plant species unparalleled since the age of the dinosaurs (Happes and McFadden, 1987). Tragically, the majority of these modern extinctions correlate directly with human-related activities, stemming in many instances from human ignorance and, more often than not, human greed. Many countries and the international community have taken various steps to prevent this illegal trade. The worldwide effort to protect the endangered species of animals and plants has never been more portentous than it is today (Happes and McFadden, 1987). The Convention on International

Trade in Endangered Species of Wild Fauna and Flora, 1973 (CITES) is one outcome of the international community's efforts. CITES entered into force on 1 July 1975 and Nepal became a contracting party to the Convention on 18 June 1975 (UNEP, 1993). CITES primarily provides for the international coordination of trade controls on wild fauna and flora, whose conservation status is unfavourable, through the acceptance of obligations under international law. Its principles have been widely accepted by a large number of states and have been implemented and enforced with considerable success (Llemm and Shine, 1993). The goal of the treaty is to control, reduce or eliminate international trade in those species whose numbers or conditions suggest further removal of individuals from their natural habitat would be detrimental to the survival of the species (Favre, 1989).

Although the National Parks and Wildlife Conservation Act is the principal piece of legislation for implementing CITES in Nepal, the Forest Act of 1993 has a similar responsibility. District forest officers have to resort to the Forest Act when CITES has to be implemented beyond protected areas, conservation areas or national parks.

Despite Nepal's obligations under CITES, the poaching and trade of rare wildlife specimens continues. There is ample anecdotal evidence to support this. Within the ten months between June 1993 and April 1994, five rhinos and ten tigers were killed in Nawalparasi district (Pandey, 1994). Bears are also being illegally hunted for their skin and gallbladders.

In a survey conducted in Kathmandu, it was found that 65 out of the 76 handicraft and souvenir shops visited sold fur coats and 7 sold other fur products. As many as 1,225 fur coats were counted during the course of this survey, 255 made from the fur of medium-sized and small cats of three species; the fishing cat, the jungle cat, and the desert cat (Heinen and Leisure, 1993). Such poaching poses a terminal threat to already reduced wildlife species.

By requiring the establishment of independent scientific authorities, CITES is in essence making countries monitor the status of Appendix I and II species in their areas before allowing them into trade. This is arguably one of the most important features of CITES. The designated management authorities of the state responsible for export fulfil an equally important role, making decisions *inter alia* that the specimens of species

listed in Appendix I, which are to be exported, were not obtained in contravention of the laws of that state for the protection of fauna and flora. The management authority is the one with the ultimate authority, in that it issues the permits, certificates or exemptions, and is the point of contact for communication for this purpose with the Secretariat and all other parties to CITES.

There has been no specific enactment of legislation in Nepal to implement its obligations under CITES. However, certain administrative measures have been undertaken. The NPWC Act prohibits, to some extent, the taking and exporting of specimens of species except with a license. In order to establish decision-making authorities under CITES, HMG has designated the Natural History Museum as the scientific authority. Similarly, HMG has designated the Department of National Parks and Wildlife and the Department of Plant Resources as the management authority for the trade of animals and plants.

Convention on Biological Diversity, 1992

Obligations Under the Convention

Under Article 6(a), parties are required to develop national "strategies, plans or programmes" for the conservation and sustainable use of biological diversity. This essentially creates an obligation for national planning. The aim of the strategies, plans or programmes prepared or adapted by the party is to make concrete the requirements of the Convention in that country, as relevant to the national context.

Article 6(b) requires parties to integrate the conservation and sustainable use of biodiversity into the relevant sectoral or cross-sectoral plans, programmes and policies. It attempts to address a major issue that exists in many countries, whereby different sectors are inflicted with their own bias —while the responsibility of conserving biological diversity is left to one authority, each sector's activities contribute to the loss of biodiversity. The integration of conservation and the sustainable use of biodiversity into the plans, policies and programmes of sectors such as agriculture, forestry, mining, industry and water resources is crucial to achieving the objectives of the Convention.

Identification and Monitoring

Article 7(a) obliges the parties to identify those components of biodiversity that must be safeguarded to ensure their conservation and sustainable use. Article 8(1), requires parties to regulate or manage the processes and activities identified under Article 7(c) if they have been found to have significant adverse effects on biodiversity.

In situ and Ex situ Conservation

The Convention recognises in situ (on site) conservation as the primary approach for biodiversity conservation, by protecting species and ecosystems at their place of origin. Under Article 8, parties are required, among other things, to (i) establish a system of protected areas or areas where special measures need to be taken to conserve biodiversity; (ii) rehabilitate and restore degraded ecosystems, and promote the recovery of threatened species; (iii) prevent the introduction of, control or eradication of alien species that threaten ecosystems, habitats or species; (iv) develop or maintain the necessary legislation and/or other regulatory provisions for the protection of threatened species and populations; and (v) where a significant adverse effect on biological diversity has been determined, to regulate or manage the relevant processes and categories of activities in that area.

The Convention envisions ex situ (off site) conservation as the complement of in situ approaches. Under Article 9, parties are required to adopt measures for ex situ conservation of the components of biodiversity, and establish and maintain facilities for such conservation and research on plants, animals and microorganisms, preferably in the country of origin or country of origin of genetic resources.

It also provides for the regulation and management of the collection of biological resources from natural habitats for ex situ conservation purposes, so as not to threaten ecosystems and in situ species.

Sustainable Use of the Components of Biodiversity

The Convention calls for consideration of the conservation and sustainable use of biological resources in national decision-making. Unless the conservation and sustainable use of biodiversity is integrated into relevant sectoral and cross-sectoral

plans and programmes, as well as in national decision-making, it will be almost impossible for any party to fulfill the obligations of the Convention and maintain essential ecological processes and life-support systems. Furthermore, under Article 10, parties are required to support local populations to develop and implement remedial action in degraded areas where biodiversity has been reduced, and encourage cooperation between government authorities and the private sector in developing methods for sustainable biological resource use.

Impact Assessment and Minimising Adverse Impacts

Under Article 14, parties are obliged to introduce environmental impact assessments (EIAs) for proposed projects that are likely to have significant adverse effects on biodiversity, with a view to avoiding or minimising such impacts. Parties are also obliged to involve the public in EIA procedures and processes and to ensure that the environmental consequences of government programmes and policies are taken into consideration.

In the case of imminent or grave danger or damage to biodiversity within the jurisdiction of other states or in areas beyond the limits of national jurisdiction, Article 14(d) requires parties to notify the potentially affected states and initiate action to prevent or minimise such danger or damage.

Access to Genetic Resources

Each party is required to create conditions to facilitate access to genetic resources for environmentally sound use by other parties, and not to impose restrictions that run counter to the objectives of the Convention. The parties are required to grant access, on mutually agreed terms, subject to the provisions of Article 15.

Under Article 16, parties pledge to provide and/or facilitate access of and transfer to other contracting parties of technologies that are relevant to the conservation and sustainable use of biodiversity. It further requires parties to cooperate with intellectual property rights subject to national legislation and international law in order to ensure that such rights are supportive of and do not run counter to the objectives of the Convention.

Although Article 21 establishes a mechanism for the provision of financial resources to parties of developing countries, both developed and developing countries are primarily required to fulfill the

objectives of the Convention using their own resources. The effectiveness of the financial mechanism depends upon the level of contributions made by developed countries, which remains to be seen.

2. Constitutional Measures

The Constitution of Kingdom of Nepal 1990 requires the state to give priority to environmental conservation. Article 26(4) proclaims:

The state shall give priority to the protection of the environment and also to the prevention of its further damage due to physical development activities by increasing the awareness of the general public about environmental cleanliness, and the state shall also make arrangements for the special protection of the rare wildlife, the forests, and the vegetation.

It remains unclear what actual effect this provision will have because it is constrained within a supplementary set of legally unenforceable Directive Principles and Policies of the state which are supposed only to guide the state in the performance of its more fundamental constitutional obligations (Richardson et al., 1991). Having said this, it is apparent that those who framed the constitution realised that Nepal's rare wildlife, forests, and vegetation are in need of special protection. Article 24(2) stipulates that principles and policies contained in the Directive Principles and Policies shall be fundamental to the activities and governance of the state, and shall be implemented in stages through laws within the limits of the resources and the means available in the country.

Policy Measures

The National Conservation Strategy (NCS), prepared in 1987, has been implemented since 1988 in collaboration with IUCN. One of the objectives of the NCS is to preserve biological diversity and to maintain essential ecological and life support systems. The NCS also states that the single sector approach of government departments toward resource conservation is not conducive to maintaining biodiversity, which requires a comprehensive approach integrating the management of

all resource sectors. The NCS suggests that Nepal lacks a comprehensive national programme for the collection of inventory data related to ecosystems as well as a scientific catalogue of flora and fauna occurring within the Kingdom (HMG and IUCN, 1988).

The Environment and Resource Conservation chapter of the Ninth Plan (1998-2002) states explicitly that, among other things, (i) natural and cultural assets, biodiversity, and traditional conservation skills will be documented, scientifically analysed and upgraded; (ii) collection, genetic analysis, and documentation of important vegetation, endemic species, and other living resources will be carried out on a regular basis; and (iii) provisions will be made for *in situ* and *ex situ* conservation in different national parks, reserves, botanical gardens, and zoos. In addition, one of the objectives of the Ninth Plan for the agriculture, forestry, and land reform sectors is to develop national parks, wildlife reserves, and protected areas for the conservation and promotion of biodiversity. This is one of the most significant steps that the government has undertaken since the inclusion of a separate chapter on environment and resource conservation, and the objectives for the forestry sector will compel other government agencies to extend the appropriate consideration to biodiversity (Belbase, 1995). However, the time has come to review the achievements made during the Eighth Plan period and to formulate the policies and plans of the Ninth Plan on the basis of lessons learnt from the successes and failures of the Eighth Plan.

The Nepal Environmental Policy and Action Plan (NEPAP) chapter on biodiversity conservation recommends among other things, the (i) identification of wetlands significant to biodiversity conservation and their protection; (ii) development of management plans to conserve biodiversity; (iii) study to assess the status of biodiversity in endemic plants and animals both terrestrial and aquatic occurring outside of the protected areas; and (iv) the establishment of a national biodiversity database and identification and strengthening of institutions responsible for research, education, and training in biological resource management (Belbase, 1993). If NEPAP is effectively implemented, it will enable the government to fulfil its treaty obligations to some extent and to significantly conserve the biodiversity of Nepal. However, the government has to strengthen various technical bodies in an effective way to be able to implement the plan.

Legal Measures

The Aquatic Animals Protection Act (AAPA), 1961 provides for the legislative protection of the habitats of aquatic species. Section 3 of the AAPA renders punishable any party introducing poisonous, noxious or explosive materials into a water source, or destroying any dam, bridge or water system with the intent of catching or killing aquatic life. The AAPA has not been effective in protecting the biodiversity of aquatic ecosystems, as both noxious and explosive materials are increasingly employed. There is no reported case of a person being prosecuted for a breach of the AAPA (Belbase, 1993). Section 4 empowers the government to prohibit the catching, killing, and harming of certain kinds of aquatic animals through notification in the Nepal Gazette. However, a notice has yet to be published.

The conservation of ecologically valuable areas and indigenous wildlife is provided for by the National Parks and Wildlife Conservation Act (NPWCA), 1973. The NPWCA prohibits within the national parks, protected areas, and wildlife areas, among other things, the (i) hunting of any animals or birds; (ii) the clearing or cultivation of any part of the land or harvesting of any crop; (iii) the pasturing or watering of any domesticated animals or birds; (iv) the cutting, burning or damaging of any tree, bush or other forest product; and (v) mining.

The new Forest Act of 1993 recognises the importance of forests in maintaining a healthy environment. The Act requires decision-makers to take account of all forest values, including environmental services and biodiversity, along with the production of timber and other commodities. The basis of the new Act's approach to forest and forest products is "resource-oriented" rather than "use-oriented."

Section 23 empowers the government to delineate any part of a national forest, which has "special environmental, scientific or cultural importance," as a protected forest. The words "environmental, scientific or cultural importance" are important, as they are new in Nepalese legislation. The inclusion of these terms lends support to the conservation of biodiversity in areas that are located outside the national parks and reserves. The provisions relating to community forests are unambiguous and precise compared with those in the previous Forest Act, 1961, and

will be an effective tool for the conservation and sustainable use of biodiversity with the involvement of local community efforts. However, the NPWCA and the Forest Act should not be equated with endangered species protection legislation or biodiversity conservation legislation.

Nepal already has an institutional and legal framework that meets the obligations of the Convention regarding the *in situ* conservation of biodiversity, as in total there are 15 national parks and other protected areas, which cover over 15% of Nepal's land area. However, it does not fulfil obligations under other articles of the CBD, which include conservation and sustainable use, identification, and monitoring, promoting environmentally sound and sustainable development in areas adjacent to protected areas, rehabilitating and restoring degraded ecosystems, encouraging equitable sharing of the benefits of indigenous knowledge and practices with indigenous people, and developing or maintaining necessary legislation and/or regulatory provisions for the protection of threatened species.

The Water Resources Act, 1992, makes environmental study a mandatory prerequisite for water resource and electricity projects. For the first time in Nepal any person who desires to set up a water-related project must submit an application to the prescribed authority along with an economic, technical, and environmental study report submitted to the prescribed officer, otherwise a license to construct and implement a water-related project will not be granted. This provision tries to implement the obligations set down under Article 14 of the Convention on Biological Diversity with regard to water resources development projects. Similar provisions need to be included in other legislation such as the Forest Act, 1993.

The recently enacted Environment Protection Act 1996 is the only piece of legislation which defines biodiversity exactly in line with the definition provided by the Convention on Biological Diversity. The government is empowered to formulate biodiversity conservation regulations under this Act. Rule 31, 32 and 33 of the Environment Protection Regulations (1997) provide legal measures to regulate access to genetic resources. Rule 31 requires foreign organisations, institutions and any individuals or organisations affiliated with them to refrain from collecting samples of any microorganisms or vegetation, and not to undertake any respect to biological diversity within

Nepal, without the prior permission of the relevant government agency.

3. Buffer Zone Management

His Majesty's Government of Nepal has promulgated the Buffer Zone Management Regulations, 1996, on the basis of section 3 of the NPWC Act, 1973. This includes a provision to allocate 30% to 50% of the revenue from the park/protected area for community development in the buffer zone. This is a significant step towards biodiversity conservation. The regulations specify the need to prepare a management work plan for community development, environmental conservation, and the balanced utilisation in forest resources of the buffer zone. The rules include procedures for:

- Demarcation of the buffer zone;
- Preparation of a management work plan;
- Formation and registration of a users' committee;
- Defining prohibited activities within buffer zones such as land encroachment, forest fires, mining and excavation, using poisons or explosives in water bodies, and illegal hunting of wildlife;
- Provision of forest development;
- Community development, without duplicating the works of any other authorities, institutions, and offices;
- Establishment of a deposit account and prescription of compensation by the users' committee; and
- Other activities including permits to hunt animals other than endangered species, research permits and keeping track of immigrants and migrants.

The rules also provide for the formation of various types of forests in the buffer zone:

- Buffer zone community forests;
- Buffer zone leasehold forests for those living below the poverty line;
- Buffer zone religious forests; and
- Buffer zone private forests.

The Buffer Zone Regulations are primarily aimed at motivating people to remain environment-friendly and to practice sustainable use of

natural resources of the zone. They require the people and park authorities to aspire to the same goals and to work together. The authority regarding the Buffer Zone Management Regulations is vested in the Warden, the DNPWC and the Ministry of Forest and Soil Conservation. The smooth operation of the Buffer Zone Management Regulations is contingent upon the transition of authority from the District Forest Officer to the Wardens.

4. In Situ Conservation

Nature without human beings would perhaps be a perfect balance; however, human beings have co-evolved with this planet and have been a force in modifying nature and its dynamics. The unprecedented increase in human numbers and activities have impacted heavily upon the capacity of the earth to support such an increase. Caring for the Earth (1991) laid down guiding principles for all the world's people to live in harmony with nature. It recognises *in situ* conservation as the primary approach to protecting biological species from extinction. The establishment of national parks and protected areas has been regarded as the means for the *in situ* conservation of biodiversity. However, the concept of national parks has changed drastically over the last 125 years since Yellowstone National Park was created in 1872. The compass needle of that movement now points towards people, and conservation with the people has been emerging as an important agenda. In Nepal, Royal Chitwan National Park was established as the first protected area in 1973, i.e., 101 years after Yellowstone National Park. It was an appropriate though somewhat overdue response by His Majesty's Government of Nepal to protect the remaining population of the one-horned rhinoceros and other large mammals like the Bengal tiger, the sloth bear, the Asian elephant, the gaur bison, and certain other species. The flood of people migrating from the hills to the fertile Dun Valley and Tarai plains could hardly have spared the national parks had they not been guarded by armed forces. With over 20 years of experience in park management, the government has recently made legal provisions to channel 30% to 50% of

park revenue to the people in order to mitigate park and people conflicts. His Majesty's Government is collaborating with UNDP to execute the "Parks and People Project" with the aim of improving the socio-economic condition of the people living in the adjoining Village Development Committees of the five National Parks and Reserves in the Tarai region: (i) the Koshi Tappu Wildlife Reserve, (ii) Royal Chitwan National Park, (iii) Parsa Wildlife Reserve, (iv) Royal Bardia National Park, and (v) Suklaphanta Wildlife Reserve.

Nepal now has a fairly extensive network of protected areas that cover over 15% of its total land area. The middle hills of Nepal lying between the Himalayan region in the north and the Tarai/Siwalik region in the south are poorly represented in the protected area system. The possibility of designating a new park area is severely limited due to the lack of any sizeable pristine area. However, opportunities for *in situ* conservation of domestic flora and fauna are high. The traditional system of forest conservation and recent developments in community forestry are most promising elements for biodiversity conservation in this extremely diverse terrain.

Models of Protected Areas in Nepal

The management models developed for the 15 protected areas in Nepal consist of various mixes of IUCN categories based upon different socio-economic settings. Five such models of protected areas are operative in Nepal.

a) National Parks (NP)

Due to historical precedent, Nepal's National Parks are guarded by armed forces and are managed by the Department of National Parks

and Wildlife Conservation (DNPWC). They are classed under IUCN Category II and are restricted to human entry without a permit. They are administered through government rules. There have been a number of management plans prepared for various parks but none of them has been implemented. Most parks are sites of research and study, but the monitoring process has not been effective except for some large mammals like the Bengal tiger and the one-horned rhino. All of the national parks have protected wildlife species successfully, but they are not free from local conflicts with people living traditionally within the park, e.g., in Langtang and Sagarmatha or in the vicinity of parks such as Royal Chitwan and Royal Bardia.

b. Wildlife Reserves (WR)

Nepal has four wildlife reserves which are governed by a special set of wildlife rules laid down in 1977 (2034 BS). The Koshi Tappu Wildlife Reserve is a Ramsar Site, besides being the only habitat for wild buffalo. Parsa was established as an annex to the Royal Chitwan National Park, and Suklaphanta was set up as a savanna habitat for swamp deer. They are all guarded by the army and managed by the DNPWC. They may be classified under IUCN Category IV. The Shivpuri Watershed and Wildlife Reserve are also classed under this category. It is managed by a separate authority under the Department of Watershed Management.

c. Hunting Reserves (HR)

DNPWC manages a hunting reserve at Dhorpatan which is rich in blue sheep. It, too, is guarded by the army and is frequented by trophy hunting expeditions. There is no management plan, but DNPWC issues only a few licenses, thus limiting animal hunting.

National Parks

- ◆ An area set aside for conservation management and utilisation of animals, birds, vegetation or the landscape together with the natural environment.
 - ◆ Entry is restricted without a permit.
 - ◆ Guarded by the army.
 - ◆ Managed by DNPWC.
 - ◆ IUCN Category II.
-

Wildlife Reserve

- An area set aside for conservation and management of animal and bird resources and their habitats.
- Guarded by the army.
- Managed by DNPWC.
- IUCN Category IV.

Hunting Reserve

- An area set aside for the management of animal and bird resources for the purpose of sport hunting.
- Guarded by the army.
- Managed by DNPWC.
- IUCN Category IV.

d. Conservation Area

The classic example of managing a protected area without involving the army and working in close partnership with the local community was set by the Annapurna Conservation Area right from its establishment in 1986. The area is managed by a national NGO, the King Mahendra Trust for Nature Conservation (KMTNC). The Annapurna area is the most popular destination for tourists and trekkers, it bags a share of 60% of the tourists visiting Nepal. Tourism has become a major incentive for conservation, and awareness has become a major input for the success of ACAP management. Pilot stage implementation in one VDC (Ghandruk) in 1986 was replicated in 16 VDCs in 1990. ACAP now covers 59 VDCs forming the largest protected area in Nepal (Siddhartha Bajracharya, 1995). The area is managed mainly for the sustainable use of natural ecosystems. The revenue from tourism is directly used in community development. Nepal's Conservation Areas are classed under IUCN Category VI, i.e., Sustainable Use of Natural Ecosystems.

His Majesty's Government has declared a new conservation area "Kanchanjunga Conservation Area" in eastern Nepal. The area covers, 1,650

sq km and borders Sikkim (India) and Tibet (China) on its eastern and northern boundaries. With initial support from WWF, HMG is developing this area as a new destination for ecotourism. Local NGOs are being encouraged to participate in the conservation endeavour.

e. National Park-cum-Conservation Area

The Makalu Barun National Park and Conservation Area is a mix of several IUCN categories, i.e., Category I, II, and VI. This national park (Category II) stands as a core with a buffer of Conservation Area (Category VI), while a zone of Strict Nature Reserve (Category I) and an enclave for tourism development (Category V) are also included in the park area (Shrestha et al., 1989). Scientific research is an integral part of its management plan. Unlike other national parks in Nepal it does not have an army to protect it. In essence, this protected area is like the biosphere reserve of the UNESCO/MAB programme, except for its linkages with the formal international network. The management plan is implemented jointly by an international NGO, The Mountain Institute (formerly Woodlands Mountain Institute), and DNPWC.

Conservation Area (1989 amendment)

- Area managed with an integrated plan for the conservation of the natural environment and the sustainable use of natural resources.
- No army.
- Annapurna Conservation Area is the only one which exists under this category.
- Managed by King Mahendra Trust for Nature Conservation (an NGO).
- IUCN Category VI.

National Park-cum-Conservation Area

- Makalu Barun National Park and Conservation Area.
- Includes national park and a conservation area which fulfils the buffer zone concept.
- The buffer zone is the area at the periphery of the national park or reserve which provides privileges to the local people for the sustainable use of natural resources and also for the sharing of revenue generated from the protected area.
- No presence of army.
- Managed by DNPWC.
- IUCN Category VI.

Protected Areas of International Significance

Protected areas that are a part of the network arising from international conventions, such as the World Heritage Convention (Paris, 1972) and the Wetlands Convention (Ramsar, 1971), are managed by DNPWC. The Royal Chitwan National Park and Sagarmatha National Park are listed under the World Heritage List while the Koshi Tappu Wildlife Reserve is a Ramsar Site.

Management Issues

Despite the wide coverage of the protected area system, several problems relating to management have emerged. First, in some areas conflicts have developed between the park authorities and local residents regarding the latter's right to extract products such as fuelwood, thatch grass, and fodder from the protected areas to meet their essential needs. The restriction or denial of access to parks and reserves has in some cases resulted in economic and social hardship for local people. Ineffective communication and management have worsened this problem, leading to sometimes

acrimonious relationships between the local people and park authorities.

Second, successful protection has allowed animal populations to grow, and the outcome has been far from pleasant in all cases. Some species such as the tigers, rhinoceros, and elephants have caused injuries (and occasional fatalities) to humans.

Third, to enforce protected area regulations, park authorities rely on the assistance of the Royal Nepalese Army. Although deployment of the army has helped reduce poaching within protected areas, it has created its own difficulties. Administrative authority has become divided, leading to some confusion about who has the overall authority for the management of parks. Also, soldiers who are assigned to protect parks are not given any special training and consequently lack an adequate appreciation of their new, non-military role. In addition, the cost of army protection is high, taking up about three-quarters of DNPWC's total budget.

Fourthly, in the past, communities had not been involved in management decisions and had not been entitled to a share of revenues generated from park activities. Local people have therefore tended to regard parks with suspicion. Not only has

World Heritage Sites

Royal Chitwan National Park

Special Features

- The park protects the unique Tarai ecosystem which consists of a wide variety of tropical and sub-tropical flora and fauna.
- It contains the habitats of endangered species such as tiger, rhinoceros, wild elephant, gaur, gharial, mugger, etc.
- The park represents an area of great cultural interest associated with the Tharu community.
- Bikram Baba and Balmiki Ashrams are other religious assets of the park.

Current Problems

- The park faces a severe encroachment problem.
- Rhino poaching is a serious issue.
- Increase in the number of tourists has caused disturbance to the natural harmony of the park's environment.
- Effluents from Bhrikuti Paper Mill consisting of high levels of BOD, silica, and sodium (elements which are discarded into the Narayani) are a threat to the wetlands of the park.
- The proposed East Rapti Irrigation Project will have a significant impact on the park.

Sagarmatha National Park

Special Features

- Sagarmatha, the world's highest peak, and the park itself represent the highest terrestrial ecosystem of the world.
- Represents the evolution of geological formations.
- Protects the Himalayan mountain ecosystem.
- Habitat for threatened species like Himalayan black bear, musk deer, and snow leopard.
- It represents an area of great cultural interest associated with the Sherpas.
- It protects several religious sites related to Buddhism.

Current Problems

- Heavy pressure from tourism and mountaineering.
- The traditional values of the Sherpas are undergoing changes.

their access been restricted, they have not even received compensation for the loss of crops and livestock due to wildlife depredation.

Fifth, there has been a perverse effect on areas in the immediate vicinity of the protected areas. Because of the restrictions inside the

protected areas, extractive activities have been intensified in the surrounding areas, causing severe damage to ecosystems.

Finally, and reflecting some of the points above, many protected areas do not adhere to management plans that encourage local participation.

There is a growing realisation that the ultimate success of protected areas depends upon the cooperation and support of local people. Autonomous, non-governmental committees should be created in each affected area with the authority to collect funds, including tourism revenues, and to allocate them for sustainable community development. Channelling tourist revenues into community development will help to increase people's participation in national parks and reserves.

Institutional Arrangements

There are several institutions responsible for biodiversity conservation in Nepal. The main agency responsible for protected areas is DNPWC (under MFSC), but it faces major constraints in managing and protecting areas due to the lack of financial and human resources. The Plan for the Conservation of Ecosystems and Genetic Resources, prepared as part of the Forestry Sector Master Plan, noted that "DNPWC has little effective management capacity, no working policy instructions, suffers from shared responsibilities, lack of coordination with other agencies of HMG and with local communities, and has substantial unmet training needs."

The DNPWC's authority to act is further limited in a number of ways: (i) confusion regarding administrative authority for park management between the Royal Nepalese Army and DNPWC exists even today; (ii) the Department of Immigration is responsible for issuing trekking permits in mountain protected areas, which means DNPWC has no involvement in planning tourism development; (iii) it has no power to regulate the numbers or activities of trekkers in parks; and, finally, (iv) it has neither the mandate nor the resources to work with communities outside protected areas who are most seriously affected by the presence of parks and reserves.

Other institutions directly involved in biodiversity protection include the Department of Forest (DOF), which is responsible for taking care of all flora, fauna, and ecosystems within national territories. The biodiversity outside protected areas currently receives little attention. To remedy this, the Master Plan for the Forestry Sector suggests that wildlife management outside protected areas be made the responsibility of the District Forest Office (DFO). Where necessary, the DFO should be strengthened by a wildlife management expert from the nearest park or reserve. This proposal requires further scrutiny. Finally, the Department of Plant Resources carries out taxonomic as well as ecological research on plant species.

Protection Opportunities for Other Important Areas

The 800 km of the Himalayan range that lies in Nepal is of great biodiversity value and has great potential to attract tourists. With new areas now being opened for tourism development, new threats to biodiversity are being created. The Manaslu area in central Nepal has come under pressure from tourism development. IUCN Nepal conducted a reconnaissance survey and made recommendations to resolve the conflicting interests between tourism and biodiversity conservation. Special biodiversity conservation areas have been identified for immediate action. Among them, the "hidden valley" concept is being studied by IUCN Nepal's Biodiversity team to develop a management model based upon the traditional monastic authority of the lama and the people's high regard and religious compassion towards living souls. The King Mahendra Trust for Nature Conservation is entrusted to implement the Asian Development Bank project on developing ecotourism in the area, studied by IUCN Nepal.

Royal Chitwan National Park

Surface area	93,200 ha
Buffer zone area	70,000 ha
IUCN management category	II (National Park) X (World Heritage Site since 1984)
Number of visitors	1996/97 61,246 1997/98 69,464
Revenues (1997/98)	US \$ 710,157
Budget (1997/98)	US \$ 101,666
Altitude range	150-815 m
Wildlife species	56 mammals >500 birds 47 reptiles 9 amphibians 126 fish
Scientific research and facilities	The most studied protected area of Nepal. Research Centre established in the 1970s – operated since 1993 by KMTNC/NCRTC
Staff	94 technical plus 14 administrative staff – total 108 DNPWC staff plus >500 Royal Nepalese Army park protection force
Visitor facilities	Visitor centre, souvenir shop, museum, gharial breeding centre, 7 lodges, 4 tented camps, elephant rides, boating, 160 km of road
Number and value of thatch and reed grass collection permits (winter season 1996/97)	75,143 permits generated \$ 5,571
Exchange rate	1\$ = 68 NRs

Source for all key features in the tables: DNPWC, 1996/97 and 1997/98 Annual Report.

Shivpuri Watershed and Wildlife Reserve

Surface area	9,736 ha
IUCN management category	IV (Managed Nature Reserve)
Number of visitors	1993/94 3,000
Revenues (1993/94)	US \$ 23,759
Budget (1993/94)	US \$ 107,407
Altitude range	1336-2732m
Number of wildlife and NRDB threatened species	19 mammals 151 birds 1 reptile
Scientific research and facilities	Yes
Staff	31, excluding 700 Royal Nepalese Army personnel.
Visitor facilities	Information centre

Khaptad National Park

Surface Area	22,500 ha
IUCN Management Category	II (National Park)
Management Plan	None
Number of visitors	1996/97 12 1997/98 7
Revenues (1997/98)	US \$ 47
Budget (1997/98)	US \$ 35,655
Altitude range	1400-3300m
Wildlife species	18 mammals 217 birds
Number of donor-assisted projects	None
Scientific research and facilities	Ecological survey (Kattel, 1981). Avifauna well studied (Inskipp, 1989). No research facilities.
Staff	28 technical and 3 administrative – total 31 DNPWC staff plus one company of the Royal Nepalese army
Visitor facilities	None

Royal Bardia National Park

Surface area	96,800 ha
IUCN management category	II (National Park)
Number of visitors	1996/97 1,855 1997/98 1,622
Revenues (1997/98)	US \$ 39,953
Budget (1997/98)	US \$ 77,769
Altitude range	152-1441m
Wildlife species	48 mammals 260 birds 24 reptiles 3 amphibians 50 fish
Scientific research and facilities	KMTNC, WWF, NORAD studies
Staff	89 technical and 8 administrative – total 97 DNPWC staff plus two companies (320 soldiers) of the Royal Nepalese Army
Visitor facilities	Tented camp and one lodge, elephant rides, boating, 165 km of road
Number and value of thatch and reed grass collection permits (winter season 1996/97)	48,923 permits generated \$ 3,597

Rara National Park

Surface Area	10,600 ha
IUCN Management Category	II (National Park)
Management plan	1976-81 (Bolton, 1976)
Number of visitors	1996/97 178 1997/98 93
Revenues (1997/98)	US \$ 2,875
Budget (1997/98)	US \$ 33,533
Altitude range	2800-4048 m
Wildlife species	51 mammals 214 birds 1 reptiles 3 fish
Scientific research and facilities	Ecological, socio-economic, and tourism surveys (1988-1990) No scientific facilities
Staff (1994/95)	25 technical and 3 administrative – total 28 DNPWC staff plus a company of the Royal Nepalese Army.
Visitor facilities	None, but a visitor centre is planned

Shey Phoksumdo National Park

Surface Area	355,500 ha
IUCN Management Category	II (National Park)
Management plan	Under preparation (WWF, Nov. 1995)
Number of visitors	1996/97 672 1997/98 220
Revenues (1997/98)	US \$ 1,022
Budget (1997/98)	US \$ 47,745
Altitude range	2000-6883m
Wildlife species	26 mammals 176 birds 1 reptile
Scientific research and facilities	Surveys of vegetation, blue sheep, snow leopard and Himalayan thar (1974-1990) have been carried out
Staff (1994/95)	43 technical and 2 administrative – total 45 DNPWC staff plus a company of the Royal Nepalese Army.
Visitor facilities	None

Dhorpatan Hunting Reserve

Surface Area	132,500 ha
IUCN Management Category	VIII (Multiple Use Management Area)
Management plan	None, but Wegge (1976) divided DHR into hunting blocks
Number of visitors	1996/97 222 1997/98 226
Revenues (1997/98)	US \$ 1,741
Budget (1997/98)	US \$ 35,175
Altitude range	2850-5500m
Wildlife species	18 mammals 137 birds 1 reptile
Scientific research and facilities	Ecology, and population of blue sheep (Upreti, 1977). No research facility.
Staff (1994/95)	31 technical and 4 administrative – total 35 DNPWC staff
Visitor facilities	None developed

Annapurna Conservation Area

Surface Area	762,900 ha
IUCN Management Category	VI (proposed)
Management plan	Operational plan (Sherpa <i>et al.</i> , 1986)
Number of visitors	1994/95 45,700
Revenues (1994/95)	US \$ 540,000
Budget (1994/95)	US \$ 648,150 (expenditure)
Altitude range	1151-8091m
Wildlife species	94 mammals 456 birds 34 reptiles
Scientific research and facilities	Surveys of vegetation; bharal population in Manang District; research of birds at Pipar and a snow leopard study. No scientific facilities, but a research centre is planned at Kuldi Ghar.
Staff (1994/95)	240+
Visitor facilities	Visitor centre at Ghandruk

Langtang National Park

Surface Area	171,000 ha
IUCN Management Category	II (National Park)
Management plan	Management plan – Borradaile et al., 1977
Number of visitors	1996/97 6,501 1997/98 7,063
Revenues (1997/98)	US \$ 9,839
Budget (1997/98)	US \$ 54,791
Altitude range	792-7245 m
Wildlife species	45 mammals 290 birds 2 reptiles 2 amphibians
Scientific research and facilities	Many studies have been carried out. No scientific facilities
Staff (1994/95)	70 technical and 6 administrative – total 76 DNPWC staff plus one battalion of the Royal Nepalese Army.
Visitor facilities	Many lodges; helipads and a Short Take Off and Landing (STOL) airstrip

Sagarmatha National Park

Surface Area	114,800 ha
IUCN Management Category	II (National Park) X (World Heritage Site; Criteria: i, ii, iii, and cultural)
Management plan	Garrat, 1981
Number of visitors	1996/97 15,980 1997/98 17,412
Revenues (1997/98)	US \$ 5,940
Budget (1997/98)	US \$ 40,241
Altitude range	2845-8848m
Wildlife species	34 mammals 199 birds 5 reptiles
Number of donor-assisted projects	SPCP (WWF), Oko Himal/Austrian Federal Development Cooperation
Scientific research and facilities	Many studies have been carried out. Ev-K2-CNR "pyramid" laboratory at 5,050m
Staff (1994/95)	35 technical and 3 administrative – total 38 DNPWC staff plus one company of the Royal Nepalese Army.
Visitor facilities	Airstrip at Lukla and Namche Bazaar. All grades of accommodation available.

Makalu Barun National Park and Conservation Area

Surface Area	233,000 ha (150,000 ha in MBNP; 83,000 ha in MBCA)
IUCN Management Category	II (National Park) VII (Multiple Use Management Area) Shrestha <i>et al.</i> , 1990b
Management plan	Tourism management plan (Brewer and Sherpa, 1995)
Number of visitors	1996/97 837 1997/98 914
Revenues (1997/98)	Not available
Budget (1997/98)	US \$ 571,456
Altitude range	435-8463 m
Wildlife species	81 mammals 400 birds 12 reptiles 2 amphibians
Scientific research and facilities	Research is being undertaken which will form the basis of a management plan. No scientific facilities.
Staff	Proposed staffing levels: three wardens, four assistant wardens, eight rangers and a number of scouts (Shrestha <i>et al.</i> , 1990).
Visitor facilities	No visitor facilities, but visitor centre is planned for Khandbari (Shrestha <i>et al.</i> , 1990)

Kanchanjungha Conservation Area

Surface Area	203,000 ha
IUCN Management Category	VI (Conservation Area)
Management plan	Not available
Number of visitors	1997/98 631
Revenues (1997/98)	Not available
Budget (1997/98)	Not available
Altitude range	1200-8568 m
Wildlife species	19 mammals 202 birds
Scientific research and facilities	None
Staff	One project manager, two project and seven co-managers community development assistants
Visitor facilities	None

Royal Suklaphanta Wildlife Reserve

Surface area	30,500 ha
IUCN management category	IV (Managed Nature Reserve)
Number of visitors	1996/97 521
	1997/98 100
Revenues (1997/98)	US \$ 3,446
Budget (1997/98)	US \$ 77,769
Altitude range	90-270m
Wildlife species	32 mammals
	>350 birds
	3 reptiles
	28 fish
Scientific research and facilities	None
Staff	47 technical and 5 administrative – total 52 DNPWC staff, plus one company of the Royal Nepalese Army
Visitor facilities	One tented camp, elephant rides, 180 km road
Number and value of thatch and reed grass collection permits (winter season 1996/97)	33,796 permits generated \$ 2,485

Koshi Tappu Wildlife Reserve

Surface area	17,500 ha
IUCN management category	IV (Managed Nature Reserve)
Number of visitors	1996/97 488
	1997/98 312
Revenues (1997/98)	US \$ 7,902
Budget (1997/98)	US \$ 60,330
Altitude range	75-81m
Wildlife species	23 mammals
	256 birds
	15 reptiles
	2 amphibians
	105 fish
Scientific research and facilities	None
Staff	24 technical and 4 administrative – total 28 DNPWC staff plus one company of the Royal Nepalese Army
Visitor facilities	Elephant rides, 30+ km of road, boating. Wildlife lodge adjacent to the reserve.
Number and value of thatch and reed grass collection permits (winter season 1996/97)	12,643 permits generated \$ 930

Parsa Wildlife Reserve

Surface area	49,900 ha
IUCN management category	IV
Number of visitors	1996/97 47 1997/98 2
Revenues (1997/98)	US \$ 2,577
Budget (1997/98)	US \$ 45,190
Altitude range	100-950m
Wildlife species	26 mammals > 500 birds 5 reptiles 3 amphibians 8 fish
Scientific research and facilities	Wildlife organisation, park-people interface, and conservation in Nepal
Staff	38 technical and 5 administrative – total 43 DNPWC staff, plus 1 company of the Royal Nepalese Army
Visitor facilities	No special facilities for tourists, road 50+ km
Number and value of thatch and reed grass collection permits (winter season 1996/97)	4,833 permits generated \$ 289

Role of the Army in Biodiversity Conservation

The Royal Nepalese Army (RNA) has played a critical role in preserving the mega fauna (rhinoceros, tigers, crocodiles, pythons, bears, and so on) in protected areas. Their role has been particularly significant during the transfer of political power from one system to another, as happened during 1950-51 (Rana regime to democratic forces), 1960-61 (Multiparty Democracy to Partyless Panchayat System), and 1980-81 (National Referendum). Hundreds of confiscated items such as animal skins, rhino horns, elephant tusks, and other animal parts are stored at Tikauli Army Post in Chitwan. A huge bulk of confiscated items were burnt in May 1998. The Royal Chitwan National Park was literally saved by the army from being engulfed by illegal settlers from elsewhere. However, the role of army has remained somewhat questionable in the protected areas of the mountain region where indigenous people could have done the job. At present, the Royal Nepalese Army contributes to biodiversity conservation by protect-

ing national parks and wildlife reserves from wood smugglers, poachers, livestock grazing, forest fires, and public encroachment. RNA is also involved in wildlife reserves and watershed conservation projects. In addition, the RNA is also active in afforestation, soil conservation, and relief/rescue work during natural calamities (NCS Newsletter No. 2, 1995). Biodiversity conservation is the function of human society at large. The demands of a specific situation have to be met through appropriate decisions, and HMG has often had to use the army for protection of a national park. Nepalese soldiers in various armed forces of the world have illustrated their great adaptability, from their role as mercenaries in world wars to the peace keeping forces of the UN. Ample opportunities exist to use the Royal Nepalese Army in the conservation of biological diversity in Nepal through proper adjustments and training.

Transboundary Protected Areas

Nepal is situated between China and India, and most of its protected areas lie along the interna-

tional borders. As such, a number of transboundary issues confront the effective management of these protected areas. These include poaching and illegal hunting, seasonal migration of birds and wildlife, differing patterns of management practices and law enforcement, restrictions for monitoring across international borders, illegal logging and fishing, and above all, policy incompatibility in conservation and monitoring. Transboundary tourism in protected areas offers great potential for raising park revenue. His Majesty's Government of Nepal is, with China and India, endeavouring to resolve transboundary problems in park management and to enhance park revenue from increased tourism. The Qomolangma Nature Preserve (QNP) in China is contiguous to three Nepalese National Parks: Makalu-Barun, Sagarmatha, and Langtang. These protected areas represent the highest terrestrial ecosystem on earth, and also contain deep valleys which sink to below 1000m, producing tropical ecosystems juxtaposed with temperate and alpine conditions along the verticality of the mountain slopes. When Kanchanjunga area is added to the system, the overall biological significance of this complex will be formidable. Transboundary management agreements should, therefore, be viewed as a priority activity in the Hindu-Kush Himalayan region. The QNP, MBNP, and CA were all established as sister projects with the initiation of The Mountain Institute. Scientific collaboration and exchange programmes have taken place from the very early days of the project's inception.

Similarly, dialogues with Indian authorities are on-going in an effort to solve transboundary problems. Royal Chitwan National Park is contiguous with India's Valmiki Nagar and Udayapur Sanctuaries. Royal Bardia National Park and Suklaphanta Wildlife Reserve are also contiguous with the Dudhwa National Park of India. Crop depredation by wild elephants, migration of re-introduced rhinos, illegal killing of ungulates, and infrastructure development along water courses are being considered for management agreements. There is also a great scope for information exchange and training for the monitoring and management of these protected areas.

Successes of *In Situ* Conservation

Nepal's protected area network contains a wealth of floral and vegetational diversity. Shrestha (1985) highlighted the botanical wealth of mountain

parks, and in 1996 also systematically enumerated endemic plant species in the protected area system. Of the 35 forest types described for Nepal (Stainton, 1972), almost all occur within protected areas, which cover over 15% of Nepal. One of the most obvious exclusions is the *Lithocarpus pachyphylla* forest and the *Larix griffithii* forest, both of which occur in the Kanchanjunga area. It must be stressed here that the strength of Nepal's protected areas is better evaluated in terms of its success in preserving a mix of differing flora and fauna, representing six floristic provinces and two biogeographic realms. For example, Makalu Barun National Park and Conservation Area has over 3,000 species of flowering plants, which include 25 of Nepal's 30 species of rhododendron, 48 species of primula, 47 species of orchids, 19 species of bamboos, 15 species of oak, 18 species of fodder trees, and 67 species of medicinal and aromatic plants. Similarly, the highest altitudinal record set by a plant species (6,135 m) is attained by *Stellaria decumbens* (The Guinness Book of World Records) in Makalu Barun National Park. Living examples of *Tetracentron sinense* are found *in situ* in Nepal, while its close relatives are found only as fossils in Japan.

The Annapurna Conservation Area links eastern Himalayan flora with that of the western Himalayas and the Central Asiatic flora with the oriental. This area has the largest number of plants endemic to Nepal (55 species), claiming over 22% of the country's total 246 endemic species (Shrestha, 1996). *Pedicularis annapurnensis* is one of these.

Langtang National Park is an important site of Holotype localities for plants. A large number of Himalayan plants were first discovered in the Gosaikunda and Langtang area. The type locality of some of the better-known plants such as *Juniperus recurva*, *Michelia doltsopa*, *M. Kisopa*, *M. velutina*, *Cornus capitata*, *Abies spectabilis*, *Tsuga dumosa*, *Meconopsis napaulensis*, *M. simplicifolia*, *Larix himalaica*, and *Anemone vitifolia* are found in this national park. In addition, over 20 species of high-value medicinal plants occur here.

Lake Rara National Park and Khaptad National Park are important as repositories of western Himalayan flora. Western Himalayan oaks such as *Quercus incana*, *Q. lanuginosa*, and *Q. dilatata* and western Himalayan conifers like *Abies pindrow*, *Cupressus torulosa*, *Cedrus deodara*, and *Picea smithiana* are predominant in these parks

which are most famous for their wealth of medicinal herbs.

Shey Phoksumdo National Park is reputed for its Central Asiatic flora, on the one hand, and a small representation of Mediterranean elements on the other (Shrestha, 1985). Olive trees, pomegranates, and pistachios are characteristic Mediterranean flora found in southern Dolpo. In addition, there are also 20 species of endemic plants restricted to this national park.

Fauna

Conservation successes in Nepal with respect to wildlife species is dealt with concisely in *Banking on Biodiversity* by T.M. Maskey (1995). The populations of many protected and endangered mammals have increased considerably. For example, after active efforts towards their conservation, the population of one-horned rhinoceros has been raised from 60 individuals in 1960 to 466 in 1994. The population is increasing at a rate of 3.7% a year. The rhino translocation to Royal Bardia National Park also promises to be successful in the rehabilitation of endangered species in their own previous natural range of distribution. The tiger population in Chitwan and Bardia, the black buck in Khairiphanta, the Himalayan thar, and the musk deer in Sagarmatha and Langtang National Parks are successfully conserved under *in situ* conditions. The situation of birds is uncertain (Maskey, 1995) but the Koshi Tappu Wildlife Reserve has a record of 300 species (Inskipp, 1989) and the Makalu Barun and Sagarmatha Parks

have 440 species (Jackson et al., 1990) in the Koshi Basin of eastern Nepal.

Shey Phoksumdo National Park is the best habitat for snow leopard and blue sheep, while Koshi Tappu is the only locality for wild buffaloes. Grazing of domesticated water buffaloes and cattle in Koshi Tappu is a great threat to the Ramsar Site. Cross-breeding of wild buffalo and domesticated buffalo is a major concern for wild buffalo (*Bubalus bubalis*) conservation under *in situ* conditions.

5. Ex Situ Conservation

The Convention on Biological Diversity emphasises *ex situ* conservation as a complementary activity and one supporting *in situ* measures (Glowka et al., 1994). Off-site, i.e. *ex situ* conservation, is a major tool for ensuring conservation of certain species which have drastically declined or even come close to extinction in natural habitats. A number of Nepalese fauna such as the black buck (*Antelope cervicapra*), the gharial crocodile (*Gavialis gangeticus*), the Asiatic elephant (*Elephas maximus*), and the musk deer (*Moschus moschiferus*) are successfully raised in captivity.

Zoos and botanical gardens are appropriate centres for *ex situ* conservation. In Nepal, both of these have a long history of existence and warrant vigorous development to enable them to

Shey Phoksumdo Endemics

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| 1. <i>Aconitum naviculare</i> var. <i>leiocarpum</i> | 2. <i>Carex hamoneuros</i> |
| 3. <i>Aster perlunoularis</i> ssp. <i>nepalensis</i> | 4. <i>Clematis Phlebantha</i> |
| 5. <i>Corydalis alburyi</i> | 6. <i>Eramaniopsis pumila</i> |
| 7. <i>Fagopyrum megacarpum</i> | 8. <i>Impatiens williamsii</i> |
| 9. <i>Nepeta staintonii</i> | 10. <i>Pedicularis sectifolia</i> |
| 11. <i>Primula ramzanæ</i> | 12. <i>Primula reidii</i> var. <i>williamsii</i> |
| 13. <i>Premula sharmae</i> | 14. <i>Saussurea chrysotricha</i> |
| 15. <i>Saussurea linearifolia</i> | 16. <i>Saussurea platyphyllaria</i> |
| 17. <i>Saxifraga nigra</i> | 18. <i>Saxifraga neopropagulifera</i> |
| 19. <i>Saxifraga rhodopetala</i> | 20. <i>Sedum nepalaicum</i> |
| 21. <i>Staintoniella nepalensis</i> | |

best serve current conservation needs. *In vitro* culture of plant tissues and gene banks is also being tried in Nepal for the purpose of agricultural and horticultural development. Nepal has a large number of wild relatives of cultivated plants and domesticated animals and many trees, medicinal herbs, and ornamental plants which would merit *ex situ* conservation and development. Therefore, the Central Zoo, the Royal Botanical Garden, and the National Agricultural Research Council need to be strengthened for *ex situ* conservation of the components of biological diversity.

The Central Zoo

The Central Zoo in Jawalakhel, Lalitpur submetropolitan area, was expanded from the private collection of Prime Minister Juddha Shamsher Rana in 1932. The zoo covers an area of 6 ha and most animals are kept in cages except the rhinoceros, the tiger, the black buck, and other ungulates. The zoo houses over 500 individual animals, of which 230 are mammals of 31 species, 240 are birds belonging to 53 species, and 35 are reptiles from 16 species. These animals include endangered species such as the one-horned rhinoceros, the Royal Bengal tiger, the sloth bear, the Himalayan black bear, the elephant, the gaur, the black buck, the Assamese macaque, the striped hyena, the lynx, and the mugger crocodile. The bird section has several endangered species which includes the saker falcon, the Nepalese national bird the Himalayan monal (*danphe* in Nepali), the sarus crane, the black-necked stork, and the demoiselle crane. There is, however, no aquarium in the zoo.

Management of the zoo has passed from one institute to another, before finally coming to rest with a national NGO, the King Mahendra Trust for Nature Conservation. The new management has prepared a master plan which allows the zoo to address itself to functioning as a centre for *ex situ* conservation of animals besides delivering its recreational and educational services.

The Royal Botanical Garden

The Royal Botanical Garden at Godawari covers an area of over 80 ha, much of which is natural greenery of local flora and vegetation. It lies at the base of Phulchoki hill which rises to 2715m and borders the Kathmandu Valley. The Royal Botani-

cal Garden, ever since its establishment in 1962, has endeavoured to include indigenous plants from all over Nepal and to have a representative collection of medicinal herbs, trees, orchids, ferns, and ornamental flowers. The garden has a rich collection of exotic cacti, roses, chrysanthemums and lilies. Botanical surveys and collection for the herbarium, supported by research on tissue culture, orchid propagation, anatomical features, and cytogenetical composition of Nepalese plants are some of the key activities in the Royal Botanical Garden. The National Herbarium with over 100,000 dried specimens of plants and with hundreds of plant samples of economic value serves as a rich repository of floral knowledge in Nepal. Scientific support for *ex situ* conservation could easily be mobilised if the Royal Botanical Garden is strengthened for the purpose of *ex situ* conservation in Nepal.

Lumbini Development Trust

Lumbini, the birth-place of Lord Buddha, has recently been a focus of activity for IUCN Nepal. IUCN Nepal is helping the Lumbini Development Trust to restore the atmosphere of sanctity in Lumbini. A wetland ecosystem has been restored and the vegetation is being manipulated to bring back natural trees and shrubs. The grassland area has become the refuge of approximately 50 blue bulls (*Boselaphus tragocamelus*), the largest of the Asian antelopes. Lumbini has also been identified as a crane sanctuary by the International Crane Foundation. IUCN Nepal and ICF have made an agreement to improve the environment in order to restore its natural integrity. *Ex situ* conservation of sarus crane is being tried in this area.

6. Legal Instruments Related to Biodiversity Conservation

National Acts

1. Ancient Monument Protection Act, 1956
2. Aquatic Animals Protection Act, 1961
3. Plant Protection Act, 1972
4. National Park and Wildlife Conservation Act, 1973
5. King Mahendra Trust for Nature Conservation

- Act, 1982
6. Soil and Watershed Conservation Act, 1982
 7. Nepal Petroleum Act, 1983
 8. Kathmandu Valley Development Authority Act, 1988
 9. Nepal Drinking Water Corporation Act, 1988
 10. Town Development Act, 1988
 11. Municipality Act, 1991
 12. Village Development Committee Act, 1991
 13. Electricity Act, 1992
 14. Forest Act, 1992
 15. Industrial Enterprises Act, 1992
 16. Vehicle and Transport Management Act, 1992
 17. Water Resources Act, 1992
 18. Environment Protection Act, 1996

International Conventions Related to Biodiversity Conservation

1. Convention on International Trade in Endangered Species of Wild Fauna and Flora
2. Convention on the Conservation of Migratory Species of Wild Animals
3. Convention on Biological Diversity
4. Ramsar Convention
5. World Heritage Convention

Environmental Treaties to which Nepal is a Party

1. Plant Protection Agreement for the South East Asia and Pacific Region, 1956, *12 August 1965*
2. Geneva Convention on High Seas, 1958, *27 January 1963*

3. Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water, 1963, *7 October 1964*
4. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space Including the Moon and other Celestial Bodies, 1966, *10 October 1967*
5. Treaty on the Non-Proliferation of Nuclear Weapons, 1968, *3 February 1970*
6. Treaty on Prohibition of the Emplacement of Nuclear Weapons and other Weapons of Mass Destruction on the Seabed and Ocean Floor and the Subsoil Thereof, 1971, *18 May 1972*
7. Bangkok Agreement on the Network of Aquaculture Centres in Asia and the Pacific, 1988, *4 January 1990*
8. Framework Convention on Climate Change, 1992
9. Vienna Convention on Protection of Ozone Layer, 1985
10. Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, 1989, *August 1996*
11. Convention on Combating Desertification in Countries Experiencing Serious Draught and/or Desertification, particularly in Africa, 1994, *September 1996*
12. Ramsar Convention 17 December 1987
13. Convention on International Trade in Endangered Species of Wild Fauna and Flora, 18 *June 1975*
14. Convention Concerning the Protection of World Cultural and Natural Heritage, 1972
15. Convention on Biological Diversity, 1992, *23 November 1993*



Local fishing community in the Tarai. The supply of fish in Nepal as a whole is not enough to make it a part of everyone's diet.



Between the low-lying fields of banana and the snow-capped peak of Mt. Annapurna (8,091m) lie eight different ecological zones squeezed along the slopes of the Himalaya.

Skulls of the Himalayan black bear are kept as trophies by local people who have to fight constantly with these crop-raiding animals. Corn cultivation along the slash and burn slopes is, in fact, a wildlife feeding programme on the one hand and a protein harvesting plan for the community on the other.



Environmental Impact Assessment

Article 14 (a) of the Convention on Biological Diversity requires those party to the Convention to introduce environmental impact assessment (EIA) of development projects to guard against possible adverse effects on biological diversity. The process of integrating EIA into the national development process is a fairly new one in Nepal.

Article 14 (b) is broader in scope and further requires the parties to introduce appropriate arrangements to ensure that the environmental consequences of its programmes and policies likely to have significant adverse impacts on biological diversity be duly taken into account. His Majesty's Government of Nepal, in collaboration with IUCN, initiated a programme under the NCS Implementation Project (1989-1996) to develop national and sectoral guidelines for establishing a national system for EIA. As such, the National EIA Guidelines were endorsed by the government in 1992 as an "umbrella" framework. Subsequently, several sectoral EIA guidelines have been prepared. These relate to forestry, industry, hydropower, irrigation, mining, water, tourism, sanitary land-fill sites, housing, urban development and transport. EIA guidelines for all these sectors dwell upon the need to examine rare, endangered, and protected biological species in the assessment process. Besides, it is mandatory for any project to undergo an EIA process if it is located near a protected area or an area known to have rare and endangered species (*Nepal Gazette* Part 4, Section 43, No. 5, 19 July 1993). The legal basis for the implementation of EIA was formalised with the enactment of the Environmental Protection Act, 1996.

The EIA Guidelines for the Forestry Sector, prepared by the Ministry of Forests and Soil Conservation in collaboration with the National Planning Commission/IUCN National Conservation Strategy Implementation Project, were officially gazetted in Volume 45, Number 19 on 21 August 1995.

The guidelines aim to facilitate the sustainable use of forest resources for socio-economic development and to meet the basic needs of communities for forest products; to make proposals socio-culturally acceptable, economically feasible, and environmentally benign; to conserve genetic resources and biodiversity and minimise environmental damage in forest areas; and to facilitate the identification of positive and negative impacts of programmes to be implemented by other agencies in forest areas.

The situations and conditions for the use of the guidelines can be outlined as follows:

- Proposals that directly affect forest areas and forests.
- Proposals related to plantation, soil erosion control, conservation of wildlife habitat, and the development of forest-based industries.
- Proposals to be implemented in forest areas but not initiated by the forestry sector.
- Development proposals related to hydropower, roads, irrigation, stone quarrying, drinking water, resettlement, agriculture, tourism,

livestock development, and utilisation of forest products that can directly affect national parks and other such conservation areas.

The guidelines define three categories of proposals, (a) those not requiring Initial Environmental Examination (IEE) listed in Schedule I, (b) those requiring IEE listed in Schedule II, and (c) those requiring EIA as listed in Schedule III (EIA Guidelines for the Forestry Sector. NPC/TUCN–NCS Implementation Project 1995).

Proposals Requiring Environmental Impact Assessment

Schedule - III

(relating to Section 10)

1. Proposals related to the preparation of forest management plans.
2. Proposals related to monoculture plantation of indigenous species exceeding 250 ha in the Tarai and exceeding 100 ha in the hills in a single plot.
3. Proposals related to pure plantation of tested exotic species exceeding 100 ha in the Tarai and 50 ha in the hills in a single plot.
4. Proposals related to leasing of forests exceeding 250 ha in the Tarai and exceeding 100 ha in the hills as a single plot.
5. Proposals related to the construction of new tourist resort hotels and safaris, educational institutions, hospitals, and industrial establishments or other construction work in all types of forests and protected areas.
6. Proposals related to the establishment of a new herbal centre for commercial production in public forests with clear felling.
7. Development proposals to be implemented in national parks, wildlife reserves, and conservation areas.
8. Proposals related to clear felling of forests exceeding 5 ha in area.
9. Proposals related to the establishment of medium- and large-scale forest-based industries using process technology such as rosin and turpentine, rubber, plywood and veneer, catechu and wood-based matches, pulp and paper; and high firewood consuming industries such as cardamom and tea within 1 km radius of forest areas.
10. Commercial or industrial processing of medicinal and aromatic plants which may discharge toxic and/or hazardous pollutants.
11. Proposals related to the establishment of sawmills, and brick, tile, and tobacco industries within a 5 km radius of the nearest forests.
12. Proposals related to the establishment of sawmills with an annual capacity exceeding 100,000 cu ft/yr.

Note: Threshold criteria may be redefined in the future. In some cases, it may be necessary to develop new criteria for the same threshold.

Small-, medium-, and large-scale industries shall be based on the classification of the *Industrial Enterprises Act, 1992 (2049)*.

In the process of building an EIA system in Nepal, IUCN Nepal, with its Environmental Core Group (ECG), tested the Forestry Sector EIA Guidelines in the operational Forest Management Plan for Bara District. It was a great opportunity to test the effectiveness of the guidelines and to provide hands-on training to ECG members (Tuladhar, 1995; NCS Newsletter Nepal No. 2). The Bara Forest Management Plan has been developed for production-based forest development in Nepal. The strategic level EIA of the forest analysed two alternatives – the “do nothing” scenario and the implementation of the operational forest management plan in 19 major issues ranging from biodiversity conservation to marketing strategy. It recommended implementation of the plan by revising it to incorporate a number of concerns that included high-level government decisions. This was done since the plan is considering a departure from the general forest policy.

The EIA system in Nepal was introduced as per the requirements of bilateral and multilateral donors who abide by their own procedures. The EIA as a national system is still in its infancy (Ram Khadka, EIA Newsletter 13). Khadka (1996) identifies the following constraints and weaknesses in EIA implementation:

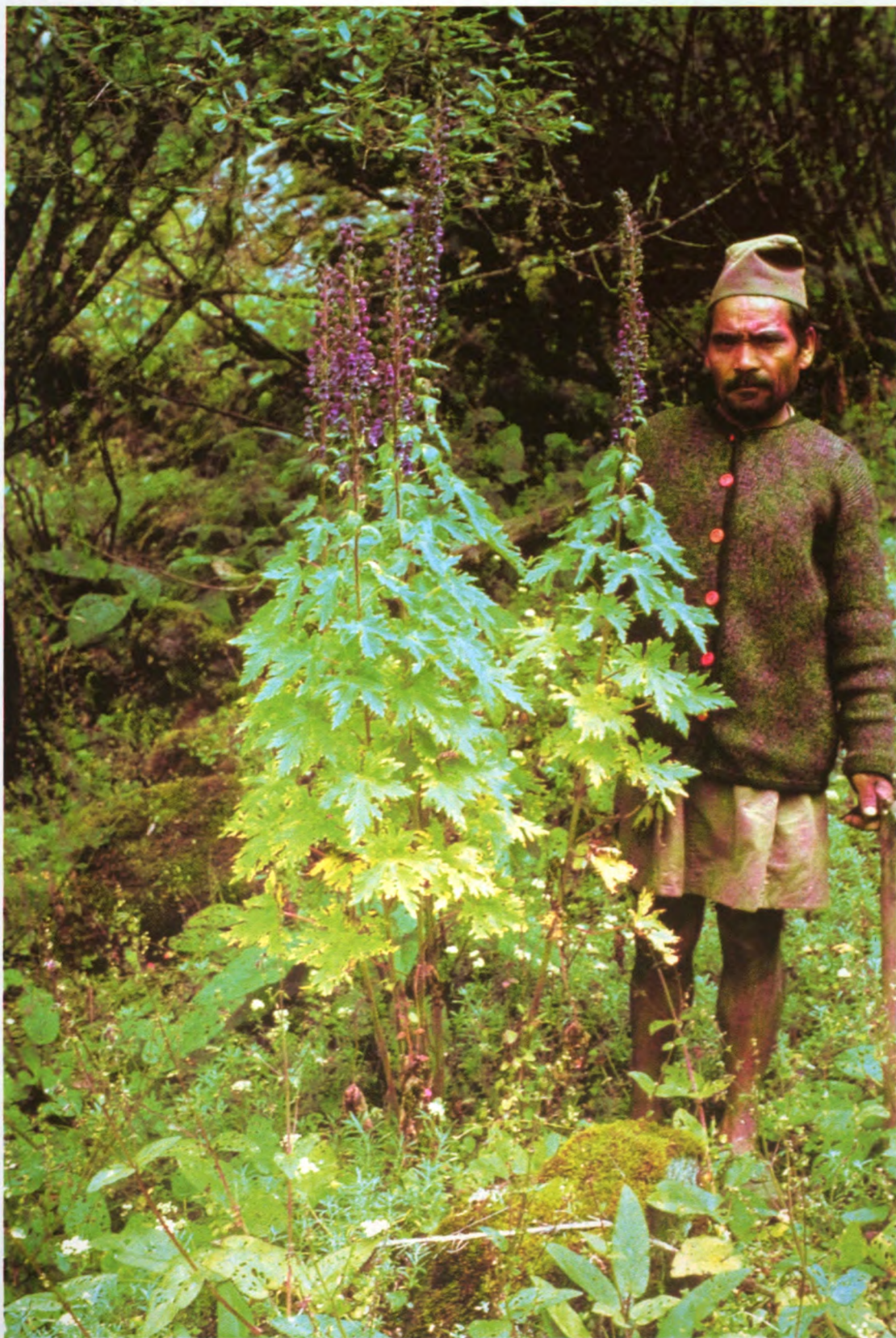
- The current level of EIA training is inadequate;
- EIA is still considered to be an “add-on” project burden;

- EIA regulations are still to be drafted;
- EIAs are often based on inadequate data;
- There is no system for the integration of the EIA and environmental management budget within the overall project budget;
- There is no proper system for EIA report review within the Ministry and therefore no quality control;
- EIA is considered a project clearing mechanism;
- In most cases, EIA has been undertaken during the later stage of the project cycle.
- With one exception (EIA of the Bara Forest Management Plan), EIA is usually undertaken only at the project level.

The Water Resources Act and the Electricity Act have made EIAs mandatory for proposed projects generating and transmitting more than 1 MW of electricity. The Environment Protection Act makes EIAs mandatory for prescribed development projects. The nature, size, and criteria of development projects which must undertake EIAs will be provided in the Environment Protection Regulations, which is to be promulgated under the Environment Protection Act. It is equally important to broaden the scope of Environmental Impact Assessment beyond projects and to include programmes or policies which are likely to have a significant adverse impact on biodiversity.

Aconite tubers (*Aconitum spicatum*) are deadly poisonous tubers used as medicine after a special detoxifying process. Poachers use the poison to kill musk deer, laying poisoned bamboo spears strategically along narrow paths.





School children in Seduwa village (eastern Nepal). Children represent our future: what we do today will have a direct impact upon their lives.



Looking Ahead



1. A Vision for Nepal

Different visions of Nepal can be found in Nepalese art, literature, culture, history and religion. Poet Laureate Laxmi Prasad Devkota (1901-1959) was inspired by a Nepal that is "*sundar, shanta, vishal*" (beautiful, peaceful, great). The Late Prithivi Narayan Shah (1723-1775) saw Nepal as a garden where thirty-six different ethnic groups live side by side. Rudyard Kipling's famous line, "the dreams of Kew are the facts of Kathmandu" alludes to the extraordinary variety of plants to be found in the valley.

Asia traditionally recognises the Himalaya as a spiritual abode, the lofty home of gods and goddesses; Sage Padma Sambhawa himself recognised Nepal as a hidden treasure of Buddhist faith and culture. Today, this country of rich biological diversity and diverse cultures must continue to be a land of social harmony in the spirit of Lord Buddha's principles of peaceful co-existence with nature. Greatness must be achieved through the country's economic growth and its ability to deliver the means for its people to have a better quality of life.

Guiding Principles

1. Biological diversity has ecological, economic, social, cultural, scientific, and an intrinsic value in and of itself.
2. Biodiversity conservation is a form of economic development. It is an investment that yields substantial local, national, and global benefits.
3. Investment in research and development of biological resources brings long-term benefits to the nation.
4. Respect for every form of life is inherent in Nepalese tradition and culture.
5. The Directive Principles of the Nepalese Constitution arrange for the special protection of rare wildlife, forests and vegetation.
6. The constitution also includes arrangements for the equitable distribution of economic gains arising from the use of biological diversity at the genetic, species, and ecosystem levels.
7. The knowledge, innovations, and practices of the indigenous and local communities should be respected and their use and maintenance carried out with the support and involvement of these communities.
8. Cultural expressions in Nepalese life have developed to maintain diversity of nature; hence the conservation of culture should become an integral part of biodiversity conservation.
9. *In situ* conservation is better achieved by investing in communities outside protected areas. The focus of activity must be where people live and work.
10. Biodiversity conservation can be sustained only if public awareness and conservation work is of good quality and if policy-makers have access to reliable information upon which to base policy choices.

2. Prospects for the Future

The National Conservation Strategy of Nepal has identified four objectives. These aim to bring about sustainable development to satisfy the basic needs of the people, to ensure sustainable use of natural resources, to preserve biological diversity, and to maintain ecological and life support systems. All of these objectives are linked to biological resources and their diversity. Biological resources in Nepal are pronounced in terms of their diversity rather than their quantity. Biodiversity is great compared to the country's size, but now there is conflict between the requirements of poverty alleviation and the urgency of conserving rare and unique species and habitats. Nepal's wealth of genetic resources in agro-ecosystems and its indigenous knowledge is in decline, and faces continual threats from the so-called improved varieties and high-yielding crops.

Societies throughout Nepal are heavily dependant upon the integrity and diversity of nature. Farms, forests, and rangelands are a day to

day reality for over 90% of the Nepalese population. The evaluation of the Eighth Plan (1992-97) clearly indicated a decline in the productivity of the agricultural sector, the yield of principal food-grains remained unchanged or has even declined. On the other hand, the fertility rate of women remains at 5.2 children per woman, one of the highest in the world, while the literacy rate stands at 39.6 %, one of the lowest in the world. Thus Nepal's first and overriding priority must be economic and social development and poverty eradication.

The Convention on Biological Diversity (CBD) calls for the conservation of biological diversity and the sustainable use of its components in a fair and equitable way. Nepal has already set aside over 15% of its territory as protected areas. Nepal pioneered the concept of people's involvement in protected area management. Previous efforts to manage a national park without the support of the resident local population were not altogether successful. Therefore, the government has introduced the buffer zone concept, whereby a certain

share of revenue from the park is ploughed back into the community for its development. This is a novel way to support the conservation of biodiversity. However, there is also an urgent need to develop scientific, technical, and institutional capacity to ensure the full range of benefits from the conservation of species and ecosystems. The pool of biological resources; especially the wild relatives of domesticated plants and animals, and new genetic materials for medicine, agriculture, horticulture and livestock; would certainly warrant a system of scientific research coordinated with the realities of modern market forces. The main challenge to conserving the biological diversity of Nepal lies in finding ways and means to bring substantial economic returns from the use of biodiversity. Opportunities to these ends lie in the superlative scenic beauty of the mountain environment, the broad spectrum of the country's habitat diversity, the dynamism of regenerating forests and agriculturally active land, the immense power potential of hydroelectricity, and of course, the sturdy people adapted to harsh environments and their ability to steward land resources.

Lying in the central sector of the Himalaya, Nepal links China and the South Asian subcontinent, the two great land masses of Asia. In Nepal the distinct flora and fauna of the eastern and western Himalayas merge to form a unique diversity of biological species. Biologically as well as geophysically, Nepal is perfectly positioned to provide linkages for regional cooperation in the sphere of biodiversity conservation. Biological diversity and the laws of nature governing them do not respect any political boundaries. The approach of nations towards safeguarding biological resources for the future of humankind should take account of this truth. Exchange of information, technical and scientific cooperation, and provisions for access to and transfer of technology within the broad framework of the Convention on Biological Diversity are emerging as key issues which must be addressed very soon for the future of this region.

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Founded in 1948, IUCN–The World Conservation Union brings together States, government agencies and a diverse range of non-governmental organisations in a unique world partnership: over 900 members in all, spread across some 139 countries.

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