NEPAL BIODIVERSITY STRATEGY

His Majesty's Government of Nepal
Ministry of Forests and Soil Conservation

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Ministry of Forests and Soil Conservation (MFSC)

FOREWORD

His Majesty's Government of Nepal is committed to the protection and management of biological resources and their diversity on a sustainable basis for the benefit of Nepal's present and future generations and for the global community as a whole, in accordance with the principles of the Convention on Biological Diversity.

The Nepal Biodiversity Strategy records the understanding reached between the Government and the People of Nepal on the thrust and direction to be taken over the next twenty years to protect and manage Nepal's biodiversity. This Strategy is the result of extensive consultations with a variety of stakeholders over a considerable period of time. The Strategy puts every woman and man at the centre of natural resource management in Nepal.

This document is the Government's commitment to adopt a more cohesive and strategic approach to conservation at the landscape level. It lays the ground for the preparation of periodic Action Plans that will be the mechanism through which the Strategy will be implemented.

This Strategy embodies a strong commitment to fulfil our international obligations as signatory to the Convention on Biological Diversity. I am confident that this Strategy shall serve as a guide to everyone in the country whose actions may have a bearing on managing our unique biodiversity. However, the implementation of this Strategy through the Action Plans will be on the basis of partnerships between specialised Government institutions and NGOs, conservation partners, the private sector, academia and other exponents of civil society.

Sher Bahadur Deuba

Right Honourable Prime Minister
&
Minister for Forests & Soil Conservation

EXECUTIVE SUMMARY

The goal

The Nepal Biodiversity Strategy (NBS) is a commitment by His Majesty's Government and the people of Nepal for the protection and wise use of the biologically diverse resources of the country, the protection of ecological processes and systems, and the equitable sharing of all ensuing benefits on a sustainable basis, for the benefit of the people and to honour obligations under the Convention on Biological Diversity. Biological diversity in Nepal is closely linked to the livelihoods and economic development of most of her people, and relates to agricultural productivity and sustainability, human health and nutrition, indigenous knowledge, gender equality, building materials, water resources, and the aesthetic and cultural well being of the society.

This NBS, which was developed through the participation of a broad cross-section of Nepali society, is intended to serve as a guide to all government organisations, the private sector and civil society. It sets objectives for the protection of biological diversity in Nepal and identifies or restates Government policy on natural resources and their diversity.

The outcomes of the NBS will be a stronger political commitment, an information management system, enhanced human and institutional capacity, clear policies and legislation, detailed Action Plans, heightened public awareness and an effective monitoring and evaluation process.

Background

Nepal has a population of 23.2 million people, 48.5% of which lives in the Terai, 44.2% in the Mid-hills and 7.3% in the Mountains. The 2001 census indicates an average population growth rate of 2.27%, highest in the Terai and lowest in the Mountains. The economic well being of Nepal is very closely bound to its natural resources – arable land, water, forested areas, and protected areas.

Tourism is the second most important source of foreign exchange for Nepal, after agriculture, and approximately 45% of tourists coming to Nepal visit protected areas, generating substantial revenue. Tourism will therefore remain central to the economic sustainability of the protected area system and the protection of biodiversity.

Biological resources and diversity

Nepal's location in the centre of the Himalayan range places the country in the transitional zone between the eastern and western Himalayas. Nepal's rich biodiversity is a reflection of this unique geographic position as well as its altitudinal and climatic variations. It incorporates Palaearctic and Indo-Malayan biogeographical regions and major floristic provinces of Asia, creating a unique and rich diversity of life. Although comprising only 0.09% of global land area, Nepal possesses a disproportionately large diversity of flora and fauna at genetic, species and ecosystem levels. This diversity is found in the dense tropical monsoon forests of the Terai, the deciduous and coniferous forests of the subtropical and temperate regions, and the sub-alpine and alpine pastures and snow-covered peaks of the Himalayan mountain range.

The biological resources of the Terai and Siwalik are mostly dominated by Sal trees (*Shorea robusta*), tropical deciduous riverine forest and tropical evergreen forest. These ecosystems are of international importance both in terms of the number of globally threatened wildlife and floral species found in them as well as their diversity. Unfortunately, the Terai is also heavily populated, resulting in high pressure on the forest and agricultural resources.

The Mid-hills have the greatest diversity of ecosystems (52) and species in Nepal. This is due to the great variety of terrain types and the occurrence of subtropical to temperate climatic zones comprising a rich flora and fauna. Nearly 32% of Nepal's forests occur in the Mid-hills.

The Mountains are the meeting place of the Palaearctic region to the north and the Indo-Malayan region to the south. There are 38 major ecosystems in the Mountains, and while they are relatively less diverse in flora and fauna compared to the Mid-hills and lowlands because of harsh environmental conditions, they are nevertheless characterised by a large number of endemic species.

Forests play a vital role in maintaining ecological balance as well as economic development in Nepal. Pristine forests are a major attraction for tourists. The forest environment is a major source of energy, animal fodder and timber, and forest catchment areas are the main sources of water used in hydroelectric power generation, irrigation and domestic consumption. Rural people depend on many non-timber forest products (NTFPs) for their subsistence living.

Rangelands in Nepal comprise grassland, pasture, scrubland and forest, and are estimated to cover about 1.75 million hectares, or nearly 12% of Nepal's land area. Nepal's rangelands are rich in biodiversity, ranging from subtropical savannahs, temperate grasslands, alpine meadows, and the cold, arid steppes north of the Himalayan range.

About 21% (3.2 million hectares) of the total land area of Nepal is cultivated, the principal crops being rice, maize, wheat, millet and potatoes. Crops such as rice, rice bean, eggplant, buckwheat, soybean, foxtail millet, citrus fruits and mango have high genetic diversity relative to other food crops. Many crop species in Nepal owe their variability to the presence of about 120 wild relatives of the commonly cultivated food plants.

There are many different types of wetlands in Nepal, ranging from perennially flowing rivers to seasonal streams, lowland oxbow lakes, high altitude glacial lakes, swamps, marshes, paddy fields, reservoirs, and ponds. These wetlands are biologically diverse and are known to support more than 20,000 waterfowl.

The Himalayan mountain system is unique in the world. Several biologists have reported plants and animals above 5,000m. Mosses and lichens are found up to 6,300m, cushions of flowering *Stellaria decumbens* in Makalu occur up to 6,135m, and *Ephedra* species up to 5,200m. An important feature of the mountain biodiversity of Nepal is the number of different levels of biological organisation above the species level - genera, families, phyla, habitats, and ecosystems - indicating high levels of *beta* diversity.

Existing protective mechanisms

A number of successes have been recorded over the years in the protection and management of biological resources and their diversity, particularly with protected ecosystems and species, community forestry, agrobiodiversity and mountain biodiversity. The impetus for this has been the recognition that Nepal's biodiversity is the mainstay of the country's economy and the well being of its people. While the Nepal Biodiversity Strategy will build on the legacy of enlightened environmental planning that has resulted in several successful conservation stories, the present institutional structure of the country does require strengthening for its effective implementation. The NBS will facilitate this with a review of past achievements and lessons learned and identification of the major constraints and existing gaps which need to be addressed.

Threats to biodiversity

In the NBS, existing weaknesses, gaps, difficulties and other problems that threaten Nepal's biological diversity are analysed to determine the major causes of these problems. Immediate and the root causes are identified.

It must be stressed that this causal chain analysis is only preliminary and that NBS Implementation Plan will provide an opportunity for this analysis to be reviewed, with the broad participation of all stakeholders. However, the results so far are considered as indicative of some of the basic origins of the threats to Nepal's biodiversity, and can be summarised as follows:

- Low levels of public awareness and participation;
- High population pressures and prevailing poverty;
- Weak institutional, administrative, planning and management capacity;
- Lack of integrated land and water use planning;
- Inadequate data and information management; and
- Inadequate policies and strategies for biodiversity conservation.

These and other fundamental problems that may be identified through a broad-based analysis hold the key to successful biodiversity conservation in Nepal. Until these fundamental problems and root causes are addressed, success is not likely to be sustainable and the threats will reappear.

The NBS seeks to consolidate and build on past successful efforts and prescribes additional interventions required to address the root causes of the major threats to Nepal's biodiversity. In addition, since human and financial resources are limited, criteria are proposed for ranking problems and root causes identified according to their overall impact on biodiversity and priority for remediation.

Implementation mechanisms

Mechanisms for the implementation of the NBS, roles and responsibilities of various Government ministries, the private sector and the People of Nepal are outlined in the NBS.

The NBS will be implemented through the project activities that comprise the NBS Implementation Plan. In addition to the teams responsible for specific projects and activities, effective implementation will require the creation of the following two bodies and NBU as a secretariat of the NBCC:

- National Biodiversity Co-ordination Committee (NBCC)
- Thematic Sub-Committees

There is a strong commitment to make the implementation of the NBS a participatory approach. Public participation will be based on effective public information and education campaigns aimed at raising environmental sensitivity and awareness. In addition to the usual invitations for dialogue, submissions, objections and other reactions, the NBS seeks to involve the public in the early planning stages of resource use as well as in the bioresources management process. This will avoid confrontations and transform opposition into co-operation. The NBS will be implemented through a series of partnership arrangements.

Financial support for the implementation of the NBS will be sought from traditional and new sources and managed by the Nepal Biodiversity Trust Fund. The fund will support conservation education, training, applied research, sustainable income-generating activities, anti-poaching control, women-focused programmes, indigenous knowledge and practices, and policy development in accordance with national priorities identified in the NBS. Trust Fund board members will raise funds, manage, provide grants and advocate for biodiversity conservation.

In order to ensure transparency and accountability, an effective monitoring and evaluation process is being established based on quantifiable indicators to assess progress towards achieving the objectives of the NBS. The strategic objective of monitoring and evaluation activities under the NBS is to measure the extent to which the three principles of the Convention on Biological Diversity are being respected, namely the conservation of biodiversity, the sustainable use of its components, and the fair and equitable sharing of benefits accrued from them.

Acronyms

ACAP	Annapurna Conservation Area Project
ADB	Asian Development Bank
NBU	National Biodiversity Unit
CA	Conservation Area
CF	Community Forest
CBD	Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species of Fauna and Flora
COP	Conference of the Parties
DANIDA	Danish International Development Agency
DBC	District Biodiversity Committee
DDC	District Development Committee
DFO	District Forest Office
DNA	De-ribo Nucleic Acid
DNPWC	Department of National Parks and Wildlife Conservation
DSCWM	Department of Soil Conservation and Watershed Management
EPC	Environment Protection Council
EU	European Union
FAO	Food and Agriculture Organisation
FUG	Forest User Group
GEF	Global Environment Facility
HR	Hunting Reserve
ICIMOD	International Centre for Integrated Mountain Development
IPR	Intellectual Property Rights
IUCN	International Union for the Conservation of Nature - World Conservation Union
HDI	Human Development Index
HMGN	His Majesty's Government of Nepal
KMTNC	King Mahendra Trust for Nature Conservation
LU	Livestock Unit
MFSC	Ministry of Forest and Soil Conservation
NBS	National Biodiversity Strategy
NBSIP	Nepal Biodiversity Implementation Plan
NBU	National Biodiversity Unit
NGO	Non-Governmental Organisation
NPWC	National Parks and Wildlife Conservation
NTFP	Non-Timber Forest Product
INGO	International Non-Governmental Organisation
ITNC	International Trust for Nature Conservation
NBCC	National Biodiversity Co-ordination Committee
NP	National Park
PA	Protected Area
SI	Smithsonian Institution
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
VDC	Village Development Committee
WR	Wildlife Reserve
WWF	World Wildlife Fund

List of Tables

Table of Contents

1 INTRODUCTION

1.1 OBJECTIVES AND SCOPE OF THE STRATEGY

The Nepal Biodiversity Strategy (NBS) records the commitment of His Majesty's Government of Nepal (HMGN) and the People of Nepal to the protection and wise use of biological diversity and resources, on a sustainable basis, for the benefit of the People of Nepal and to honour the obligations of the Convention on Biological Diversity, to which Nepal is signatory. Biological diversity in Nepal is closely linked to the livelihoods of many people and their economic development, and touches upon agricultural productivity and sustainability, human health and nutrition, indigenous knowledge, gender equality, building materials, climate, water resources and the aesthetic and cultural well being of the society.

The NBS sets objectives for the protection of biological diversity in Nepal and identifies or restates Government policy on natural resources and their diversity. The Strategy also makes it clear that this is a commitment of His Majesty's Government as a whole and not of a single ministry. It therefore serves as a guide to all government organisations as well as the private sector and civil society.

The goal of the NBS is to provide a strategic planning framework for the conservation of biological diversity, the maintenance of ecological processes and systems, and the equitable sharing of the benefits accrued.

The NBS integrates the conservation and sustainable use of the diversity of biological resources with national development processes by:

- Reflecting the current state of knowledge of biological resources in various Government strategies, academic institutions, development plans, programmes, institutional arrangements and policies, including those mentioned in the Master Plan for the Forestry Sector;
- Identifying important policy and planning gaps, constraints on resources and facilities, implementation problems and current conservation practices and assessing further needs;
- Identifying current pressures and threats on biodiversity;
- Assessing the present and future significance and value of biodiversity to the Nepali people;
- Identifying conservation priorities and a time-frame for research, planning, management and investments;
- Assessing the costs of conserving biodiversity in Nepal; and
- Developing long-term plans, implementation mechanisms, and monitoring and evaluation systems for biodiversity conservation.

The NBS addresses, in the first instance, those at Central Government level who are charged with the responsibilities for the protection and management of the natural environment and its biological resources. However, values and links to biological resources go well beyond the environment alone. The NBS therefore also addresses other sectors within the public administration framework, particularly those involved in land or water use and development, forestry, agriculture, urban development, industry and commerce, road works, rural development, mining, energy, wildlife, national planning, foreign affairs and economic management. It also addresses local government officials, community and indigenous group leaders, INGOs and NGOs, the private sector (particularly resource management and resource use companies), and other government agencies and organisations outside the government whose actions, however unwittingly, may have consequences for the natural environment and biological resources.

The outcomes of the NBS will be:

A stronger political commitment The NBS reflects the commitment of His Majesty's Government and the people of Nepal.

Solid foundations An information management system, enhanced human and institutional capacity, clear policies and equitable legislation will be developed as the foundations for effective protection and management of biodiversity.

Detailed Action Plans Detailed action/implementation plans based on the goals and objectives of the NBS, will be developed, clearly identifying who will do what, when, where and how, with what human and institutional facilities and what financial resources.

Heightened public awareness Public awareness and sensitivity to biodiversity issues will be heightened through the better provision of information, greater opportunities for participation and the equitable distribution of the benefits of biodiversity conservation.

Effective evaluation system The NBS will establish a monitoring and evaluation process to gauge the success of implementation against predetermined indicators.

1.2 PRINCIPLES AND DEFINITIONS

1.2.1 PRINCIPLES

The following principles (not in any particular order) have been adopted in the formulation of the NBS and will provide guidance to all those involved in the implementation of the Strategy:

1. Those ecosystems, species and biological resources which are indigenous as well as endemic and which together give Nepal its distinct and unique ecological character are paramount in the protection and management of Nepal's biodiversity.

2. Poverty alleviation and economic and social development in rural areas are effective mechanisms for the sustainable use of biological resources and the conservation of biodiversity in Nepal.

3. The conservation of biodiversity may result in adverse impacts on some communities and individuals. Such adverse effects will be identified, minimised, and compensated.

4. The meaningful involvement and participation of local communities, indigenous peoples, conservation groups, and the public in general is crucial to the successful and long-term conservation of biological diversity.

5. Meaningful public participation is not possible without genuine public information designed to educate and inform at all levels, as appropriate.

6. Long-term sustainable use of biological resources can only be achieved if the benefits are shared fairly and equitably, and the innovations, practices, and knowledge of indigenous peoples and local communities are respected.

7. Biological diversity is best conserved *in-situ* through the conservation of natural ecosystems and habitats accompanied by the recovery and maintenance of viable populations of species in their natural surroundings. In accordance with Government policy, a landscape planning approach to managing biodiversity on an ecosystem level will be applied.

8. A comprehensive, representative and ecologically viable protected areas system, integrated with the management processes of other natural resource sectors including forests, agricultural lands, wetlands, rangelands and mountains, is crucial for the long-term *in-situ* conservation of biodiversity.

9. Human resources development, institutional capacity building and the empowerment of women leading to full participation at all levels, from policy development through planning to management and implementation, are essential to conserve and manage biodiversity effectively.

10. The identification of the status, true value and significance of Nepal's biodiversity and biological resources and their monitoring are central components to developing biological diversity conservation and sustainable use management plans. However, lack of information should not be considered as a reason to postpone action for conserving biodiversity.

1.2.2 DEFINITIONS AND CONCEPTS

The following definitions and concepts, some of which are from the Convention on Biological Diversity and other salient documents, have been adopted for this Strategy:

Biological diversity or biodiversity is the total variety of life on Earth. It encompasses the total number, variety, and variability of life forms, levels, and combinations existing within the living world. As such, biodiversity means the richness and variety of living beings from all sources including, *inter alia*, terrestrial, marine and freshwater ecosystems, and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

Biological resources includes genetic resources, organisms or parts thereof, populations or any other biotic component of ecosystems with actual or potential use or value for humanity.

Biotechnology means any technological application that uses biological systems, living organisms, or derivatives thereof to make or modify biological products or processes for specific use.

Domesticated or cultivated species means species in which the evolutionary process has been influenced by humans to meet their needs.

Ecosystem diversity comprises the variety of habitats, the dynamic complexes of plant, animal and micro-organism communities and their non-living environment, which interact as a functional unit, and their change over time. Ecologists have identified 118 ecosystems in Nepal representing distinct biological communities with their associated flora and fauna.

***Ex-situ* conservation** means the conservation of components of biological diversity outside of their natural habitats.

Genetic diversity refers to the variation of genes and/or genomes within living organisms, that is, the genetic differences between populations of a single species and between individuals within a population. In other words, this covers distinct populations of the same species such as the hundreds of traditional rice varieties in Nepal.

Habitat means the place or type of site where an organism or population naturally occurs.

***In-situ* conditions** means conditions where genetic resources exist within ecosystems and natural habitats and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties.

***In-situ* conservation** means the conservation of ecosystems and natural habitats and the recovery and maintenance of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties.

Landscape approach to planning and management of natural resources means a comprehensive, ecosystem-based approach, which takes into account living resources and includes local people and their wellbeing within the context of their physical environment and in harmony with natural cycles and processes.

Protected area means a geographically defined area that is regulated and managed to achieve specific conservation objectives.

Species diversity refers to the frequency and variety of species (wild or domesticated) within a geographical area. The total number of species in the world has been estimated to range from 5 to 30 million, out of which approximately 1.7 million have been described (WCMC 1992). There are different ways to describe species diversity. One often used to measure species diversity is *species richness*, which gives the total number of species within a particular sample area or geographical area. *Species evenness*, also known as *taxonomic diversity*, is expressed as the relationship of the number of species in different taxa, and indicates the relative abundance of taxa. For example, an island with two bird species and one lizard species has greater taxonomic diversity than an island with three bird species but no lizards (Raven 1992). *Species dominance* refers to the most abundant species (Botkin & Keller 1995).

Sustainable use means the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations.

1.3 METHODOLOGY

The NBS was developed with the participation of a broad cross-section of Nepali society and following the guidelines developed by UNDP/GEF (Hagen unpublished) for the preparation of effective national biodiversity strategies and action plans.

Following an initial analysis and review of existing conservation plans, policies, legislation and institutions, and in order to identify biodiversity conservation issues throughout the country, five regional workshops were organised by the contractor, Resources Nepal, with representation from all 75 districts of Nepal. Participants at these workshops represented District Development Committees, NGOs, INGOs, sectoral government agencies, and Community-Based Organisations. These in-depth, district-level interactions helped to identify and prioritise conservation issues. Concerns raised were presented to national-level, inter-sectoral government agencies, professional societies, NGOs and INGOs to explore opportunities to enhance biodiversity conservation within and outside the protected areas system.

The NBS is also the result of extensive consultations with government representatives at management level as well as with local experts and international scientists. Eight national experts workshops were held on protected areas, community forests, non-timber forest products, plant resources, rangeland biodiversity, wetland biodiversity and agrobiodiversity (crops and livestock genetics).

Over 120 NGOs and INGOs and all 75 District Development Committees participated in the development of the NBS. Over 350 government officials and national and international technical experts were consulted on various drafts. In addition, three biodiversity field surveys were conducted, 43 technical papers and a Geographical Information Systems manual were written, and a Geographical Information Systems document on protected areas was published. A team of nine national experts contracted by the Institute of Biodiversity, Nepal further reviewed and updated the Strategy.

The first draft comprised strategic elements, a plan of action and specific project proposals, and was known as the Draft Nepal Biodiversity Action Plan (NBAP). The NBAP was reviewed by an independent expert who also incorporated additional ideas. The, a team of experts and reviewers further revised the draft and brought the NBAP to its final draft shape.

At this stage, a formulation team was formed and there was a final round of extensive, structured consultations at the grassroots level with the primary objective of substantiating earlier findings and reaching as many grassroots level people as possible. Consultations took place in 10 districts representing the Terai, Mid-hills and Mountain regions. The districts selected were Morang, Chitwan, Nawalparasi, Bardia, and Kailali in the Terai, Kavre, Dhading and Myagdi in the Mid-hills, and Mugu and Humla in the Mountains. There were 29 sample sites in the Terai, 22 sites in the Mid-hills, and 14 in the Mountains within districts selected for consultations. The number of respondents totalled 1,254, of which 492 were women.

The draft was again revised to reflect inputs from these consultations. Comments and consensus arising from a last national biodiversity workshop in July 2001 in Kathmandu were forwarded to the final expert team entrusted with the final editorial work leading the production of the Strategy to its adopted stage; this comprises two documents: the Nepal Biodiversity Strategy and the NBS Implementation Plan.

2 NEPAL'S BIODIVERSITY AND ITS SIGNIFICANCE

2.1 PHYSICAL SETTING

2.1.1 Location

Nepal is situated on the southern slopes of the central Himalayas and occupies a total area 147,181km^2. The country is located between latitudes 26^{o}22' and 30^{o}27' N and longitudes 80^{o}40' and 88^{o}12' E. The average length of the country is 885km from east to west and the width varies from 145km to 241km, with a mean of 193km north to south. Hills and high mountains cover about 86% of the total land area and the remaining 14% are the flatlands of the Terai, which are less than 300m in elevation. Altitude varies from some 60m above sea level in the Terai to Mount Everest (Sagarmatha) at 8,848m, the highest point in the world.

Nepal's biodiversity is a reflection of its unique geographic position and altitudinal and climatic variations. Nepal's location in the central portion of the Himalayas places it in the transitional zone between the eastern and western Himalayas. It incorporates the Palaearctic and the Indo-Malayan biogeographical regions and the major floristic provinces of Asia (the Sino-Japanese, Indian, western and central Asiatic, Southeast Asiatic, and African Indian desert) creating a unique and rich terrestrial biodiversity.

2.1.2 Physiography

Wide altitudinal variations and diverse climatic conditions have resulted in four main physiographic zones. The extreme altitudinal gradient has resulted in nine bio-climatic zones from tropical to nival within a short horizontal span.

Table 2.1 Physiographic zones of Nepal

PHYSIOGRAPHIC ZONE	SURFACE AREA (%)	ELEVATION (m)	CLIMATE
High Himal	23	above 5,000	Tundra-type & Arctic
High Mountains	20	4,000-5,000	Alpine
		3,000-4,000	Sub-alpine
Mid-hills	30	2,000-3,000	Cool temperate monsoon
		1,000-2,000	Warm temperate monsoon
Lowlands (Terai & Siwalik Hills)	27	500-1,000	Hot monsoon & Subtropical
		below 500	Hot monsoon & Tropical

Source: LRMP (1986)

According to Hagen (1998), Nepal has seven physiographic divisions, which are, from south to north: Terai, Siwalik Hills zone, Mahabharat Lekh, Midlands, Himalaya, Inner Himalaya, and Tibetan marginal mountains.

Terai The Terai belt is a flat and valuable stretch of fertile agricultural land in southern Nepal, which forms part of the alluvial Gangetic plain. It lies at an altitude of between 60-300m between the Indian border and the first, outer foothills. The original forest cover in the Terai was dense and this is still so in western Nepal, but in other parts there has been a great deal of habitat destruction and ruthless felling of trees.

Siwalik Hills Zone The Siwalik Hills Zone, which rises abruptly from the Terai plains and reaches an elevation of between 700-1,500m, is wider in the western and far-western regions of Nepal and narrower in the east. It is mainly composed of sedimentary rock and big boulders.

This zone comprises the southernmost hill region of Nepal. The Bhabar rises from the Terai in the north and comprises a narrow but continuous belt of forest, locally known as *Char Kose Jhadi*, which is about 8-12km wide. The Bhabar is formed by the accumulation of gravel, boulders, stone, and sand that are washed down from the foothills. Water is scarce in these parts throughout the year except during the monsoon, when sizeable streams often rise up.

The Bhabar is not, however, an entirely independent range since in some areas the Mahabharat Lekh, which lies behind it to the north, merges into the Siwalik Hills Zone. In other areas the two ranges are separated by broad and gently sloping valleys, called Dun valleys. Important Dun valleys are the Dang Valley in western Nepal, the Chitwan Valley in central lowland Nepal, and the Trijuga Valley in eastern Nepal. Dun valleys are under intensive cultivation, and due to the removal of forest cover serious soil erosion has been a problem particularly in recent years.

Mahabharat Lekh The Mahabharat Lekh, or range, also known as the *inner Himalayan range*, lies between the Siwalik Hills to the south and the midlands to the north. The range is well developed in eastern and central Nepal and underdeveloped in western Nepal. It is composed of hard rocks such as granite or quartzite and limestone. The elevation of the Mahabharat Lekh is from 1,500m to 2,700m. Major rivers, namely the Bagmati, Babai, and Rapti Rivers, flow from the northern to the southern edges of the Mahabharat range.

Midlands The Midlands lie north of the Mahabharat and occupy the central region of the country. The average altitude is 2,000m with elevations ranging from 600-3,500m. The Midlands comprise the high valleys of Nepal, of which the most important with very dense human populations are the Kathmandu, Pokhara, Trishuli and Banepa Valleys. Agriculture is intensive in this part of the country where the farmers have made terraces on the steep hillsides, sometimes up to the very tops of the high hills. Forests have been severely degraded in this region and the rate of soil erosion is alarming. All the rivers that flow from the Himalayas down to the plains combine their waters into three great rivers, the Sapta Koshi in eastern Nepal, the Narayani in central Nepal, and the Karnali in far-western Nepal. The midlands are rich in schist and quartz rocks.

Himalaya The Himalayan zone lies in the north of Nepal, above 4,000m in elevation and stretches from the east to the west of the country. It comprises sub-alpine and alpine climates where summer grazing pastures are found in the lower elevations and where high altitude plants species adapted to extremes of cold and desiccation are found in the higher elevations. Heavy snowfall occurs during the winter months. Above 5,500m the Himalaya is covered with perpetual snow and there is no vegetation. Above 6,000m, the region is considered as arctic desert or the nival zone.

Inner Himalaya There are several inner Himalayan valleys with desert conditions such as the upper Kaligandaki and Bheri Valleys, located at altitudes above 3,600m. These valleys are very dry and the monsoon climate is absent.

Tibetan Marginal Mountain Range To the north of the Dhaulagiri and Annapurna Himals are the almost treeless plateaus, called the Tibetan Plateau or arid zone. This zone includes parts of Dolpa, Mustang, and Manang, where the climate and vegetation are Tibetan in character.

2.1.3 Climate

A wide range of climatic conditions exists in Nepal mainly as a result of altitudinal variation. This is reflected in the contrasting habitats, vegetation, and fauna that exist in the country. Other important climatic factors influencing biodiversity and the composition of flora and fauna in Nepal include rainfall, winter snowfall, temperature, and aspect.

Rainfall Eighty percent of the precipitation that falls in Nepal comes in the form of summer monsoon rain, from June to September. Winter rains are more common in the western hills. The average annual rainfall in Nepal is about 1,600mm, but total precipitation differs in each eco-climatic zone. The eastern region is wetter than the western region. For example, Taplejung (1,768m) in the far-eastern Mid-hills receives an average annual rainfall of 2,024mm, whereas Baitadi (1,635m) in the far-western region receives only 1,037mm. The southern flanks of the Himalayas, such as at Pokhara, receive a higher amount of rainfall (3,345mm), while the rain-shadow areas of Dolpa, Jomsom, and Mustang receive considerably less (295mm).

Temperature Temperature varies with topographic variations. In the Terai, winter temperatures are between 22-27^{o}C, while summer temperatures exceed 37^{o}C. In the Mid-hills, temperatures are between 12-16^{o}C. In general, the average temperature decreases by 6^{o}C for every 1,000m gain in altitude (Jha 1992). Deforestation, industrialisation, and urbanisation have influenced a rise in temperature in recent years.

Aspect Aspect has an important influence on vegetation, particularly at lower altitudes. In general, moisture is retained more on north and west faces, while south and east faces are drier because of their longer exposure to the sun.

2.1.4 Soil

Soil formation is related to physiographic zone. In the Terai, the soil is alluvial and fine to medium textured. In the Siwalik Hills, soil is made up of sedimentary rocks with a sandy texture, while in the Mid-hills it is of medium to light texture with a predominance of coarse-grained sand and gravel. The soil in the high mountains is shallow, stony, and glacial. The hill slopes tend to lose their topsoil through erosion (HMGN/ADB/FINNIDA 1988).

2.1.5 River systems

The major perennial river systems that drain the country are the Mahakali, Karnali, Narayani, and Koshi Rivers, all of which originate in the Himalayas. These big rivers hold water resources with tremendous potential for large-scale hydropower and irrigation development. Medium-sized rivers include the Babai, West Rapti, Bagmati, Kamla, Kankai, and Mechi Rivers; these generally originate in the Mid-hills or in the Mahabharat range. The Terai region has a large number of small and usually seasonal rivers, most of which originate in the Siwalik Hills (HMGN/ADB/FINNIDA 1988).

2.1.6 Land use

The latest physiographic data show that Nepal comprises around 4.27 million hectares (29% of total land area) of forest, 1.56 million hectares (10,6%) of scrubland and degraded forest, 1.7 million hectares (12%) of grassland, 3.0 million hectares (21%) of farmland, and about 1.0 million hectares (7%) of uncultivated lands. It has been reported (HMGN-DFRS 1999) that forest cover in the Terai and hill areas decreased at an annual rate of 1.3% and 2.3% respectively between 1978/79 and 1990/91. On average, forested areas have decreased at an annual rate of 1.7% and scrublands have decreased at an annual rate of 0.5%. In terms of total land area, the Terai occupies only 23.1%whereas hills occupy 41.7% and mountains 35.2%.

2.2 SOCIO-ECONOMIC SETTING

2.2.1 Population and human development

Nepal has a population of 23.2 million (2001 census). 48.5% of the population lives in the Terai, 44.2% in the Hills and 7.3% in the Mountains. The average population density is 157.73/km^2, with the highest density (330.78/km^2) in the Terai, medium density in the Hills (167.44/km^2) and lowest in the Mountains (32.62/km^2). In relation to Nepal's five development regions, the Central Development Region accommodates 34.7% of the total population, followed by the Eastern Development Region with 23.1%, the Western Development Region with 19.6%, the Mid-Western Development Region with 12.9%, and the Far-Western Development Region with 9.5%.

The average annual growth rate was 2.08% between 1981 and 1991, but the figures from the 2001 census indicate a population growth rate of 2.27%. The growth rate is highest in the Terai and lowest in the Mountains.

Table 2.2 summarises the population data from the 2001 census.

Table 2.2 Population density and distribution in Nepal

CHARACTERISTIC	TERAI	HILLS	MOUNTAINS	NEPAL
Area (km^2)	34,019	61,344	51,818	147,181
Area (%)	23.1	41.7	35.2	100
Population (%)	48.5	44.2	7.3	100
Eastern Development Region (%)	14.3	7.1	1.7	23.1
Central Development Region (%)	17.0	15.3	2.4	34.7
Western Development Region (%)	7.5	12.0	0.1	19.6
Mid-Western Development Region (%)	5.3	6.3	1.3	12.9
Far-Western Development Region (%)	4.3	3.5	1.7	9.5
Density (per km^2)	330.78	167.44	32.62	157.73

Source: Preliminary results of Population Census of 2001.

The rate of urbanisation in Nepal is low compared to other developing countries, and some 85% of the population still lives in rural areas with limited access to health and education services. The average literacy rate is now 39.6%, a significant improvement from 14% in 1971.

The 1999 Human Development Index (HDI) for Nepal is 0.463. While there has been a very slow but gradual improvement in human development in all years except for 1993, the current level is still low even by South Asian standards. The indices also show that deprivation in access to employment is much higher than deprivations in health or education. Residents of the Hills and Terai enjoy a higher level of human development than residents of the Mountains. A similar pattern appears when the HDI is disaggregated by gender, with the gender-sensitive development index being lowest in the Mountains, thus further accentuating an imbalance in this region, which is already very high on a national level.

2.2.2 Natural resources of economic significance

The economic well being of Nepal is very closely bound to its natural resources - agricultural land, wetlands, forests, and protected areas.

Although only comprising some 20% of land area, agricultural land is the major determinant of economic activities and the nation's socio-political identity, according to the Nepal Human Development Report, 1998 (NSAC, 1998). Agricultural land is unevenly distributed, with 55.7% in the Terai, 37.3% in the Hills and 6.9% in the Mountains. Agriculture contributes over 50% of household income, provides employment for about 80% of the population, and has a significant influence on the manufacturing and export sectors of the economy.

Freshwater resources are abundant in Nepal, with approximately 200 billion m^3/s flowing through its river systems. The commercial hydroelectric potential has been estimated at up to 45,000MW. The potential for crop irrigation is also very high, probably approaching 90% of cultivable land.

Forests cover some 29% of the land area. This is a mere fraction of the original forest cover, which has suffered increasing population pressures and demand for arable land, pastures, fuel, fodder and farm implements. The high demand for agricultural land has led to considerable deforestation and loss of land cover. This, together with natural phenomena such as floods and landslides, is thought to contribute to an annual soil loss of 20-25 tonnes/ha.

However, in spite of the decline in forest cover, forested land is still one of the most valuable natural resources of Nepal through its attraction for eco-tourism. The majority of protected areas, including the major National Parks, comprise forested land, and their contribution to the national economy, through foreign exchange earnings, is of major importance.

Tourism is the second most important source of foreign exchange for Nepal. Tourist arrivals in 1999 numbered 421,188 and the figure is expected to grow by 8-10% annually in the near future. Approximately 45% of tourists visited protected areas in 1998/99 (see Table 2.3). Four protected areas, Royal Chitwan National Park, the Annapurna Conservation Area, Sagarmatha (Mount Everest) National Park and Langtang National Park, received the bulk of tourists, and there is a lot of potential for increasing the numbers of tourists visiting other protected areas. As tourism-related activities in and around protected areas generate revenue, tourism will remain central to the economic sustainability of the protected areas system.

Table 2.3 Number of visitors in protected areas (1998/99)

Protected Area	Number of Visitors		Total
	Indian Nationals	Other Nationals	
Lowlands			
Koshi Tappu WR	1,584	466	2,050
Parsa WR	0	2	2
Royal Chitwan NP	21,748	55,518	77,266
Royal Bardia NP	0	2,853	2,853
Royal Suklaphanta WR	59	159	218
Mid-hills			
Shivapuri NP	0	7,900	7,900
Dhorpatan HR	0	112	112
Khaptad NP	0	13	13
High Mountains			
Kanchenjunga CA	0	881	881
Makalu Barun NP	0	ca. 1,000	1,000
Sagarmatha NP	0	21,372	21,372
Langtang NP	0	10,889	10,889
Manaslu CA[(1)]	0	104	104
Annapurna CA[(1)]	0	66,320	66,320
Shey Phoksundo NP	0	489	489
Rara NP	4	144	148
TOTAL	**23,395**	**168,222**	**191,617**

Sources: DNPWC-MFSC (Annual Report 1998/99)
[(1)] KMTNC

2.3 NEPAL'S ECOSYSTEMS AND SPECIES

2.3.1 DIVERSITY AT DIFFERENT ALTITUDES

2.3.1.1 Lowlands (Terai and Siwalik Hills, below 1,000m)

The biological diversity contained in the Terai and Siwalik Hills (lowlands) ecosystems are of international importance both in view of the number of globally threatened species of wildlife and flora as well as the diversity of ecosystems contained within the area (BPP 1995f). The Terai is heavily populated, resulting in serious pressures on forest resources. The lowlands are mostly dominated by Sal (*Shorea robusta*), tropical deciduous riverine forest, and tropical evergreen forest. Sal forests have suffered greatly from lopping and felling of trees by local villagers in eastern and central Nepal, but it still form some magnificent stands of tall trees in western Nepal.

Recognising the great significance of the biodiversity of the lowlands, HMGN established five protected areas in the Terai and Siwalik Hills. These are: Koshi Tappu Wildlife Reserve, Parsa Wildlife Reserve, Royal Chitwan National Park, Royal Bardia National Park and Royal Suklaphanta Wildlife Reserve. While the Terai ecosystems are well represented within these protected areas, coverage of the Siwalik Hill ecosystems is less comprehensive (Maskey 1996). Out of 23 ecosystems described by Dobremez in the lowlands, 15 are included in the current protected areas of Nepal (Table 2.4). Unfortunately, biological resources outside these protected areas are under great pressure from exploitation and the conversion of forests to farmland.

Table 2.4 Ecosystems identified by Dobremez (1970), and their representation in protected areas

PHYSIOGRAPHIC ZONE	TOTAL NUMBER OF ECOSYSTEMS	NUMBER IN PROTECTED AREAS
Terai	10	10
Siwalik Hills	13	5
Mid-hills	52	33
Highlands	38	30
Other	5	2
Total	**118**	**80**

Source: modified from BPP (1995i) by Maskey (1996)

Dobremez (1996) presented an altitudinal distribution of flora in central Nepal. He categorised biogeographical domains into 11 levels of vegetation at altitude differences of 500m. The Biodiversity Profiles Project (BPP 1995f) lists 1,885 species of angiosperms, 61 species of bryophytes and 81 species of pteridophytes from the Terai and Siwalik Hills (Table 2.5).

Table 2.5 Number of species of flora and fauna occurring in each physiographic zone

GROUP	TERAI & SIWALIK HILLS <1,000m	MID-HILLS 1,000-3,000m	HIGHLANDS >3,000m
Plantae			
Bryophytes	61 (8.40%)	493 (66.62%)	347 (46.89%)
Pteridophytes	81 (21.32%)	272 (71.58%)	78 (20.53%)
Gymnosperms	-	16 (84.20%)	10 (52.63%)
Angiosperms	1,885 (36.53%)	3,364 (65.19%)	> 2,000 * (38.70%)
Animalia			
Butterflies	325 (51.1%)	557 (88.00%)	82 (13.10%)
Fishes	154 (83.20%)	76 (41.10%)	6 (3.20%)
Amphibians	22 (57.20%)	29 (67.40%)	9 (20.90%)
Reptiles	68 (68.00%)	56 (56.00%)	13 (13.00%)
Birds	648 (77.8 0%)	691 (82.50%)	413 (49.60%)
Mammals	91 (50.27%)	110 (60.70%)	80 (44.20%)

Source: BPP (1995f). * Approximate figure. Species of flora and fauna may occur in more than one physiographic zone, and therefore the percentages (of the total number of species of each group found in Nepal) do not necessarily add up.

Most of the exploratory work on the flora of Nepal has been done in the Mid-hills Mountains, and the current number of floral species in the Terai and Siwalik Hills may change significantly with more surveys. The faunal diversity in the different ecological zones is not well categorised, however, faunal diversity is high in the Terai and Siwalik Hills (BPP 1995f). The Biodiversity Profiles Project lists 648 bird species, 111 of them confined species, in the Terai and Siwalik Hills (out of 833 bird species found in Nepal). The lowland fauna is more endangered than the Mid-hills or Mountain fauna (Table 2.6) because of greater human activity in the lowlands (Terai and Siwalik Hills).

2.3.1.2 Mid-hills (1,000-3,000m)

The Mid-hills have the greatest ecosystem diversity as well as species diversity in Nepal. This is due to the great variety of terrain and the occurrence of subtropical to temperate flora and fauna in this zone. Nearly 32% of the forests in Nepal occur in the Mid-hills, and the zone includes 52 types of ecosystems. Dobremez (1996) listed the highest number of angiosperms in the Mid-hills, particularly between 2,000-2,500m in altitude. The Biodiversity Profiles Project (BPP 1995f) lists 3,364 species of angiosperms, 493 species of bryophytes, 272 species of pteridophytes and 16 species of gymnosperms in the Mid-hills. Furthermore, 557 species of butterflies, 76 species of fishes, 29 species of amphibians, 56 species of reptiles, 691 species of birds and 110 species of mammals are listed in the Mid-hills.

Table 2.6 Number of threatened species of fauna according to physiographic zone

FAUNA GROUP	THREATENED CATEGORY*	PHYSIOGRAPHIC ZONE		
		Lowlands	**Mid-hills**	**Highlands**
Butterflies	E	0	12	0
	V	7	28	11
	S	31	63	7
Total		**38**	**103**	**18**
Fishes	E	18	9	0
	V	8	9	1
	S	1	1	0
Total		**27**	**19**	**1**
Herpetofauna				
Frogs	S	3	6	2
Crocodiles	V	1	0	0
	E	1	0	0
Turtles	V	3		
	S	11		
Lizards	S	2	3	
Snakes	V	3	2	
	S	3	1	
Total		**27**	**12**	**2**
Birds	CR	4	4	
	E	42	37	13
	V	53	47	19
	S	80	88	44
Total		**179**	**176**	**76**
Mammals	CR	2		3
	E	8	2	5
	V	23	29	6
	S	16	16	12
Total		**49**	**47**	**26**

* IUCN Threat Categories (IUCN-Nepal 1995a, b): Critically Endangered (CR), Endangered (E), Vulnerable (V), Susceptible (S)

Source: BPP (1995f, g, h). Species may occur in more than one physiographic zone, and therefore the percentages (of the total number of species of each group found in Nepal) do not necessarily add up.

2.3.1.3 Highlands (above 3,000m)

The Nepal highlands are the meeting place of two major geographical regions of the world - the Palaearctic region to the north and the Indo-Malayan region to the south. There are 38 major ecosystems found in the highlands. Recognising the significance of these ecosystems, HMGN established seven protected areas in the highland mountains (and three protected areas spanning the Mid-hills and highlands), covering 78.52% (20,939km^2) of total protected areas. These protected areas represent 30 of the 38 ecosystems of the highlands (Table 2.4).

The highlands are relatively less diverse in flora or fauna than the Mid-hills and lowlands because of the adverse environmental conditions. However, they are characterised by a large number of endemic species. They comprise around one third of the total forest cover of Nepal, representing birch, oak, rhododendron, juniper, fir, cedar, larch, and spruce forests. About 420 phanerogamic species have been recorded above 5,000m on both sides of the Himalayan range in the Everest region (Miehe 1989).

2.3.2 ECOSYSTEMS DIVERSITY

2.3.2.1 Forest ecosystems

Forests play a vital role in maintaining ecological balance and economic development. Pristine forests are also a major attraction for foreign tourists. Major energy sources, animal fodder and timber are all found in the forest environment. Forest catchments are the main sources of water used for hydroelectric power, irrigation, and domestic/household consumption. Rural people are very dependent on many non-timber forest products (NTFPs) for their subsistence needs.

Forest types

Nepal has a very diverse flora with 35 forest types, as classified by Stainton (1972). These forest types are categorized into ten major groups - tropical, subtropical broad-leaved, subtropical conifer, lower temperate broad-leaved, lower temperate mixed broad-leaved, upper temperate broad-leaved, upper temperate mixed broad-leaved, temperate coniferous, sub-alpine and alpine scrub forests. In addition, there are some patches of plantation forest. The habitats and characteristics of the major forest types within these groups are briefly described below:

(1) Tropical forest (below 1,000m): This forest type is predominantly composed of *Shorea robusta* in the southern parts of Nepal. *Acacia catechu/Dalbergia sissoo* forests replace *Shorea robusta* forests along streams and rivers. There are other riverine forests with mainly evergreen species such as *Michelia champaca* or deciduous species such as *Bombax ceiba*. *Shorea robusta* forests are replaced by *Terminalia/Anogeissus* forests in the foothills of western Nepal.

(2) Subtropical broad-leaved forest (1,000-2,000m): *Schima wallichii/Castanopsis indica* forests are found in central and eastern Nepal. Riverine forests of *Cedrela/Albizia* occur along large rivers such as the Arun on subtropical foothills. *Alnus nepalensis* forests are widespread along streams and in moist places.

(3) Subtropical pine forest (1,000-2,200m): *Pinus roxburghii* forests occur particularly on the south-facing slopes of the Mid-hills and Siwalik Hills in western and central Nepal.

(4) Lower temperate broad-leaved forest: This forest type occurs between 2,000-2,700m in the west and 1,700-2,400m in the east. *Alnus nitida, Castanopsis tribuloides/C. hystrix, Lithocarpus pachyphylla,* and several species of *Quercus* forests thrive in the Mid-hills. Among them, *Alnus nitida* forests are confined to the riverbanks of the Mugu Karnali, at 2,130-2,440m. *Quercus leucotrichophora/Q. lanuginosa* forests and *Q. floribunda* forests occur mostly in west Nepal, whereas *Q. lamellosa* forests are widespread in central and eastern Nepal. *Lithocarpus pachyphylla* forests occur in eastern Nepal.

(5) Lower temperate mixed broad-leaved forest (1,700-2,200m): This type of forest is confined to north and west-facing slopes. In many places, prominent tree species of this forest type belong to the Lauraceae family.

(6) Upper temperate broad-leaved forest (2,200-3,000m): *Quercus semecarpifolia* forests are widespread in central and eastern Nepal on south-facing slopes but it are absent in heavy rainfall areas such as the upper Arun and Tamur valleys and the hills lying north of Pokhara.

(7) Upper temperate mixed broad-leaved forest (2,500-3,500m): This forest type occurs in central and eastern Nepal, mainly on north and west-facing slopes. *Acer* and *Rhododendron* species are prominent throughout this altitude range. However, *Aesculus/Juglans/Acer* forests are mostly confined to western Nepal.

(8) Temperate coniferous forest (2,000-3,000m): *Pinus wallichiana, Cedrus deodara, Cupressus torulosa, Tsuga dumosa* and *Abies pindrow* forests characterise the temperate conifer forest type. However, many of the above species also thrive above 3,000m. *Pinus wallichiana* is an aggressive coloniser and is found in temperate parts of Nepal, extending to 3,700m. *Cedrus deodara*, *Picea smithiana, Juniperus indica* and *Abies pindrow* forests occur in the western Himalayas. The valley of the upper Bheri River demarcates the eastern boundary for *Cedrus deodara*. *Larix himalaica* forests only occur in the Langtang and Buri Gandaki valleys of Nepal, preferring moraine habitats. *Larix griffithiana* is an eastern Himalayan larch species and extends to 3,940m. Both, *Cupressus torulosa* forests and *Tsuga dumosa* forests are widespread throughout Nepal between 2,130-3,340m.

(9) Sub-alpine forest (3,000-4,100m): *Abies spectabilis, Betula utilis*, and *Rhododendron* forests occur in subalpine zones, the latter in very wet sites.

(10) Alpine scrub (above 4,100m): Juniper-Rhododendron associations include *Juniperus recurva, J. indica, J. communis, Rhododendron anthopogon,* and *R. lepidotum* associated with *Ephedra gerardiana,* and *Hippophae tibetana* in inner valleys. *Caragana versicolor, Lonicera spinosa, Rosa sericea* and *Sophora moocroftiana*, amongst others, occur north of the Dhaulagiri-Annapurna massif. Alpine meadows, locally

called 'Kharka', are subjected to grazing during the summer and rainy seasons. Perpetual snow occurs above 5,200m, and mosses and lichens are found in scattered locations. *Stellaria decumbens* and *Parrya lanuginosa* have been recorded at an elevation of about 6,100m, but beyond 6,000m, in the Arctic desert/nival zone, even mosses and do not survive.

Plantation Forests

Nepal has been striving to improve its degraded forests and grasslands in the Terai and Mid-hills with plantations. As a result, a number of districts now have substantial areas of plantation forest comprising both indigenous and exotic species. Major species of planted forests in the Terai are *Dalbergia sissoo, Eucalyptus* species, and *Tectona grandis*, particularly in the Sagarnath and Nepalgunj Forestry Development Projects, which are implemented by the Forest Product Development Board. *Pinus roxburghii, P. wallichiana, P. patula,* and *Alnus nepalensis* are largely planted in the Mid-hills.

Non-Timber Forest Products

Non-Timber Forest Products (NTFPs) are defined as any kind of goods derived from forest species, both plant and animal, other than timber or phalloid. A narrower definition of NTFPs appropriate for Nepal includes all biological materials, other than timber, fodder or phalloid (Hammett 1993). Medicinal and aromatic plants and other minor forest products are among six primary programmes formulated in the Master Plan for Forestry Sector, Nepal (HMGN/ADB/FINNIDA 1988).

Recently, there has been increasing awareness of the importance of NTFPs as a result of factors such as the dependence of rural communities on NTFPs, site quality, new market preferences for natural products, increasing concern about the conservation of forests and their biodiversity, and the occurrence of many non-wood products amongst the biological richness and ecological complexity of natural forests (FAO 1994; Grimes *et al*. 1994). The value of these products can be far greater than that of timber harvests or the land converted to pasture or agriculture (Roque 1992). In Southeast Asia, at least 29 million people depend on NTFPs for subsistence income.

An identification manual published by the Forest Resource Information System Project (FRISP), under HMGN and the Finnish International Development Agency (FINNIDA), has illustrations, descriptions and other useful field notes for over 121 varieties of NTFPs in Nepal (Malla *et al*. 1997). Parajuli *et al.* (1998) have described 70 non-timber species together with information on the parts used, occurrence, conservation status, royalty rate, market price, active constituents and ethnobotanical uses. Similarly, a list of 139 vascular, non-timber plant species, with their vernacular name, habit, distribution, parts used and uses has been compiled by Chaudhary (1998).

Sustainable management of NTFPs is important because of their value as a perennial source of subsistence income and as a means of conserving biodiversity. Little attention, however, has been given to the biological, socio-economic and conservation importance of NTFP resources. However, a clear understanding of this resource is still lacking in Nepal.

2.3.2.2 Rangeland ecosystems

Collectively, rangelands in Nepal comprise grasslands, pastures, scrubland and forests (MOPE 1998). The rangeland environment supplies forage or vegetation for grazing or browsing livestock. Nepal's rangelands have high biodiversity as they range from subtropical savannahs to temperate grasslands and alpine meadows, and include the cold, arid steppes north of the Himalayas. Nepal's total grassland areas are estimated to cover about 1.75 million hectares, or nearly 12% of Nepal’s total land area. About 70% of the rangelands are situated in the western and mid-western regions, and it is estimated that only 37% of rangeland forage is actually available or accessible for livestock (LMP 1993; Pariyar 1998).

Rangeland Resource Development Rangeland management has not as yet been comprehensively addressed by the government sector (Pariyar 1998). Most of Nepal's initiatives are targeted towards forage research and development. A programme was first initiated in the late 1950s with the establishment of cheese factories in north–central Nepal for processing yak and chauri (a yak-cattle hybrid) milk. A temperate cultivar evaluation-cum-forage production programme was launched in 1953, and FAO's Pasture, Fodder and Livestock Development Project was

implemented in Nuwakot and Rasuwa districts in the late 1960s. Similarly, rangeland improvement programmes were strengthened with the establishment of a Pasture & Fodder Development Farm in Rasuwa district in 1971 and a Pasture Development Project at Khumaltar in 1978. USAID's Resource Conservation and Utilisation Project (RCUP) and the Swiss-funded forage improvement activities in Dolakha and Sindhupalchowk were implemented as external assistance projects and continued until the 1980s (Basnyat 1999).

Profound changes have taken place primarily through the expansion of agriculture land into rangelands. The transformation of traditional pastoral production systems and a general desiccation of alpine rangelands due to climatic changes are thought to be modifying the vegetation composition and reducing plant productivity (Miller 1993). Political changes in Tibet after 1959 also disrupted centuries-old transhumance patterns. Since then, there have been several negotiations on the issues of rangeland availability for both Nepali and Tibetan herds, and, in 1983, the two governments agreed that it would be prohibited to allow animals from each country to cross the common border to graze. These political, social, economic and ecological transformations have cumulatively degraded many previously remote pastoral areas and their environments.

Realising the severe impacts of such a border closure as well as the shortage of fodder, Nepal initiated the Northern Areas Pasture Development Programme in 1985, which focuses on rangeland management and fodder development in four critical districts - Humla, Mustang, Sindhupalchowk and Dolakha, and six other districts that are beginning to experience a forest/fodder crisis - Manang, Dolpa, Gorkha, Mugu, Sankhuwasabha, and Taplejung. Between 1987 and 1990, the High Altitude Pasture Development Project provided extensive support to the initiative, while the Himalayan Pasture & Fodder Research Network supported research. These two FAO/UNDP-funded activities supported HMGN's district level forage improvement programme aimed at reducing the fodder crisis.

The Hills Leasehold Forestry & Forage Development Project, 1992, was jointly implemented by the Department of Forests, Department of Agriculture, Nepal Agricultural Research Council and the Agriculture Development Bank of Nepal to alleviate poverty and restore degraded hill slopes in 12 districts through access to credit and technological assistance for poor farmers. This will help improve applied fodder and pasture research in degraded hill areas, but institutional relationships between researcher, technician, and farmer, and between the public and private sectors are still being developed.

The grasslands of Nepal, which are a component of rangelands, are divided into five climatic zones (Table 2.7), but a high proportion is located in the Mid-hills and Mountain regions. Grasslands contribute to biological diversity with various flowering plant species and habitat for wildlife, including black buck, nilgai, swamp deer, hog deer, chital, gaur and sambar in subtropical grasslands; and taking, musk deer and goral in alpine grasslands. In addition, these grasslands also sustain domestic livestock, which are another important biological resource.

Table 2.7 Grassland categories according to climatic zones

ZONE	REMARKS
Tropical	Grasslands grazed almost all the year round.
Subtropical	Non-palatable species such as ferns, stinging nettle, and *Eupatorium* species are becoming dominant because of heavy grazing.
Temperate	Winter grazing for cattle, sheep and goats. Burning to improve grasslands is a common practice, causing increased soil erosion.
Sub-alpine	Seasonal grazing only because of heavy snow cover in winter. Burning of grasslands at the end of the grazing season and in early spring is common.
Alpine	Grasslands are grazed only during the summer (June - September).

Plant Species in Rangelands Different types of grasses are the distinguishing characteristic of grasslands and provide forage for wild animals as well as for domestic cattle. Plant species found in the different rangelands of Nepal have been identified as follows:

Table 2.8 Plant species found in the rangelands of Nepal

RANGELAND	PLANT SPECIES
Tropical (Terai)	*Ageratum conyzoides, Artemesia vulgaris, Arthraxon sikkimensis, Arundinella nepalensis, Bothriochloa glabra, Bothriochloa intermedia, Brachiaria villosa, Chrysopogon aciculatus, Cissus repens, Cymbopogon pendulus, Cynodon dactylon, Cyperus difformis, Desmodium heterocarpon, Desmostachys bipinnata, Digitaria longiflora, Eragrostiella nardoides, Eragrostis atrovirens, Eragrostis nigra, Eragrostis pilosa, Eragrostis unioloides, Hackelochloa granularis, Heteropogon contortus, Hymenachne pseudointerrupta, Imperata cylindrica, Ischaemum rugosum, Narenga porphyrocoma, Neyraudia reynaudiana, Panicum notatum, Paspalidium flavidum, Paspalum conjugatum, Paspalum scrobiculatum, Phragmites karka, Pogonatherum paniceum, Rotala indica, Saccharum arundinaceum, Saccharum spontaneum, Sacciolepis indica, Setaria pallidefusca, Sporobolus diander, Trudax procumbens, Vetiveria zizaniodes*.
Subtropical	*Ageratum conyzoides, Agrostis pilosula, Anaphallis busua, Apluda mutica, Apocopis paleacea, Artemisia vulgaris, Arthraxon sikkimensis, Arundinella bengalensis, Arundinella nepalensis, Arundinella setosa, Bothriochloa intermedia, Bothriochloa pertusa, Brachiaria ramosa, Brachiaria villosa, Campanula cana, Capillipedium assimile, Capillipedium parviflorum, Carex alopecuroides, Cheilanthus grisea, Chrysopogon aciculatus, Chrysopogon fulvus, Chrysopogon gryllus, Cymbopogon jawarancusa, Cymbopogon pendulus, Cymbopogon stracheyi, Cynodon dactylon, Cynogolossum zeylanicum, Cyperus niveus, Cyperus rotundus, Desmodium heterocarpon, Desmodium microphyllum, Digitaria longiflora, Digitaria setigera, Dimeria fuscescens, Dryopteris fillix-mass, Elephantopus scaber, Eleusine indica, Eragrostiella nardoides, Eragrostis atrovirens, Eragrostis nigra, Eragrostis pilosa, Eragrostis unioloides, Eulalia mollis, Eulaliopsis binata, Eupatorium adenophorum, Euphorbia thymifolia, Gonostegia hirta, Heteropogon contortus, Heteropogon contortus, Imperata cylindrica, Isachne globosa, Ischaemum rugosum, Justicia procumbens, Laggera alata, Micromeria biflora, Paspalidium flavidum, Paspalum distichum, Paspalum scrobiculatum, Pennisetum pedicellatum, Perotis hordeiformis, Phyllanthus parvifolius, Pogonatherum paniceum, Rotala indica, Saccharum spontaneum, Sacciolepis indica, Schizachyrium brevifolium, Setaria pallidefusca, Sida rhombifolia, Sporobolus fertilis, Thysanolaena maxima.*
Temperate	*Agrostis myriantha, Agrostis gigantea, Agrostis micrantha, Agrostis munroana, Agrostis pilosula, Anaphalis triplinervis, Andropogon munroi, Apluda mutica, Apocopis paleacea, Artemisia dubia, Arthraxon sikkimensis, Arundinella birmanica, Arundinella hookeri, Arundinella nepalensis, Arundinella setosa, Berberis aristata, Berberis asiatica, Bothriochloa intermedia, Bothriochloa ischaemum, Brachypodium sylvaticum, Bromus nepalensis, Calamagrostis emodensis, Calamagrostis epigejos, Calamagrostis pseudophragmites, Capillipedium assimile, Chrysopogon gryllus, Colquhounia coccinea, Cotoneaster microphyllus, Cymbopogon distans, Cymbopogon pendulus, Cymbopogon schoenanthus, Dactylis glomerata, Danthonia cumminsii, Deschampsia caespitosa, Desmodium elegans, Deyeuxia scabrescens, Digitaria longiflora, Elymus canaliculatus, Elymus semicostatus, Elymus thomsonii, Eragrostis nigra, Erianthus longesetosus, Eulalia mollis, Eulaliopsis binata, Festuca gigantea, Festuca leptopogon, Festuca modesta, Festuca ovina, Festuca rubra, Festuca wallichiana, Glyceria tonglensis, Hackelochloa granularis, Helictorichon virescens, Helictotrichon asperum, Helictotrichon virescens, Imperata cylindrica, Koeleria cristata, Miscanthus nepalensis, Muhlenbergia duthieana, Muhlenbergia himalayensis, Muhlenbergia huegelii, Oryzopsis lateralis, Pennisetum flaccidum, Phleum alpinum, Poa alpina, Poa angustifolia, Poa annua, Poa pagophila, Poa pratensis, Pogonantherum crinitum, Pteridium acquilinum, Rosa brunonii, Schizachyrium delavayi, Setaria pallidefusca, Stipa roylei, Themeda anathera, Themeda quadrivalvis, Themeda triandra, Trisetum clarkei, Trisetum spicatum.*
Sub-alpine	*Agrostis inaequiglumis, Agrostis pilosula, Anthoxanthum hookeri, Artemisia stricta, Bromus grandis, Bromus himalaicus, Calamagrostis pseudophragmites, Calamagrostis emodensis, Chrysopogon gryllus, Cymbopogon schoenanthus, Danthonia cumminsii, Deyeuxia scabrescens, Duthiea nepalensis, Elymus canaliculatus, Elymus dahuricus, Elymus nutans, Elymus schrenkianus, Elymus sibiricus, Festuca leptopogon, Festuca ovina, Festuca polycolea, Helictotrichon virescens, Koeleria cristata, Pennisetum flaccidum, Poa alpigena, Poa ludens, Stellarea chamaejasme, Stipa consanguinea, Stipa duthiei, Stipa royleii, Stipa sibirica, Stipa staintonii, Trigonella emodi, Trisetum spicatum.*
Alpine	*Androsace delavayi, Aster stracheyi, Bistorta vivipara, Carex atrofusca, Cortia depressa, Gernium donianum, Kobresia nelpalensis, Kobresia caricina, Kobresia duthei, Kobresia kanaii, Nardostachys grandiflora, Picrorhiza scrophulariiflora, Poa pagophila, Potentilla peduncularis, Rheum moocroftianum, Saussurea gossypiphora, Swertia multicaulis*.
Steppe	*Agrostis pilosula, Andropogon munroi, Aristida adscensionis, Arthraxon submuticus, Arundinella setosa, Berberis angulosa, Berberis concinna, Bothriochloa intermedia, Bothriochloa pertusa, Bromus grandis, Bromus himalaicus, Bromusporphyranthos, Calamagrostis emodensis, Calamagrostis garhwalensis, Calamagrostis pseudophragmites, Caragana brevifolia, Caragana versicolor, Carex atrata, Cerastostigna ulicinun, Chrysopogon gryllus, Cymbopogon schoeanthus, Cymbopogon strachey, Cymbopogon stracheyi, Danthomia cumminsii, Danthonia cachemyriana, Deyeuxia holciformis, Deyeuxia pulchella, Deyeuxia scabrescens, Elymus canaliculatus, Elymus dahuricus, Elymus schrenkianus, Elymus semicostatus, Eulalia mollis, Festuca ovina, Fimbristylis complanata, Helictotrichon virescens, Indigofera cylindracea, Juniperus indica, Juniperus squamata, Kobresia macrantha, Kobresia seticulnis, Koeleria crista, Koeleria cristata, Lespedeza juncea, Medicago falcata, Melica jacquemontii, Melica scaberrima, Oryzopsis lateralis, Pennisetum flaccidum, Poa alpigena, Poa pagophila, Poa poophagorum, Poa pratensis, Potentilla fructicosa, Rhododendron anthopogon, Rhododendron lepitodum, Rhododendron nivale, Rosa sericea, Stipa moocroftiana, Stipa sibirica, Themeda roylei, Themeda triandra, Trisetum aeneum.*

Sources: Whyte (1968), Field & Pandey (1968), Stainton (1972), Pariyar & Shrestha (1984), Miller (1987), Archer (1990).

Rangeland Biodiversity and Endemism Nepal's high altitude rangelands are home to a unique assemblage of flora and fauna (Yonzon and Heinen 1997). About 131 endemic plant species (53% of the total number of endemic plants in Nepal) are found in the high altitude rangelands (Shrestha 1997). Of 41 key non-timber forest products, 14 species (34% of the total number of NTFPs in Nepal), primarily medicinal herbs, occur in alpine rangelands. Endangered wildlife species also occur predominantly in this region. They include the snow leopard (Uncia uncia), Tibetan wolf (Canis lupus), Tibetan argali (Ovis ammon hodgsonii), lynx (Felis lynx), brown bear (Ursus arctos), Tibetan wild ass (Equus heminonus), and wild yak (Bos mutus) (conservation status unclear). Although bird species diversity is low, 9 species are restricted to alpine rangelands and, of these, 5 species are of international significance: imperial eagle, Pallas' fish eagle, Hodgson's bushchat, lesser kestrel, Kasmir flycatcher (Inskipp 1989).

Although human activities have degraded wildlife habitat and contributed to the loss of biodiversity, primarily through poaching and trapping of wildlife and the over-harvesting of herbs and medicinal plants throughout Nepal, several mountain protected areas may safeguard rangeland biodiversity within their borders. Rangeland in the protected areas makes up 4,773km^2, which is about 27% of the total rangeland in Nepal and about 18% of Nepal's protected areas. Such rangeland coverage, however, should not lead to complacency because there have not been any programmes in the protected areas system to specifically address rangeland biodiversity.

Rangeland Productivity Rangelands provide 36% of the total feed requirement for livestock in Nepal. Estimated forage production from high altitude grazing lands is comparatively higher, reflected in their carrying capacity (Table 2.9).

Table 2.9 Productivity of rangelands in different ecosystems

RANGELAND	AREA (km^2)	PRODUCTIVITY (TDN in tonnes/ha)	CARRYING CAPACITY (LU/ha)	STOCKING RATE (LU/ha)
Subtropical & Temperate	6,293	0.58	0.54	7.07
Alpine	10,141	1.54	1.42	0.64
Steppe	1,875	0.06	0.09	1.19

TDN = Total Digestible Nutrient; LU = Livestock Unit
Source: Rajbhandari & Shah, 1981; Miller, 1989

2.3.2.3 Wetland ecosystems

Wetlands are sites distinguished by the presence of water, which often have unique soils that differ from adjacent uplands and support vegetation adapted to wet conditions. They comprise a wide range of inland, coastal and marine habitats characterised by the presence of flood-tolerant vegetation. The Ramsar Convention defines wetlands as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish, or salty, including areas of marine waters, the depth of which at low tide does not exceed 6 meters", and which may include "riparian and coastal zones adjacent to the wetlands, or islands or bodies of marine water deeper than six meters at low tide lying within".

Wetland Sites Nepal has many different types of wetlands that range from areas of permanently flowing rivers to areas of seasonal streams, lowland oxbow lakes, high altitude glacial lakes, swamps and marshes, paddy fields, reservoirs and ponds (Scott 1989) (Table 2.10). Wetlands in Nepal are rich in biological diversity and are known to regularly support more than 20,000 waterfowl during the peak period between December-February. They are broadly classified into two categories: natural and man-made. The natural wetlands comprise lakes and ponds, riverine floodplains, swamps, and marshes, while man-made wetlands include water storage areas and deep-water agricultural lands (IUCN-Nepal 1996).

Table 2.10 Total wetland areas in Nepal

WETLAND TYPE	ESTIMATED AREA (ha)	PERCENT
Rivers	395,000	53.0
Lakes	5,000	0.7
Reservoirs	1,380	0.2
Village ponds	5,183	0.7
Paddy fields	325,000	43.6
Marshland	12,000	1.6
Total	**743,563**	**100.0**

Source: DOAD, 1992, Fisheries Development Division

The systematic study of wetlands in Nepal is very recent. Surveys conducted over the last 15 years on the distribution of wetlands in three ecological zones (high mountains, Mid-hills and Terai) have contributed much to the knowledge of these (Shrestha & Nepali 1987; Scott 1989; Suwal & Shrestha 1990; Bhandari 1992; Shrestha 1992; Maskey 1992; Gurung & Pradhan 1992; Sah 1997; Jha & Lacoul 1998). In 1996, IUCN-Nepal prepared a detailed wetland inventory of 163 sites from the Terai and 79 sites from the hills and mountains (Table 2.11). HMGN has undertaken rapid assessments of the status of wetlands in the Terai (lowlands). In total, 51 sites were explored and 36 deemed of significant biodiversity importance (BPP 1995a) (Table 2.12). Additionally, Sah (1997) conducted a detailed study of the ecological and social features of wetlands in the Koshi Tappu Wildlife Reserve.

Table 2.11 Number of Wetland Sites in Nepal

DEVELOPMENT REGION	NUMBER OF SITES (%)		TOTAL (%)
	Terai	Hills and Mountains	
Eastern	18 (7.4)	24 (9.9)	42 (17.4)
Central	37 (15.3)	15 (6.2)	52 (21.5)
Western	34 (14.4)	16 (6.6)	50 (20.7)
Mid-western	12 (5.0)	22 (9.1)	34 (14.0)
Far-western	62 (25.6)	2 (0.8)	64 (26.4)
Total	**163 (67.4)**	**79 (32.6)**	**242 (100.0)**

Source: IUCN-Nepal (1996)

The Koshi Tappu wetland is considered of international significance and was added to the Ramsar list of wetlands of global importance on December 17, 1987. New proposals for including other sites in the Ramsar list include Bishazari Tal (180ha) in Chitwan (Gitanagar VDC), Gaindahawa Tal (11 ha) in Rupandehi (Bishnupura VDC), Jagdishpur Reservoir (156ha) in Kapilvastu (Niglihawa VDC), Bidahiya Tal (100ha) in Bardia (Chailahi VDC), Ghodagodi Tal (150ha) in Kailali (Darkh Nidi VDC), Narcrodi Tal (100ha) in Kailali (Sandepani VDC), Rampur Tal in Kailali (Urma VDC), Deukhuria Tal in Kailali (Dhangadi municipality), Partiyani Tal (35ha) in Kanchanpur (Krishnapur VDC), and Belkot Tal (4ha) in Kanchanpur (Daiji VDC). Begnas Tal (Kaski) is acknowledged as one of the most seriously threatened wetlands in Asia but is too degraded to merit any special conservation effort (WCMC 1992).

Table 2.12 Wetland Sites in the Terai that Merit Legal Protection

SITE	DISTRICT (VDC)	SIZE (ha)	REASON FOR LISTING
Bishazar Tal	Chitwan (Gitanagar)	180	Large complex of oxbow lakes set in a very scenic environment. Of major importance as a particularly good representative of an oxbow ecosystem, supporting an appreciable assemblage of rare, vulnerable and endangered wildlife species.
Gaindahawa Tal	Rupandehi (Bisnupura)	11	Oxbow lake supporting small resident and wintering populations of several species of waterfowl.
Jagadishpur Reservoir	Kapilbastu (Niglihawa)	156	Large irrigation reservoir supporting > 4% of the Asian population of Ferruginous Duck (*Aythya nyroca*), (whose 1% criterion = 100) with 405 recorded. The same site almost reached the 1% criterion for the Lesser Whistling Duck (*Dendrocygna javanica*).
Badahiya	Bardia (Chailahi)	100	Large marshy natural depression supporting a large number of resident and wintering populations of several species of waterfowl.
Ghodaghodi Tal	Kailali (Darkh Nidi)	150	Large complex of oxbow lakes set in a very scenic environment, surrounded by dense Sal forest. Of major importance as a particularly good example of an oxbow ecosystem supporting an appreciable assemblage of rare, vulnerable and endangered wildlife species. Important site for transient migratory species moving between Dudwa National Park (India), Royal Suklaphanta Wildlife Reserve and Royal Bardia National Park. The resident population of *Nettapus coromandelianus* makes up nearly 1% of the total Asian population.
Narcrodi Tal	Kailali (Sandepani)	100	Large complex of oxbow lakes set in a very scenic environment, surrounded by dense Sal forest. Of major importance as a good example of an oxbow ecosystem supporting an appreciable assemblage of rare, vulnerable and endangered wildlife species.

Rampur Tal	Kailali (Urma)	20	Medium-sized complex of oxbow lakes set in a very scenic environment, surrounded by dense Sal forest. Of major importance as a particularly good representative of an oxbow ecosystem supporting an appreciable assemblage of rare, vulnerable and endangered wildlife species.
Deukhuria	Kailali (Dhangadi Municipality)	22	Large lake set in a very scenic environment. Of major importance as a particularly good example of an oxbow ecosystem supporting an appreciable assemblage of rare (*Sarkidiornis melanotos*), vulnerable and endangered wildlife species.
Patriyani	Kanchanpur (Krishnapur)	35	Large oxbow lake of major importance as a particularly good representative of an oxbow ecosystem supporting an appreciable assemblage of rare, vulnerable and endangered wildlife species.
Betkot	Kanchanpur (Daiji)	4	Very scenic lake of special value for maintaining genetic and ecological diversity.

Source: BPP (1995a)

Wetland Flora Wetland plants provide food, forage and cover for both domestic and wild animals. About 172 species of the major wetland plants are listed by IUCN (IUCN-Nepal 1996). Four endangered macrophyte species are often found in wetlands (Joshi & Joshi 1991): *Spiranthes sinensis* (orchid*), Cyathea spinulosa* (tree fern), *Sphagnum nepalensis* (sphagnum moss), and *Pandanus nepalensis* (screw pine). Plants growing in wetland habitats include *Nelumbo nucifera* (lotus), *Nymphaea nouchali, N. stellata, Trapa quadrispinosa* (water chestnut), *Ipomoea aquatica, Pistia stratiotes, Nymphoides indica, Hydrilla verticillata, Vallisneria natans, Monochoria vaginalis, Acorus calamus, Typha angustifolia, Saccharum spontaneum, Persicaria hydropiper, Fimbristyis dichotoma, Ceratophyllum demersum, Lemna perpusilla* (duck weed), *Eichhornia crassipes* (water hyacinth), *Potamogeton crispus* and *P. nodosus.* (Chaudhary & Singh 1996). Twenty-five percent of the estimated 7,000 species of vascular plants identified are somehow linked to wetland habitats (Bhandari 1992). Jha & Lacoul (1998) have summarised the common flora of the wetlands in different physiographic zones of Nepal.

Wetland Fauna Out of 833 bird species found in Nepal, 193 are known to be dependent on wetlands (Baral *et al.* 1996; Choudhary 1996; Halliday 1982; Scott 1989; Inskipp & Inskipp 1991; Suwal & Shrestha 1990; Perennou *et al*. 1994). Of these wetland-dependent species, about 187 are known to be dependent on the wetlands of the Terai. 180 species of water birds are reported from Koshi Tappu and the Koshi barrage (IUCN-Nepal 1996). Of the wetland birds in the Terai, 39 species are threatened on a national level. 11 species occurring in the Terai wetlands are described as globally threatened while another 11 species are identified as near-threatened (Collar *et al.* 1994). The oriental darter that breeds in just 13 countries is a resident breeder in Chitwan, Koshi Tappu, and at Ghodaghodi Tal. The spot-billed pelican, a globally threatened bird, is found on a seasonal basis at the Koshi barrage, while the wetlands in Rupendehi and Kapilbastu provide habitat for the saurus crane. The diverse wetland floras of the different ecological zones are significant producers in ecosystems that support indigenous populations of amphibians and fishes, and also attract many birds.

The gharial and marsh mugger, two species of crocodile, are the largest reptiles found in the Kali Gandaki River and the major tributaries of the Narayani River. The Gangetic dolphin is also reported in the Narayani River. A total of 185 species of fish are found in the wetlands of Nepal, out of which 8 are endemic. Three species of *Schizothorax* have been recorded in Rara Lake and as many as 43 species are found in hill streams (Shrestha 1995). About 5,000 species of insects may be found in Nepal; however, wetland insect assemblages are not fully understood.

Values Wetlands are among the most productive ecosystems in the world. They are very important in terms of their ecological, economic, cultural and recreational values. These ecosystems support a wide variety of plants and animals of economic value, which provide a wide range of goods and services as well as income-generating opportunities. Wetlands are also one of the most threatened habitats because of their vulnerability and attractiveness for development (Hollis *et al.* 1988). According to Hussain (1994), the values of wetlands can be grouped into two categories:

(1) Ecological values or indirect-use values derived from the functions of wetlands as wildlife habitats and from their essential contribution to the maintenance of ecological balance in the immediate area and beyond.

(2) Economic values or direct-use values derived from the productivity of wetland systems and the sustainable harvest of their resources. Many ethnic groups depend on wetlands for their livelihoods (Box 2.1).

Box 2.1 People Dependent on Wetland Resources

The major ethnic groups of people dependent on wetland resources for their livelihoods in Nepal are the following: the Sunaha of the Karnali River in far-western Nepal, the Khanwas (the Raji group of Sunaha are found in the Mid-hills whereas the Sunaha and the Khuna are found in the Terai), the Mallahs near the Gandak barrage in the southern part of Nawalparasi and from the districts around Janakpur in the east-central Terai, the Bote from Nawalparasi and Chitwan, the Mushahars from Nawalparasi and other eastern Terai districts, the Bantar (also called Sardad) from Sunsari and Saptari, the Gongi (also called Mallahs) from the Koshi Tappu Wildlife Reserve, the Mukhia (also called Bihin) from Rautahat, the Dushad from Parsa and other Terai districts, the Sahani from Rautahat, Sarlahi, Dhanusha, Mahottari, Parsa, and Bara, the Kewat from Nawalparasi, the Danuwars from Chitwan, Siraha, Dhanusha and Sindhuli, the Darai and the Kumal from Chitwan, Gorkha and Nawalparasi, the Barhamus from Gorkha, the Dhangar from Morang, Sunsari, Dhanusha, and Sarlahi, the Pode from the Phewa Tal area of Pokhara and from Panauti. Others include the Kushars and the Majhi from a number of Terai districts who depend primarily on fishing and aquatic resources for their livelihoods.

Source: IUCN-Nepal (1996)

Uses The wetland inventory for Nepal (IUCN-Nepal 1996) indicates that in the Terai, fishing occurs in 94% of wetland sites and animal grazing in 70%, and water for irrigation is extracted from from 69% of the sites surveyed (Table 2.13). These wetlands also serve as habitats for wild relatives of cultivated crops, endangered and threatened flora and some rare birds. Land uses around wetland sites include barren land, settlements, commercial establishments, cultivated land, pasture, grassland and open forest.

Table 2.13 Uses of Wetlands in the Terai (of the 163 inventoried by IUCN in 1996)

USE	NO. OF WETLANDS	PERCENT
Fishing	153	94
Grazing	113	70
Irrigation	112	69
Plant harvest*	96	59
Domestic use**	52	32
Fuelwood	32	20
Wildlife use	20	13
Religious use	18	11
Others***	23	14

Source: IUCN-Nepal 1996.

*Includes thatch grass, timber, aquatic crops, fodder

** Includes washing clothes and kitchenware and bathing in many wetlands in the Terai

*** Includes recreational use (13), travel routes (7), power generation (2), waste disposal (1)

2.3.2.4 Mountain ecosystems

The Mountain Agenda ratified during the 1992 UN Conference on Environment and Development (UNCED) is the most recent manifestation of international interest in conserving the islands of high biodiversity often found in mountain ecosystems. Chapter 13 of Agenda 21 also draws specific attention to the challenges and opportunities confronting mountain peoples and ecosystems. At the Fourth Meeting of the Conference of the Parties (COP) to the Convention on Biological Diversity held in Bratislava in 1998, mountain ecosystems were listed as an item for "in-depth consideration" in the Programme for Work for the Seventh COP to be held in 2004. In light of this renewed interest and the fact that more than half of Nepal is above 3,000m, the NBS proposes initial policy and programmatic steps to specifically address the conservation and sustainable use of mountain biodiversity. Sustainable Mountain development is a must, and this can only be achieved by having

a proper mountain perspective. In this context, Price (1988) suggested two programmes: (i) generating and strengthening the knowledge of the ecology and sustainable development of mountain ecosystems, and (ii) promoting integrated catchment development and alternative livelihood opportunities.

Nepal's landscape is predominantly composed of hills and mountains, covering about 83% of the total land area. Nepal has the highest mountain in the world, Sagarmatha (Everest). Ten of the world's 14 peaks over 8,000m are found in the Himalayas. 127 peaks over 7,000m and 1,311 others above 6,000m are also found in the Himalayas (Pandey 1995). Snowline in the east is at 5,000m and in the west is at 4,000m. Geomorphologically, the high Himalaya is a cold desert where coarse debris, rocks and snow dominate (Jha 1992).

Biodiversity in Nepal varies with physiographic zone, with the Mid-hills, characterised by a subtropical to temperate climate, representing the highest number of species of many floral and faunal groups. Numbers of species decreases with altitude, but it is important to note that large numbers of endemic species occur in the high mountain zone, where the topography and cold climate have facilitated floral and faunal endemism.

Another important feature of mountain biodiversity is the diversity of levels or groups of biological organisation above the species level - genera, families, phyla, habitats, and ecosystems - showing high *beta* diversity. In general, there are more lichens, bryophytes, and ferns in the mountain zone than in the lowlands. The Himalayan mountain system is unique in the world (Singh 2001). Plants and animals have been reported above 5,000m by several biologists. Mosses and lichens are seen up to 6,300m, cushions of flowering *Stellaria decumbens* in Mount Makalu occur up to 6,135m and *Ephedra gerardiana* up to 5,200m. Mammals and birds are seen above 5,000m even in very harsh environments.

The International Center for Integrated Mountain Development (ICIMOD) was established in Kathmandu in 1984 with the primary objective of promoting economically and environmentally sound development in mountain ecosystems and improving the living standards of mountain peoples in the Hindu Kush-Himalayan Region. In pursuing its mandate, ICIMOD works mainly at the interface between research and development and acts as a facilitator for generating new mountain-specific knowledge of relevance to mountain development. In this context, ICIMOD has established 28 areas of focus under five major themes. Six of these have been listed under the major theme of Sustainable Management of the Mountain Commons (ICIMOD 1999). These are:

1. People and resource dynamics in mountain watersheds
2. Governance and participation in the management of mountain commons
3. Management of forest resources
4. Management of rangelands and pastures
5. Sustainable development of mountain water resources
6. Conservation of biological diversity in mountain ecosystems

ICIMOD completed several activities related to biodiversity in the last few years and produced a number of documents including *Banking on Biodiversity* and *Managing Agrobiodiversity*. *Banking on Biodiversity* provides a broad framework for assessing and monitoring biodiversity change, describes the experiences of different countries, the drawbacks and complexities of current approaches, and identifies the need for new methods to be developed in order to improve present systems.

2.3.2.5 Agroecosystems

About 21% (3.2 million hectares) of the total land area of Nepal is used for cultivation, and the principal crops are rice (45%), maize (20%), wheat (18%), millet (5%) and potatoes (3%), followed by sugarcane, jute, cotton, tea, barley, legumes, vegetables and fruit. Crops such as rice, rice bean, eggplant, buckwheat, soybean, foxtail millet, citrus and mango have high genetic diversity relative to other food crops. Crop species in Nepal owe their variability due to the presence of about 120 wild relatives of the commonly cultivated food plants and their proximity to cultivated areas (Regmi 1995). Jha *et al.* (1996) have listed 60 food species (fruits, vegetables, cereals, legumes) and 54 wild relatives of food plants.

Table 2.14 Major cropping patterns in different physiographic regions of Nepal

PHYSIOGRAPHIC REGION	LAND TYPE	CROPPING PATTERN
< 1,000m (Tropical/ Subtropical)	Irrigated	Rice-Wheat, Rice-Rice-Wheat, Rice-Rice-Maize, Rice-Rice/ Legumes, Rice-Vegetables-Maize-Mustard-Fallow
	Rain-fed	Maize-Buckwheat-Fallow, Maize + Soybean-Mustard-Fallow, Maize/Finger millet-Wheat, Maize + Upland Rice-Wheat, Maize-Wheat-Fallow
1,000 - 2,000m (Warm temperate)	Irrigated	Rice-Wheat, Rice-Barley, Rice-Potato, Rice-Vegetable Crop, Maize/Finger millet-Wheat, Maize /Finger millet-Fallow
	Rain-fed	Maize + Soybean-Mustard/Fallow, Maize + Upland Rice-Wheat or Lentil or Fallow, Maize + Soybean-Mustard
> 2,000m (Cool Temperate)	Irrigated	Rice-Naked Barley, Rice-Wheat, Buckwheat-Wheat, Buckwheat-Naked Barley, Potato-Buckwheat or Mustard or Vegetables, Maize-Fallow, Wheat-Fallow
	Rain-fed	Potato-Fallow, Naked Barley-Fallow, Maize-Wheat, Maize-Wheat + Finger millet, Maize-Naked Barley-Finger millet

Nepal has a high degree of agroecological diversity that is largely associated with the hills and mountains, where variations in factors such as topography, slope, aspect and altitude allow for an enormous range of biological environments, climatic regimes and varied ecosystems. Broadly speaking, farming systems in Nepal vary according to the three major physiographic regions of the country, namely the Terai, the Mid-hills, and the mountains. The major cropping patterns in each physiographic region (Table 2.14), the major landraces of important food crops (Table 2.15) and the crop diversity present in each ecological zone (Table 2.16) reveal that primitive cultivars of speciality cultigens and crop landraces are the major building blocks of traditional farming systems. This suggests that the promotion and continued existence of traditional farming systems are essential for agrobiodiversity conservation in Nepal.

Table 2.15 Major Landraces of Important Food Crops

CROP	LANDRACES/BREEDS
Rice	Jaswa, Lalsar, Basmati, Kalanamak, Jethobudho, Tulsi Prasad, Chirakhe, Tauli, Jumli Marsi, Thapachiniya
Fingermillet	Balu Nala, Kree, Mudke, Nang Katuwa, Dalle, Kalobhunde, Seto Kodo, Mudule, Pangdur, Jhapre
Potato	Kalu, Jhyale, Sarkari Seto, Bhotange yellow, Shyangdorje, Khumbule, Kathmandu local, Thakali Rato, Jumla Rato, Khodapeli, Tharu local

Table 2.16 Crop Diversity in Selected Ecological Regions of Nepal

ECOLOGICAL REGION	CROP DIVERSITY*
Siwalik Hills and Terai (hot, humid and dry)	Rice, Kodo millet, chickpea, pigeon pea, lentil, jute, niger, sesame, *Brassica* species, Perilla, wild relatives of rice, eggplant, okra, mango, jackfruit.
Eastern and Central Himalaya (cool and humid)	Rice, maize, covered barley, foxtail millet, buckwheat, barley, rice bean, finger millet, blackgram, soybean, field peas, niger, Perilla, sesame, *Brassica* species, wild relatives of buckwheat, pigeon pea, citrus fruit.
Western and Far-Western Himalaya (cool and dry)	Cold tolerant rice, proso millet, wheat, naked barley, maize, buckwheat, amaranths, chenopods, rice bean, blackgram, soybean, field peas, radish, niger, sesame, *Brassica* species, Perilla, wild apple, wild pear, walnut.

(*not exhaustive)

Species diversity and variety dynamics Agricultural biodiversity is vital to marginalised mountain communities for maintaining food security. This is apparent from the 172 families, 294 genera, and 551 species/subspecies of agricultural crops that are grown in the Himalayas (Table 2.17). Furthermore, the genetic variability within each crop species is the only source of natural resistance to disease. Hence, agricultural biodiversity provides for both the immediate needs and the long-term sustenance of rural people.

Table 2.17 Estimated Percentage of Botanical Sources of Cultivated and Wild Food Crops

GROUP	No. of FOOD PLANT SPECIES	CULTIVATED FOOD PLANTS		WILD FOOD PLANTS		IMPORTED FOOD PLANTS	
		No. of SPECIES	%	No. of SPECIES	%	No. of SPECIES	%
DICOTYLEDONS							
Families	120	50	42	70	58	-	-
Genera	180	120	67	60	33	-	-
Species	395	175	44	190	48	30	8
Subspecies	25	25	100	-	-	-	-
MONOCOTYLEDONS							
Families	17	10	59	7	41	-	-
Genera	50	35	70	15	30	-	-
Species	83	50	60	20	24	13	16
Subspecies	10	7	70	3	30	-	-
PTERIDOPHYTES							
Families	3	-	-	3	100	-	-
Genera	7	-	-	7	100	-	-
Species	11	-	-	11	100	-	-
THALLOPHYTES							
Families	30	-	-	30	100	-	-
Genera	57	-	-	57	100	-	-
Species	108	-	-	108	100	-	-
GYMNOSPERMS							
Families	2	-	-	2	100	-	-
Genera	2	-	-	2	100	-	-
Species	2	-	-	2	100	-	-

Out of more than 500 plant species that are edible, 200 are cultivated. Crops such as rice (*Oryza sativa*), rice bean (*Vigna unbellata*), eggplant (*Solanum melongena*), buckwheat (*Fagopyrum esculentum, F. tatricum*), soybean (*Glycine max*), foxtail millet (*Setaria italica*), citrus (*Citrus aurantium, C. limon, C. medica*) and mango (*Mangifera indica*) have high genetic diversity. Similarly, the diversity in under-utilised food crops and tropical fruit species is noteworthy. This variability in crop species has been maintained through traditional farming systems and as a result of number of wild relatives found in proximity (Regmi 1995) (Tables 2.18 and 2.19).

Crop variety dynamics in Nepal are important. Rice is cultivated in diverse environments, and both quantity and quality of rice production is influenced by various levels of crop production management (Joshi *et al*. 1996a). Farmers in Nepal grow more than 95 local aromatic and fine rice landraces. Recent studies found more than 75 local landraces growing in the Seti River valley of Kaski district. However, only 11 varieties are widely cultivated and the rest are being replaced or discontinued for reasons such as the introduction of modern varieties that have high yield potential. Similarly, quantities of Samundraphinj, a suitable rice landrace grown in swampy lands around the lakes of Pokhara valley, is decreasing as the swampy land is being converted into ordinary agricultural land for which irrigated rice varieties have been introduced (Rijal *et al*. 1998).

Table 2.18 A few wild species of cultivated food plants

BOTANICAL NAME	COMMON ENGLISH NAME
Oryza nivara Sharma et Shastry	Wild rice
O. rufipogon Griff.	Wild rice
O. officinalis Wall. ex Watt.	Wild rice
O. granulata Nees et Arn. ex. Watt.	Wild rice
O. sativa f. *spontanea* Roschev.	Wild rice (weedy rice)

BOTANICAL NAME	COMMON ENGLISH NAME
Eleusine indica (L.) Gaertn.	Crab grass/Wild finger millet
Fagopyrum dibotrys (D. Don) Hara	Wild buckwheat
F. cymosum (Trev.) Heisn.	Wild buckwheat
F. megacarpum Hara	Wild buckwheat
Rumex nepalensis Spreng.	Wild spinach
R. hastasus D. Don.	Wild spinach
Abelmoschus moschatus Moench.	Wild okra
Colocassia antiquorum Schott.	Wild colocasia
Amaranthus viridis L.	Pigweed (without thorn)
A. spinosus L.	Pigweed (with thorn)
A. blitum L.	Pigweed
Fumaria vaillanti Loisel. (*F. paviflora* Lam.)	Wild carrot
Allium wallichii Kunth.	Wild garlic
A. hypsistum Stearn	Wild garlic
Saccharum beghalensis Retz. (*S. arundinaceum* Hook. f.)	Wild sugarcane
S. longisetosum (Anderss.) Narayanswami ex Bor	Wild sugarcane
S. spontaneum L.	Wild sugarcane
S. munja L.	Wild sugarcane
S. edule Sao.	Wild sugarcane
N. plumbaginifolia Viviani	Wild tobacco
Citrus medica L.	Narayani
Pyrus pashia Buch.-Ham. ex D. Don	Wild pear
Malus baccata (L.) Borkh.	Wild apple

Horticultural diversity Horticultural diversity is not well documented in Nepal. Several fruit and vegetable species and varieties have been introduced into the country, adding genetic diversity (Table 2.19). These include grape, strawberry, avocado, macadamia nut, olive, and coffee, as well as over one hundred high-yielding varieties of various fruit crops, such as apple, pear, plum, citrus, pecan nut, walnut, kiwi, chestnut and persimmon. There are 14 fruit and five vegetable development farms located in different ecological zones in Nepal contributing towards the production and conservation of horticultural diversity.

Table 2.19 Agroclimatic niche-based selection of fruit crops in the districts of Nepal

FRUIT	DISTRICTS
Citrus fruit	Dhankuta, Bhojpur, Terahthum, Sankhuwasabha, Panchthar, Ilam, Sindhuli, Ramechhap, Dhading, Kabhrepalanchok, Gorkha, Lamjung, Tanahu, Syangja, Kaski, Palpa, Gulmi, Salyan, Dailekh, Dadeldhura
Apple	Solukhumbhu, Sindhupalchok, Rasuwa, Mustang, Jumla, Kalikot, Dolpa, Rukum, Doti, Baitadi, Darchula
Banana	Kabhrepalanchok, Dhading, Nuwakot, Sarlahi, Dhanusha, Mahotari, Chitwan
Pineapple	Dhading, Nuwakot, Sarlahi, Chitwan
Mango	Bara, Parsa, Rauthat, Sarlahi, Mahotari, Dhanusha, Sunsari, Sirha, Saptari, Chitwan, Kapilbastu, Nawalparasi, Rupandehi, Surkhet, Dang
Walnut	Jumla, Kalikot, Bajhang, Darchula, Baitadi, Dolpa, Rukum
Pear	Dhankuta, Bhaktapur, Lalitpur, Kabhrepalanchok, Dhading, Makwanpur, Sindhupalchok, Nuwakot, Rasuwa, Palpa
Grape	Banke, Bardia, Manang, Mustang

Source: Partap, 1993

Livestock and agroecological diversity There is great diversity in indigenous livestock breeds in Nepal because of climatic and physiographic differences and prevalent traditional animal husbandry systems. Twenty-four breeds of cattle, buffalo, sheep, goat, pig and poultry are recognised in Nepal (Table 2.20), but the strains within each breed have not been adequately identified. Among known breeds, pure S*iri* cattle have become extinct in Nepal and crossbreeds of S*iri* cattle are only seen in small numbers. *Lulu* and A*chhame* cattle are on the verge of extinction. The *Yak* population is also decreasing at the rate of 1.41% a year. *Lime* buffalo is perhaps endangered and likely to disappear soon. *Lampuchhre* and *Kage* sheep are at risk. The *Bampudke* pig is on the verge of extinction while *Chwanche* and H*urrah* pigs are only seen in small numbers. Breeds and strains of domestic animals, including poultry, in different ecological belts are yet to be identified and characterised.

Table 2.20 Indigenous and exotic livestock genotypes in Nepal

AGROCLIMATIC REGION	ALTITUDE (m)	LIVESTOCK	INDIGENOUS GENOTYPES	INTRODUCED GENOTYPES
Trans-Himalaya/High Himalaya	>2,500	Cattle	*Yak, Lulu*	
		Goat	*Chyangra*	
		Sheep	*Bhyanglung, Baruwal*	
High Mountains	2,200-4,000	Cattle	*Yak, Kirko*	Brown Swiss crossed with *Yak* (experimental basis)
		Goat	*Sinhal*	
		Sheep	*Dhorel, Baruwal*	Merino, Polworth, Ramboullett, Border Liceister, Romney Marsh
Mid-hills	800– 2,400	Cattle	*Hill cattle, Achhame, Khaila*	Jersey, Holstein, Brown Swiss
		Buffalo	*Lime, Gaddi*	Murrah crossed with *Lime*
		Goat	*Khari*	Jamunapari, Barberi , Kiko
		Sheep	*Kage, Baruwal*	Merino, Polworth, Ramboullett, Border Liceister, Romney Marsh
		Pig	*Chwanche*	
		Poultry	*Sakini*	New Hampshire, Austrolorp
Lower Hills/ Siwalik Hills	300–1,500	Cattle	*Hill cattle, Achhame*	Jersey, Holstein, Brownswiss
		Buffalo	*Parkote*	Murrah crossed with *Parkote*
		Goat	*Khari*	Jamunapari, Barberi
		Sheep	*Kage*	Polworth, Ramboullett, Border Liceister, Romney Marsh
		Pig	*Chwanche, Bampudke*	
		Poultry	*Sakini*	New Hampshire, Austrolorp
Terai	<300	Cattle	*Terai cattle*	Hariana, Jersey, Holstein
		Buffalo	*Terai buffalo*	Murrah
		Goat	*Terai goat*	Jamunapari, Barberi and Beetal
		Sheep	*Lampuchhre*	
		Pig	*Hurrah*	

Indigenous livestock breeds and genetics There are at least 17 species of livestock in Nepal, five Bovidae, seven Aves, two Equidae (excluding mules), one pig (*Sus scrofa*), one rabbit (*Oryctolagus cunuculus*) and one elephant (*Elephas maximus*) species. Domestic animals include cattle (*Bos taurus* and *B. indicus*), buffalo (*Bubalus bubalis*), yak (*Bos grunniens*) and its crosses with cattle, goat (*Capra hircus*), sheep (*Ovis aries*), equids, poultry (fowl - *Gallus domesticus*, duck - *Anas platyrhyncos*, and pigeon - *Columba livia*), pigs, and, more recently, rabbits for meat and the Angora type for wool. Buffalo, cow, and goat milk are the major livestock products, with an annual production of 600,000 tonnes, 260,000 tonnes, and 51,000 tonnes respectively. Buffalo is the most important source of meat (95,000 tonnes annually), followed by goat (35,000 tonnes), pig (10,000 tonnes), poultry (9,000 tonnes), cattle (which is illegal to slaughter) (4,000 tonnes) and sheep (3,000 tonnes) (Wilson 1997). The density of livestock per unit of arable land is high (Tables 2.21 and 2.22).

The selection and distribution of various indigenous types of animals raised in different parts of the country are guided by socio-economic values and ethnocultural preferences, climate, animal husbandry systems and, in some cases, marketability. The annual status of feed supply and social preferences are two major factors that determine the type of animal and livestock management system in rural areas. Thus conservation of livestock genetic resources, incorporating both preservation and sustainable use of farm animals, exists mainly in small farming systems where farmers own few animals but keep several species (Shrestha 1984; 1998). These farming systems are characterised by small land holdings and low use of technology and inputs. Owning livestock, which is mainly for subsistence, is a risk reduction strategy as these farmers live in remote locations isolated from market services (Wilson 1995).

Table 2.21 Livestock and poultry populations in Nepal and comparison growth rates with those of the Asia-Pacific region

LIVESTOCK	POPULATION IN 1995 ('000)	AVERAGE ANNUAL GROWTH RATE (%) 1985-1995	
		Nepal	Asia-Pacific
Cattle	6,838	0.3	1.2
Buffalo	3,278	1.2	0.7
Goat	5,649	1.3	3.9
Sheep	919	1.5	-0.2
Pig	636	3.9	2.6
Duck	395	4.3	6.6
Poultry	10,000	5.7	7.1

Table 2.22 Livestock density (heads/ha) on cultivated land in Nepal

PHYSIOGRAPHIC REGION	LIVESTOCK DENSITY (MILLIONS)	SPECIES					
		Cattle	Buffalo	Goat	Sheep	Pig	Poultry
Mountains	2.18	318	120	321	153	30	483
Mid-hills	7.44	217	119	208	27	21	431
Terai	4.05	171	71	107	10	12	192
Nepal	13.67	206	98	174	30	18	333

Source: Wilson (1997)

2.3.3 SPECIES DIVERSITY

Nepal comprises only 0.09% of land area on a global scale, but it possesses a disproportionately rich diversity of flora and fauna at genetic, species and ecosystem levels. These species are found in the dense tropical monsoon forests of the Terai, in the deciduous and coniferous forests of the subtropical and temperate regions, and in the sub-alpine and alpine pastures and snow-covered Himalayan peaks. Nepal falls within two biogeographical realms - the Indo-Malayan and the Palaearctic realms – which adds to the high biodiversity level. A comprehensive summary of species diversity is given in Table 2.23.

2.3.3.1 Diversity of flora

There has been comparatively much work carried out on the higher groups of plants (angiosperms and gymnosperms), but research on the lower groups has not been extensive or systematic. Collection of Nepalese specimens began in 1802 by Buchanan Hamilton and was continued by N. Wallich during 1820-21. Since then, many parts of Nepal have been well explored. Major herbaria that house Nepalese specimens are found in the National Herbarium and Plant Laboratories, Kathmandu, the British Museum, London, the Royal Botanic Garden, Kew, the University of Tokyo, Japan, the Smithsonian Institution, Washington, D.C., the University of Grenoble, France, and the Royal Botanic Garden, Edinburg. It is estimated that the British Museum has over 40,000 specimens, the University of Tokyo about 100,000 specimens, and the National Herbarium and Plant Laboratories of Kathmandu, 150,000 specimens. Additionally, approximately 10,000 specimens are housed in different institutions of Tribhuvan University.

The compilation of a comprehensive list of the flora of Nepal is a very important task. However, despite the occasional efforts made by various institutions, such a work has not been finalised. The Flora of Nepal programme was initiated by the National Herbarium and Plant Laboratories of Godavari under the Department of Plant Resources, established during 1960-61 (DPR-MFSC 1997). The Department of Plant Resources has established seven district offices for the development of plant resources activities at district-level. The MFSC, Tribhuvan University, and the Royal Nepal Academy of Science and Technology have signed an agreement to produce a comprehensive list of the flora of Nepal.

The Department of Plant Resources has published 32 books and booklets about local and regional flora, and Tribhuvan University has published several papers on the subject. There are several M.Sc. dissertations from Tribhuvan University dealing with local flora, ecology, and biological diversity. Foreign institutions actively involved in the Flora of Nepal programme include the British Museum in London, Tokyo University, and the Royal Botanic Garden of Edinburgh.

Bacteria The number of bacteria species described in the world is between 3,000-4,000, but enormous numbers of uncultured bacteria are yet to be identified from soils, deep sea sediments and the digestive tracts and pockets of a wide variety of animals and insects (WCMC 1992). This important group of organisms has not received adequate attention in Nepal and the study of bacteria in different habitats is much needed.

Lichens During the International Workshop on Lichen Taxonomy, held in Kathmandu in 1994, lichenologists estimated that there are about 2,000 lichen species in Nepal. Lichens are found in all climatic zones. Forty-eight species of lichens are reported to be endemic to Nepal. Sharma (1995) identified 465 species from 79 genera and 30 families. Studies on lichens have been carried out mainly in eastern and central Nepal. Lichens from the lowland Terai and Siwalik Hills are much less known, and the lichens of western Nepal remain largely unexplored.

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

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

Table 2.23 An overview of species richness in Nepal

GROUP OF ORGANISM	NUMBERS OF SPECIES		REFERENCE	NEPAL REPRESENTATION (%)
	GLOBALLY[1]	NEPAL		
Bacteria	3,000-4,000	?		
Lichens	20,000	465	Sharma 1995	2.3
Fungi	69,000	1,822	Adhikari 1999	2.4
Algae	26,000	687	Baral 1995	2.6
Bryophytes	16,600	853	Compiled from Kattel and Adhikari 1992; Mizutani *et al.* 1995; Furuki & Higuchi 1995	5.1
Pteridophytes	11,300	380	Iwatsuki 1988	3.4
Gymnosperms	529	28	Koba *et al.* 1994; Akiyama *et al*. 1998	5.1
Angiosperms	220,000	5,856	Koba *et al.* 1994; Akiyama *et al*. 1998[2]	2.7
Platyhelminthes	12,200	168	Gupta 1997	1.4
Spiders	73,400	144	Thapa 1995	0.2
Butterflies and Moths	112,000	640 2,253	Smith 1994, 1997 Smith 1997 (pers. com.)	2.6
Other Insects	751,000	5,052	Thapa 1997	0.7
Fishes	18,150	182	Shrestha 2001	1.0
Amphibians	4,184	43	Shah 1995	1.0
Reptiles	6,300	100	Shah 1995	1.6
Birds	9,040	852	Grimmet *et al.* 2000	9.3
Mammals	4,000	181	Suwal & Verheugt 1995	4.5

[1]Wilson (1988; 1992).
[2]Akiyama *et al.* added 50 new species of Nepalese flowering plants to the list of Koba *et al.*
NA = Not Available

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

Pteridophytes An enumeration of pteridophytes (ferns and fern allies) has been compiled by Iwatsuki (1988). Iwatsuki recorded a total of 380 species, with 258 distributed in the eastern region and 97 in the central region of Nepal, but no collections have been made from western Nepal. The greatest number of pteridophyte species has been recorded in the Mid-hills (272 species, subtropical and temperate zones). The Siwalik Hills and the Terai (tropical zones) have 81 species, the high mountains (alpine and sub-alpine zones) 78 species, and the high Himalaya (nival zone) one species.

Gymnosperms Gymnosperms have been the best studied amongst the vascular plants of Nepal. Altogether, 27 species of gymnosperms have been listed (Koba *et al*. 1994). These include 20 indigenous species belonging to 13 genera and 10 families (Shrestha 1984-85).

Angiosperms The angiosperm flora of Nepal is impressively high on a global scale considering the area of the country. Koba *et al*. (1994) extended the list of flowering plant species prepared by Hara and Williams (1979), Hara *et al*. (1978), and Hara *et al*. (1982), and enumerated 5,806 species belonging to 203 families. To this number, a list of 50 species has been added by Akiyama *et al.* (1998), making the total number of angiosperm species in Nepal 5,856. However, Hara *et al.* (1978) and the World Conservation Monitoring Centre (Caldecot *et al*. 1994) estimated that number to be 6,500 species. The Biodiversity Profiles Project (1995h) ranked Nepal as having the tenth richest flowering plant diversity in Asia. On a world scale Nepal is placed 31st (Caldecot *et al.* 1994). It is noteworthy to mention that out of about 410 angiosperm families in the world, 203 (almost 50%) are represented in Nepal. Families with large numbers of species are the daisies (Asteraceae or Compositae, about 400 species), grasses (Poaceae or Gramineae, over 350 species), orchid (Orchidaceae, over 300 species), peas (Fabaceae or Leguminosae, 300 species), rose (Rosaceae, 180 species), sedge (Cyperacace, over 170 species), crowfoot or buttercup (Ranunculaceae, 150 species), mustard (Cruciferae, 90 species), and pink or carnation (Caryophyllaceae, 80 species).

Some families are represented by a single species, such as Dipterocarpaceae (*Shorea robusta*), Teteracentraceae (*Teteracentron sinense*), Bombacaceae (Silk tree, *Bombax ceiba*), Ochnaceae (*Ochnea obtusata*), Burseraceae (*Garuga pinnata*), Hippocastanaceae (Horse-Chestnut, *Aesculus indica*), Hamamelidaceae (Witch Hazel, *Exbucklandia populnea*), Toricelliaceae (*Toricellia tiliifolia*), Saururaceae (*Hottuynia cordata*), Myricaceae (*Myrica esculenta*), and Daphniphyllaceae (*Daphniphyllum himalense*).

Genera in Nepal represented by more than 25 species are *Saxifraga* (89), *Primula* (77), *Pedicularis* (74), *Carex* (70), *Gentiana* (51), *Ficus* (47), *Berberis* (46), *Persicaria* (45), *Rhododendron* (43), *Impatiens* (42), *Rubus* (41), *Saussurea* (38), *Potentilla* (37), *Salix* (37), *Corydalis* (36), *Aconitum* (35), *Cotoneaster* (35), *Poa* (33), *Desmodium* (32), *Juncus* (32), *Swertia* (32), *Astragalus* (31), *Stellaria* (30), *Silene* (29), *Lonicera* (28), *Ranunculus* (28), *Senecio* (28), *Cyperus* (27), *Kobresia* (27), *Dendrobium* (26) and *Epilobium* (26) (Koba *et al*. 1994).

In general, eastern (Sino-Japanese) elements dominate throughout the country, but these become less dominant as one proceeds towards the west of Nepal where Mediterranean elements become more dominant. The Terai possesses widespread North Indian elements, while in the northern Trans-Himalayan arid zone, the vegetation is similar to that of Tibet. The country can therefore be regarded as an area of transition, or merging of flora. As suggested by Stearn (1960) and later by other botanists and phytogeographers, the latitude 83^{o} E can be taken as the delimiting boundary between the western and eastern Himalayan floral provinces.

2.3.3.2 Diversity of fauna

Nepal has a relatively high number of fauna species. Higher fauna groups have been relatively well studied, however the taxonomy and distribution of the lower fauna groups, except for the butterflies and to some extent the spiders, have yet to be studied. A comprehensive Fauna of Nepal guide is essential to understand the status of species for their conservation.

Platyhelminthes Helminths are invertebrate animals without appendages and with bilateral symmetry. Most species are parasitic. They occur in the wild as well as within domestic plants and animals. In Nepal, helminths are not well studied and helminthological works are confined to the Kathmandu Valley. A checklist of 168 species of helminth parasites has been compiled, with 33 species belonging to the trematodes, 67 to the nematodes, 36 to the cestodes, and 32 species being plant Nematodes (Gupta 1997). Some common plant

helminth parasites include *Meliodogyne incognita, M. arenaria,* and *M. javanica,* all of which cause damage to vegetables. *Ascaris lumbricoides, Ancylostoma duodenale,* and *Taenia* species are common human parasites.

Spiders Thapa (1995) reported 144 species of spiders belonging to 17 families. 109 species are endemic, including 33 species that are rare in distribution and three threatened species. Most of the spiders in Nepal have been collected from the high mountains and Mid-hills. The far-western region and the entire lowland Terai and Siwalik Hills need further study.

Insects An inventory made by Thapa (1997) covers approximately 5,052 species of insects, of which 1,131 were discovered for the first time and described from Nepalese specimens. *Apis laboriosa,* the world's largest honeybee, *Attacus atlas,* the world's largest atlas moth, and *Epiophlebia laidlawi,* a relict dragonfly species, are three of the best known insect species unique to Nepal.

Butterflies & Moths Among Nepal's fauna, the butterflies are the most studied group throughout the country (Smith 1994; 1997). 640 species of butterflies have been recorded, distributed in different ecological zones. The Red Data Book of the Fauna of Nepal (BPP 1995b) lists 142 species, of which 12 are endangered, 43 are vulnerable, and the rest, 87 species, are susceptible to be threatened. There are four species and 25 subspecies which are possibly endemic (Smith 1997, pers. comm.). There are 557 species in the Mid-hills, 325 in the Terai and 82 in the Highlands (BPP 1995h). So far, 2,253 species of moths (excluding Microlepidoptera) have been recorded in Nepal (Smith 1997, pers. comm.).

Fishes The fish fauna of Nepal has been fairly well documented. Many taxonomic changes have been made in the genera and species of fish by Shrestha (2001), who listed a total of 182 species belonging to 11 orders, 31 families and 93 genera. Altogether, 34 species are known to be threatened, and 8 species are endemic.

Amphibians and Reptiles Shah (1995) listed 143 species of amphibians and reptiles in Nepal, with 43 species of amphibians (one salamander, four toads, and 38 frogs) and 100 species of reptiles (24 lizards, 14 turtles, two crocodiles and 60 snakes). Studies of amphibians and reptiles have been carried out in a number of areas in Nepal including the Arun Valley in eastern Nepal, Royal Chitwan National Park in central Nepal and the Annapurna-Dhaulagiri region in western Nepal.

Birds The birds of Nepal have been well studied. 852 species belonging to 18 orders have been recorded (Grimmet *et al*. 2000). Eleven species have become extinct over the last century. 691 bird species are recorded in the Mid-hills, 648 in the Terai and Siwalik Hills and 413 in the highlands. 111 species are confined to the Terai and Siwalik Hills, 29 species are confined to the Mid-hills and 24 to the highlands (BPP 1995f). The richest area for birds is the lowland tropical forest below 300m in the Terai, where over 500 species have been recorded (Inskipp & Inskipp 1991).

Mammals A comprehensive account of Nepal's mammalian fauna has been produced by Suwal and Verheugt (1995), who listed a total of 181 mammal species belonging to 12 orders and 39 families. Mammals are well represented in the protected areas of Nepal.

2.3.3.3 Protected, threatened and endemic species

Protected Species HMGN has imposed restrictions on the export of 12 plant species and one forest product (Table 2.24). Additionally, 27 mammal species, nine bird species, and three reptile species have been given legal protection under the National Parks and Wildlife Conservation Act, 1973 (Table 2.25). However, there are still 10 species of fish and 12 species of butterflies that need protection (Smith 1997, pers. com.).

Table 2.24 Plant species and forest products legally protected under the Forest Regulations, 1995 (amended in 2001)

BOTANICAL NAME OR FOREST RESOURCE	VERNACULAR NAME	FAMILY	IUCN STATUS	CITES CODE
Species banned for collection, use, sale, distribution, transportation and export				
Dactylorhiza hatagirea	Panch Ounle	Orchidaceae		II
Picrorhiza scrophulariiflora	Kutki	Scrophulariaceae		
Juglans regia (bark)	Okhar	Juglandaceae		
Species banned for export				
Abies spectabilis	Talis patra	Pinaceae		
Cinnamomum glaucescens	Sugandakokila	Lauraceae		
Cordyceps sinensis	Yarsa gomba	Clavicipitaceae		
Lichen species	Jhyau			
Nardostachys grandifloraI	Jatamansi *	Valerianaceae	V	
Rauvolfa serpentina	Sarpaganda, harbaruwa	Apocynaceae	E	II
Asphaltum (rock exudate)	Silajit			
Taxus buccata subsp. *wallichiana*	Loth salla	Taxaceae		II
Valerina jatamansii	Sugandabala	Valerianaceae		
Timber trees banned for felling, transportation and export				
Acacia catechu	Khayer	Leguminosae	T	
Bombax ceiba	Simal	Bombacaceae		
Dalbergia latifolia	Satisal	Fabaceae		
Juglans regia	Okhar	Juglandaceae		
Michelia champaca	Champ	Magnoliaceae	E	
Pterocarpus marsupium	Bijaya sal	Fabaceae		
Shorea robusta	Sal, Sakhuwa	Dipterocarpaceae		

Source: Forest Regulations 1995, amended in 2001
*Products processed in the country can be exported abroad with special permission from the MFSC.
IUCN Threat categories: E=Endangered; T=Threatened; V=Vulnerable

Table 2.25 Protected animal species under the National Parks and Wildlife Conservation Act, 1973

SCIENTIFIC NAME	LOCAL NAME	COMMON NAME	IUCN STATUS	CITES CODE
Mammals				
01. Ailurus fulgens	Habrey	Red panda	V	I
02. Antilope cervicapra	Krishnasar	Black buck	V	III
03. Bos gaurus	Gaurigai	Gaur	V	I
04. Bos mutus	Chaurigai	Wild yak	E	I
05. Bubalus arnee	Arna	Wild water buffalo	E	III
06. Canis lupus	Bwanso	Tibetan wolf	V	I
07. Caprolagus hispidus	Hispid kharayo	Hispid hare	E	I
08. Cervus duvauceli	Barasingha	Swamp deer	E	I
09. Elephas maximus	Hatti	Asiatic elephant	E	I
10. Felis Iynx		Lynx	E	II
11. Hyaena hyaena	Hundar	Striped hyaena		
12. Macaca assamensis	Assame Rato Bandar	Assamese monkey		
13. Manis crassicaudata	Salak	Indian Pangolin		II
14. Manis pentadactyla	Salak	Chinese pangolin		II
15. Moschus chrisogaster	Kasturi Mriga	Musk deer	E	I
16. Ovis ammon	Nayan	Great Tibetan sheep		I
17. Panthera tigris	Bagh	Bengal tiger	E	I
18. Panthera uncia	Hiun Chituwa	Snow leopard	E	I
19. Pantholops hodgsoni	Chiru	Tibetan antelope		I
20. Pardofelis nebulosa	Dwanshe Chituwa	Clouded leopard	V	I
21. Platanista gangetica	Suns	Gangetic dolphin	V	I
22. Prionailurus bengalensis	Chari Bagh	Leopard cat		I
23. Prionodon pardicolor	Silu	Spotted linsang		I
24. Rhinoceros unicornis	Gainda	Asian one-horned rhinoceros	E	I
25. Sus salvanius	Pudke Bandel	Pigmy hog	Ex (?)	I
26. Tetracerus quadricornis	Chauka	Four-horned antelope	V	III
27. Ursus arctos	Himali Rato Bhalu	Brown bear		I
Birds				
01. Buceros bicornis	Raj Dhanesh	Giant hornbill		I
02. Catreus wallichii	Cheer	Cheer pheasant	E	I
03. Ciconia ciconia	Seto Saras	White stork		

04. Ciconia nigra	Kalo Saras	Black stork		II
05. Eupodotis bengalensis	Khar Mujur	Bengal florican	E	I
06. Grus grus (G. antigone)	Saras	Common crane		II
07. Lophophorus impejanus	Danfe	Impeyan pheasant		I
08. Sypheotides indica	Sano Khar Mujur	Lesser florican	E	II
09. Tragopan satyra	Munal	Crimson-horned pheasant		III
Reptiles				
01. Gavialis gangeticus	Ghadial Gohi	Gharial	E	I
02. Python molurus	Ajingar	Asiatic rock python	V	I
03. Varanus flavescens	Sun Gohori	Golden monitor lizard	I	I

Source: DNPWC Act, 1973
CITES Codes: Appendices I, II, III
IUCN categories: Ex=Extinct; E=Endangered; I=Indeterminate; V=Vulnerable

Threatened Species Nepal has been a signatory of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) since 1973 and a number of Nepali species are listed under various CITES appendices as follows (see also Table 2.26 below):

- vascular plants - 15 species (one species of angiosperm in Appendix I; one species of pteridophyte, two species of gymnosperms and five species of angiosperms in Appendix II; three species of gymnosperms and three species of angiosperms in Appendix III)
- mammals - 58 species (29 species in Appendix I; seven species in Appendix II; 22 species in Appendix III)
- birds - 40 species (16 species in Appendix I; nine species in Appendix II; 15 species in Appendix III)
- reptiles - 13 species (seven species in Appendix I; four species in Appendix II; two species in Appendix III)
- amphibians - one species (Appendix II)
- insects - two species (Appendix II)

Table 2.26 Nepal's flora and fauna under CITES appendices, 1995

APPENDIX I	APPENDIX II	APPENDIX III
Flora		
	02. *Ceropegia* sp. (Milkweeds)	10. *Cycas pectinata* (Himalayan cycas)
01. *Saussurea lappa*	03. *Cyatheaceae* (Tree ferns)	11. *Gnetum montanum* (Genetum)
	04. *Cycadaceae* (Cycas)	12. *Meconopsis regia* (Himalayan yellow poppy)
	05. *Dioscorea deltoidea* (Dioscorea)	13. *Podocarpus neriifolius* (Podocarpus)
	06. *Orchidaceae* (Orchids)	14. *Talauma hodgsonii* (Magnolia)
	07. *Podophyllum hexandrum* (May apple)	15. *Tetracentron sinense* (Tetracentron)
	08. *Rauvolfia serpentina* (Serpentine)	
	09. *Taxus wallichiana* (Himalayan yew)	
Mammals		
01. *Ailurus fulgens* (Red panda)	30. *Cuon alpinus* (Wild dog)	37. *Antilope cervicapra* (Black buck)
02. *Bos gaurus* (Gaur bison)	31. *Equus hemionus* (Wild ass)	38. *Arctictis binturong* (Bear cat)
03. *Bos grunniens* (Yak)	32. *Manis* species (Pangolin)	39. *Bubalus arne* (Wild buffalo)
04. *Canis lupus* (Wolf)	33. *Primates* species (Monkey)	40. *Canis aureus* (Jackal)
05. *Capra falconeri* (Markhor)	34. *Pteropus* species (Flying fox)	41. *Herpestes edwardsii* (Common mongoose)
06. *Caprolagus hispidus* (Hispid hare)	35. *Ratufa* species (Squirrel)	42. *Herpestes fuscus* (Brown mongoose)
07. *Cervus duvaucelii* (Swamp deer)	36. *Tupaia glis* (Common tree shrew)	43. *Herpestes urva* (Crab-eating mongoose)
08. *Elephas maxiums* (Elephant)		44. *Marmota himalayana* (Himalayan marmot)
09. *Felis bengalensis* (Leopard cat)		45. *Martes flavigula* (Yellow-throated marten)
10. *Felis marmorata* (Marble cat)		46. *Martes foina intermedia* (Stone marten)
11. *Felis temmincki* (Golden cat)		47. *Mellivora capensis* (Haoney badger)
12. *Lutra lutra* (Otter)		48. *Mustela altaica* (Pale weasel)
13. *Melursus ursinus* (Sloth bear)		49. *Mustela kathiah* (Yellow-bellied Weasel)
14. *Moschus chrisogaster* (Musk deer)		50. *Mustela sibirica* (Himalayan weasel)
15. *Naemorhedus goral* (ghoral)		51. *Paguma larvata* (Himalayan palm)
16. *Naemorhedus sumatraensis* (Himalayan serow)		52. *Paradosurus hermaphroditus* (Common palm civet)
17. *Neofelis nebulosa* (Clouded leopard)		53. *Pradoxurus jerdoni* (Brown palm civet)
18. *Ovis ammon hodgsonii* (Argali)		54. *Tetracerus quadricornis* (Four-horned antelope)

APPENDIX I	APPENDIX II	APPENDIX III
19. *Panthera tigris* (Tiger) 20. *Panthrea pardus* (Common leopard) 21. *Uncia uncia* (Snow leopard) 22. *Pantholops hodgsoni* (Chiru) 23. *Platanista gangetica* (Gangetic Dolphin) 24. Presbytis entellus (Langur) 25. *Prionodon pardicolor* (Linsang) 26. *Rhinoceros unicornis* (Greater One-horned Rhinoceros) 27. *Selenarctos thibetanus* (Himalayan black bear) 28. *Sus salvanius* (Pygmy hog) 29. *Ursus arctos* (Brown bear)		55. *Viverra zibetha* (Large Indian civet) 56. *Viverricula indica* (Small Indian civet) 57. *Vulpes bengalensis* (Indian fox) 58. *Vulpes montana* (Mountain fox)
Birds		
01. *Aceros nipalensis* (Rufous-necked hornbill) 02. *Aquila heliaca* (Imperial eagle) 03. *Ardeotis nigricepas* (Great Indian bustard) 04. *Buceros bicornis* (Giant hornbill) 05. *Catreus wallichii* (Cheer pheasant) 06. *Eupodotis bengalensis* (Bengal floricon) 07. *Falco jugger* (Lagger falcon) 08. *Falco pelegrinoides* (Barbary falcon) 09. *Falco peregrinus* (Red-capped falcon) 10. *Grus nigricollis* (Black-necked crane) 11. *Haliaeetus albicilla* (White-tailed eagle) 12. *Lophophorus impejanus* (Himalayan monal) 13. *Psittacula krameri* (Rose ringed parakeet) 14. *Rhodonessa caryophyllacea* (Pink-headed duck) 15. *Tetraogallus tibeatanus* (Tibetan snowcock) 16. *Tragopan melanocephalus* (Western horned pheasant)	17. *Anthracoceros* species (Pied hornbill) 18. *Ciconia nigra* (Black stork) 19. *Falconiformes* species (Falcon) 20. *Gruidae* species (Crane) 21. *Ithaginis cruentus* (Blood pheasant) 22. *Otididae* species (Lesser florican) 23. *Pitta nympha* (Indian pitta) 24. *Platalea leucorodia* (Eurasian spoonbill) 25. *Sarkidiornis melanotos* (Comb duck {Nakta})	26. *Anas acuta* (Northern pintail) 27. *Anas clypeata* (Northern shoveler) 28. *Anas crecca* (Common tern) 29. *Anas penelope* (Eurasian wigeon) 30. *Anas querquedula* (Garganey) 31. *Aythya nyroca* (White-eyed pochard) 32. *Bubulcus ibis* (Cattel egret) 33. *Casmerodius albus* (Great egret) 34. *Columba livia* (Rock pigeon) 35. *Dendrocygna bicolor* (Fulvous whistling duck) 36. *Egretta garzetta* (Little egret) 37. *Gracula religiosa* (Talking mynah) 38. *Streptopelia senegalensis* (Laughing dove) 39. *Threskiornis aethiopicus* (Black-headed ibis) 40. *Tragopan satyra* (Crimson-horned pheasant)
Reptiles		
01. *Crocodulus palustris* (Mugger crocodile) 02. *Gavialis gangeticus* (Gharial) 03. *Python molurus molurus* (Indian python) 04. *Testudinidae* species (Land tortoise) 05. *Trionyx gangeticus* (Ganges softshell) 06. *Trionyx hurum* (Peacock softshell) 07. *Varanus flavescens* (Golden monitor lizard)	08. *Elachistodon westermanni* (Indian egg-eating snake) 09. *Naja naja* (Cobra) 10. *Ophiophagus hannah* (King cobra) 11. *Ptyas mucosus* (Dhaman or common rat snake)	12. *Viperra russellii* (Russel's viper) 13. *Xenochrophis piscator* (Checkerd keelback)
Amphibians		
	01. *Rana tigerina* (Indian bull frog)	
Insects		
	01. *Troides aeacus aeacus* (Golden birdwing) 02. *Troides helena* subsp. *serberus* (Common birdwing)	

Source: IUCN-Nepal 1995b - Nepal's Flora and Fauna in the current CITES lists

CITES Status Categories: Appendix I: Species threatened with extinction; Appendix II: Species not yet threatened, but which could become endangered if trade is not controlled; Appendix III: Species identified by any party as being subject to regulation in that country and which require international co-operation to control trade.

Sixty species of non-endemic plants are regarded as threatened (Table 2.27). These include 12 endangered species, 11 vulnerable species, 22 rare species, two indeterminate species, five insufficiently known species, and seven threatened species (Shrestha & Joshi 1996).

Table 2.27 List of non-endemic threatened plants

	SCIENTIFIC NAME	FAMILY	IUCN CATEGORY
1	*Allium przewalskianum*	Amaryllidaceae	V
2	*Choerospondias axillaris*	Anacardiaceae	R
3	*Pistacia chinensis* subsp. *integerrina*	Aanacardiaceae	R
4	*Alstonia neriifolia*	Apocynaceae	R
5	*Alstonia scholaris*	Apocynaceae	R
6	*Beaumontia grandiflora*	Apocynaceae	V
7	*Rauvolfia serpentina*	Apocynaceae	E
8	*Arisaema untile*	Araceae	I
9	*Helwingia himalaica*	Araliaceae	I
10	*Hoya arnottiana*	Asclepiadaceae	K
11	*Tylophora belsotemma*	Asclepiadaceae	Ex?
12	*Podophyllum hexandrum*	Berberidaceae	V
13	*Alnus nitida*	Betulaceae	R
14	*Oroxylum indicum*	Bignoniaceae	V
15	*Maharanga bicolor*	Boraginaceae	K
16	*Maharanga emodi*	Boraginaceae	K
17	*Crateva unllocularis*	Capparaceae	R
18	*Megacarpaea polyandra*	Cruciferae	V
19	*Cycas pectinata*	Cycadaceae	E
20	*Dioscorea deltoidea*	Dioscoreaceae	T
21	*Dioscorea prazeri*	Dioscoreaceae	T
22	*Elaeocarpus sphaericus*	Elaeocarpaceae	V
23	*Lithocarpus fenestrata*	Fagaceae	K
24	*Swertia chirayita*	Gentianaceae	V
25	*Gnetum montanum*	Gnetaceae	E
26	*Acacia catechu*	Fabaceae	T
27	*Butea monosperma*	Fabaceae	E
28	*Dalbergia latifolia*	Fabaceae	V
29	*Gloriosa superba*	Liliaceae	R
30	*Lilium walllichianum*	Liliaceae	R
31	*Paris polyphylla*	Liliaceae	V
32	*Magnolia globosa*	Magnoliaceae	R
33	*Michelia champaca*	Magnoliaceae	E
34	*Michelia kisopa*	Magnoliaceae	E
35	*Talauma hodgsonii*	Magnoliaceae	E
36	*Olea ferruginea*	Oleaceae	R
37	*Paeonia emodi*	Paeoniaceae	R
38	*Calamus acanthospathus*	Palmae	E
39	*Calamus latifolius*	Palmae	E
40	*Calamus leptospadix*	Palmae	E
41	*Wallichia densiflora*	Palmae	R
42	*Passiflora napalensis*	Passifloraceae	E
43	*Larix griffithiana*	Pinaceae	R
44	*Larix himalaica*	Pinaceae	K
45	*Ceratostigma ulicinum*	Plumbaginaceae	R
46	*Podocarpus neriifolius*	Podocarpaceae	E
47	*Hydrobryum griffithii*	Podostemaceae	R

	SCIENTIFIC NAME	FAMILY	IUCN CATEGORY
48	*Rheum nobile*	Polygonaceae	R
49	*Helicia nilagirica*	Proteaceae	R
50	*Aconitum ferox*	Ranunculaceae	T
51	*Aconitum gammiei*	Ranunculaceae	R
52	*Aconitum heterophyllum*	Ranunculaceae	R
53	*Aconitum laciniatum*	Ranunculaceae	T
54	*Aconitum spicatum*	Ranunculaceae	T
55	*Prunus carmesina*	Rosaceae	R
56	*Bergenia ciliata*	Saxifragaceae	T
57	*Picrorhiza scrophulariaefolia*	Scrophulariaceae	V
58	*Tetracentron sinense*	Tetracentraceae	R
59	*Ulmus wallichiana*	Ulmaceae	R
60	*Nardostachys grandiflora*	Valerianaceae	V

Source: Shrestha and Joshi 1996

Altogether, 27 mammal species are listed as threatened by IUCN: eight as Endangered, ten as Vulnerable, four as Indeterminate, and five as Insufficiently Known. Additionally, 22 bird species, nine reptile species (one Endangered, two Vulnerable, one Rare, four Indeterminate and one Insufficiently Known), and two insect species are listed under IUCN's Red List (1995) (Table 2.28). Nine species of birds are regarded as threatened in Nepal.

One rodent species, the Himalayan field mouse (*Apodemus gurkha*), which is found in central Nepal between 2,200-3,600m, is endemic to Nepal. Two species of mammals, the pigmy hog (*Sus salvanius*) and the Indian Chevrotain (*Moschiola meminna*), have probably become extinct in Nepal (IUCN-Nepal 1995a).

Table 2.28 Nepal's Threatened Animals in the IUCN Red List, 1994

ORDER/FAMILY	SCIENTIFIC NAME	COMMON NAME	STATUS
CLASS: MAMMALIA			
Carnivora/CANIDAE	*01. Canis lupus*	Grey Wolf	V
	02. Cuon alpinus	Asiatic Wild	V
	03. Vulpes benghalensis	Bengal Fox	I
FELIDAE	*04. Catopuma temmincki (Felis temmincki)*	Asiatic Golden Cat	I
	05. Neofelis nebulosa	Clouded Leopard	V
	06. Panthera tigris tigris	Tiger	E
	07. Prionaliurus marmorata (Felis marmorata)	Marbled Cat	K
	08. Prionaliurus viverrinus, Felis viverrinus, F. viverrina)	Fishing Cat	K
	09. Uncia uncia (Panthera unica)	Snow Leopard	E
MUSTELIDAE	*10. Aonyx cinerea*	Oriental Small-clawed Otter	K
	11. Lutra perspicillata	Smooth -coated Otter	K
URSIDAE	*12. Ailurus fulgens*	Lesser Panda (Red Panda)	V
	13. Melurus ursinus (Ursus ursinus)	Sloth Bear	V
	14. Selenarctos thibetanus (Ursus thibetanus)	Asiatic Black Bear	V
Cetacea/LATANESTIDAE	*15. Platanista gangetica*	Ganges River Dolphin	V
Proboscidea/ELEPHANTIDAE	*16. Elephas maximus*	Asian Elephant	E
Perissodactayla/ RHINOCEROTIDAE	*17. Rhinoceros unicornis*	Greater One-horned-Rhinoceros	E
Artiodactyla/SUIDAE	*18. Sus salvanius*	Pygmy Hog	E
CERVIDAE	*19. Cervus duvauceli duvauceli*	Swamp Deer	I
BOVIDAE	*20. Antilope cervicapra*	Blackbuck	V
	21. Bos gaurus (B. frontalis)	Gaur	V
	22. Bos mutus (B. grunniens)	Wild Yak	E
	23. Bubalus arnee (B. bubalus)	Wild Water Buffalo	E
	24. Capricornis sumatraensis (Naemorhedus sumatraensis)	Mainland Serrow	T
	25. Hemitragus jemlahicus	Himalayan Thar	K
	26. Tetracerus quadricornis	Four-horned Antelope	V
Lagomorpha/OCHOTONIDAE	*27. Ochotona nubrica*	Nubra Pika	I
LEPORIDAE	*28. Caprolagus hispidus*	Hispid Hare	E
CLASS: AVES			
Pelacaniformes/ PELACANIDAE	*01. Pelecanus philippensis*	Spot-billed Pelican	I

ORDER/FAMILY	SCIENTIFIC NAME	COMMON NAME	STATUS
Ciciniformes/CICONIIDAE	*02. Leptoptilos dubius*	Greater Adjutant Stork	E
	03. Leptoptilos javanicus	Lesser Adjutant Stork	V
Falconiformes/ACCIPITRIDAE	*04. Aythya baeri*	Baee's Pochard	V
	05. Aegypius monachus	Cinerous Vulture	V
	06. Aquila heliaca	Imperial Eagle	R
	07. Haliaeetus albicvilla	White-tailed Eagle	V
	08. Haliaeetus leucoryphus	Pallas's Sea-Eagle	R
FALCONIDAE	*09. Falco naumanni*	Lesser Kestrel	R
Galliformes/PHASIANIDAE	*10. Catreus walllichi*	Cheer Pheasant	E
	11. Francolinus gularis	Swamp Francolin	V
	12. Tragopan melanocephalus	Western Tragopan	E
Gruiformes/OTIDIDAE	*13. Eupodotis bengalensis (Houbaropsis bengalensis)*	Bengal Florican	E
	14. Eupodotis indica (Sypheotides indica)	Lesseer Florican	E
Charadriformes/ SCOLOPACIDAE	*15. Gallinago nemoricola*	Wood Snipe	I
Coraciiformes/ALCEDINIDAE	*16. Alcedo hercules*	Blyth's Kingfisher	E
BUCEROTIDAE	*17. Aceros nipalensis*	Rufous-necked Hornbill	R
Passeriformess/ MUSCICAPIDAE	*18. Chaetornis striatus*	Bristled Grasssbird	K
	19. Chysomma altirostre (Moupinia altirostris)	Jerdon's Babbler	V
	20. Paradoxornis flavirostris	Black-breasted Parrotbill	I
	21. Saxicola insignis	White- throated Bushchat	K
	22. Spelaeornis caudatus	Rufous-throated Wren- Babbler	K
CLASS: REPTILLIA			
Testudines/EMYDIDAE	*01. Geoclemys hamiltonii (Domania hamiltonii)*	Black Pond Turtle	I
	02. Kachuga kachuga	Red-crowned Roofed Turtle	I
	03. Melanochelys tricarinato (Geochelone or Nicoria tricarinata)	Three-keeled Land Tortoise	I
	04. Indotestudo elongata (Geochelone elongata)	Elongated Tortoise	K
Crocodyla/CROCODYLIDAE	*05. Crocodylus palustris*	Mugger	V
GAVIALIDAE	*06. Gavialis gangeticus*	Gharial	E
Sauria/VARANIDAE	*07. Varanus flavescens*	Yellow Monitor Lizard	I
Serpentes/BOIDAE	*08.Python molurus*	Indian Python	V
COLUBRIDAE	*09. Elachistodon westermanni*	Indian Egg-eating Snake	R
CLASS: INSECTA			
Odanata/EPIOPHLEBIIDAE	*01. Epiophlebia laidlawi*	Relict Himalayan Dragonfly	V
Lepidoptera/PAPILIONIDAE	*02. Teinopalpus imperialis*	Kaiser-l-Hind	R

Source: IUCN-Nepal 1995a. Endangered Wildlife - Nepal's threatened animals in the IUCN Red list 1994

A summary of all threatened plants and animals in Nepal is given below in Table 2.29.

Table 2.29 Numbers of threatened plant and animal species in Nepal

GROUPS	CITES			IUCN RED LIST								HMGN	PROPOSED
	I	II	III	Ex	E	V	R	I	K	T	CT		
Lichens												1	
Fungi												1	
Algae													
Bryophytes													
Pteridophytes		1											
Gymnosperms		2	3									2	
Angiosperms	1	5	3	1	12	11	22	2	5	7		8	
Insects		2				1	1						
Butterflies & Moths													12
Fishes													10
Amphibians		1											
Reptiles	7	4	2		1	2	1	4	1			3	
Birds	16	9	15		6	6	4	3	3			9	
Mammals	29	7	22		8	10		4	5	1		27	
TOTAL	**53**	**31**	**45**	**1**	**27**	**30**	**28**	**13**	**14**	**8**		**51**	**22**

Source: IUCN (1995 a, b); BPP (1995a, b, c, d, e, f, g, h, i)

Endemic species Altogether, 342 plant species and 160 animal species have been reported as being endemic to Nepal (Table 2.30).

Table 2.30 Endemic species in Nepal

GROUP	NO. OF SPECIES	REFERENCE
Lichens	39	Sharma, 1995
Fungi	16	Joshi & Joshi, 1991
Algae	3	Joshi & Joshi, 1991
Bryophytes	30	Joshi & Joshi, 1991
Pteridophytes	8	Joshi & Joshi, 1991
Angiosperms	246	Shrestha and Joshi, 1996
Total	**342**	
Spiders	108	Thapa, 1995
Butterflies & Moths	*30	Smith, 1997 (pers. com.)
Fishes	8	Shrestha 1995
Amphibians & Reptiles	11	Shah, 1995
Birds	2	Shah, 1995
Mammals	1	Suwal & Verheugt, 1995
Total	**160**	

(* Possible endemic taxa).

Oberonia nepalensis is a recently reported endemic species of angiosperm (Shakya & Chaudhary 1999)

Tomoptera maskeyi is an endemic amphibian species**.**

2.3.4 GENETIC DIVERSITY

Genetic diversity is the basis of heritable variation within and between populations of organisms. Ultimately, this diversity resides in the variations in sequences of the four, nucleotide base pairs, which constitute the genetic code. Farmers have used genetic diversity for thousands of years in agriculture. Hundreds of plant and wild animal species have been domesticated and have been bred for desirable characteristics such as size, disease resistance, taste, and productivity. Modern breeders also take advantage of genetic diversity. For example, a few plants from one tiny population of wild rice provided the gene for resistance to the grassy stunt virus, and so the Asian hybrid rice crop whose genotype made it susceptible to disease has flourished (Glowka *et al.* 1994).

Until recently, genetic diversity was only given consideration amongst domesticated species and populations held in zoos or botanical gardens (Raven 1992). However, because of habitat destruction and degradation, the number of plant and animal species is decreasing and their genetic diversity is threatened, and conservation of genetic diversity has become a major issue today. Molecular techniques and screening of genes is being applied for the preservation of wild species. Hence, knowledge of how much genetic variation exits within a species, how variation is partitioned between and within populations, and where the species has its centres of diversity is fundamental to applied conservation (Rowe & Cronk 1995).

Genetic diversity can be identified by determining allozyme variation, the amount of DNA, and the structures and numbers of chromosomes of any cell of an organism (WCMC 1992). Allozyme variation is a common method of assessing genetic diversity. Allozymes that differ by one or a few amino acids have different overall electrical charges, which can be assessed using electrophoresis. Methods such as Restriction Fragment Length Polymorphism and DNA amplification using Polymerase Chain Reaction thermocycler are being applied to individual organisms to identify variations (Smith 1994; Gillings & Briscoe 1996).

Knowledge of the genetic diversity of plants in Nepal is poor. The very few studies that have been done using modern techniques include analyses of the genetic diversity in rice using Rubisco (Ribulose biphosphate carboxylase/oxygenase), Restriction Fragment Length Polymorphism, DNA fingerprinting using Randon Amplified Polymorphic DNA, and DNA amplification using Polymerase Chain Reaction (PCR) (Shakya *et al*. 1993; Agrawal & Agrawal 1994).

3 EXISTING MECHANISMS FOR CONSERVING BIODIVERSITY

A great deal of effort has been made over the years in Nepal to protect and manage biological resources and their diversity. The impetus for this has been the recognition that biodiversity is the mainstay of Nepal's economy and of the well being of its people. More recently, Nepal joined the world community in recognising the global importance of biodiversity and acceded to a number of international conventions and other agreements to conserve it. While there is ample room for improvement, many mechanisms are already in place for biodiversity protection and resource management, and a number of lessons can be learned from past experience. This chapter discusses these mechanisms and the lessons learned, as well as the gaps and constraints that exist in the system.

3.1 INSTITUTIONAL FRAMEWORK

Appropriate and effective institutions are fundamental to the implementation of policies, legislation and international conventions relating to the conservation of biodiversity. Nepal has developed its institutional capacity for the protection and management of its valuable biological resources and its main elements are described below. However, while the Nepal Biodiversity Strategy builds on the legacy of enlightened environmental planning that has resulted in several successful conservation stories in Nepal, the present institutional structure does require strengthening (Belbase 1999), and the NBS will provide for this.

3.1.1 PARLIAMENTARY COMMITTEE ON NATURAL RESOURCES AND ENVIRONMENT

The Constitution of the Kingdom of Nepal, 1990, provides for the establishment of a Natural Resources and Environment Committee in the House of Representatives. The powers and functions of the Committee include the evaluation of the policies and programmes, resource mobilisation and administration in collaboration with the Ministries of Water Resources, Land Reform and Management, Agriculture, Forest and Soil Conservation, and Population and Environment, and relevant departments and agencies under these ministries. The Committee is required to submit a report to the House of Representatives, including comments and recommendations. While preparing the report, the Committee is empowered to consult representatives of the ministries and departments and relevant experts.

The Committee on Natural Resources and Environment has existed since July 1991; however, it has been dormant for most of the time. As multiparty democracy matures in Nepal, the efficacy of such parliamentary committees is expected to improve. When fully functional, this Committee can be expected to have a very positive impact on the conservation of biodiversity.

3.1.2 ENVIRONMENT PROTECTION COUNCIL

The Environment Protection Council (EPC) was first established in 1992 and carried out several important activities during its first two years. Acting on the initiative of the EPC, HMGN ratified the Convention on Biological Diversity and the Convention on Climate Change, and acceded to the Vienna Convention on the Protection of the Ozone Layer and the Montreal Protocol on Substances that Deplete the Ozone Layer. Furthermore, on the EPC's initiative, vehicular emission standards have been developed and, to some extent, are being enforced.

The Environment Protection Act, 1996, recognised the EPC and provided for its establishment as a statutory body. However, the Act does not provide for the composition, powers, and functions of the EPC, which has therefore remained under the chairmanship of the Prime Minister, with seven independent experts as members. The Environment Protection Regulations, 1997, are also silent on the role of the EPC. In the absence of such guidance under the Environment Protection Act and Regulations, it is hard to determine whether the EPC would be an appropriate institution for developing policies and legislation and overseeing their implementation as well as those of various programmes.

Article 10 of the CBD requires each party to integrate consideration of conservation and sustainable use of biological resource into national decision-making. In order to do so, and for the co-ordination of such, the establishment and effective functioning of a high-level, multidisciplinary body is crucial. It would probably not be advisable to entrust this responsibility to an institution such as the current EPC unless its advisory status, powers, functions, and secretariat are strengthened by law.

3.1.3 LOCAL AUTHORITIES

The District Development Committee (DDC) is the apex body of local government in each district, and Section 189(g) (1) of the Local Self-Governance Act, 1998, requires the DDC to formulate and implement plans for the conservation of biological diversity and soil. Section 189(g) (2) further requires the DDC to ensure the protection and promotion of the environment. Similarly, Section 28(h) (2) requires Village Development Committees (VDCs) to formulate and implement programmes for the conservation of biological diversity and soil. Development activities take place in each district with the approval of the District Council of each DDC. Since the majority of the population lives in the 3,912 VDCs and 58 Municipalities, activities for the protection of indigenous knowledge, innovations and practices should begin at the local level. However, no practical measures have been taken to integrate conservation, sustainable use of biological resources and equitable and fair sharing of the benefits arising out of these into district level decision-making in Nepal.

3.2 PROTECTED AREAS

3.2.1 BACKGROUND

The first legislation to protect Nepal's wildlife was introduced more than a hundred and fifty years ago in the 1840's, during the regime of Jang Bahadur Rana, when restrictions were placed on the hunting of certain animals. The Central Zoo was also established during this period. The importance of conserving wild species of fauna and flora was first recognised by HMGN in Nepal's first Five-Year Development Plan (1956-1961). The Rhino Patrol, established in 1961 as a result of this first Plan, was fairly successful in controlling the poaching of large mammals. It was only after the 1970's that an effective conservation programme allowed for the establishment of protected areas. So far, nine national parks, three wildlife reserves, three conservation areas, and one hunting reserve have been established in the three different ecological zones of Nepal: the Terai, Mid-hills and high mountains (Table 3.1).

Protected areas (PAs) were initially established in Nepal for the protection of wildlife, especially endangered wildlife. However, the objectives have since been broadened to include the preservation of natural, historic, scenic, and cultural values. According to the latest estimates, 26,695km^2, 18.32% of the total area of Nepal, is now declared protected.

The National Parks and Wildlife Conservation (NPWC) Act of 1973 provides the legal basis for the management of PAs. The Act, subsequently amended four times, in 1974, 1982, 1989 and 1994, recognises the following six categories of PAs in Nepal:

National Park
The NPWC Act defines a national park as an area set-aside for the conservation and management of the natural environment, including the ecological, biological and geomorphologic associations of aesthetic importance. To develop the area for eco-tourism is the second objective, provided that this is compatible with sustainable conservation.

Strict Nature Reserve
This is an area of unusual ecological or other significance, set aside for the purpose of scientific study. The inaccessible lower Barun Valley, fed by the Saldima River, a glacier-fed tributary of the Arun River, is the most pristine area in the Makalu-Barun National Park, and thus has been designated as a Strict Nature Reserve, the first in Nepal.

Wildlife Reserve
A Wildlife Reserve is an area established for the conservation and management of plants and wildlife and their habitat.

Hunting Reserve
This is an area set aside for the conservation and management of wildlife to provide opportunities for legal recreational hunting.

Conservation Area
This type of protected area is managed according to an integrated plan for the conservation of the natural environment and the sustainable use of the natural resources contained within it.

Buffer zone
A buffer zone is a designated area surrounding a national park or a reserve within which the use of forest products by local people is regulated to ensure sustainability.

Table 3.1 Protected areas of Nepal

CATEGORY (YEAR OF ESTABLISHMENT)	AREA (km^2)	ALTITUDE (m)
National Park (NP)		
Royal Chitwan NP (1973)	932	150-815
Royal Bardia NP (1976/1988)	968	152-1,494
Shivapuri NP (2002)	144	1,366-2,732
Khaptad NP (1984)	225	1,000-3,276
Makalu Barun NP (1991) [1]	1,500	435-8,463
Sagarmatha NP (1976)	1,148	2,800-8,850
Langtang NP (1976)	1,710	792-7,245
Shey Phoksundo NP (1984)	3,555	2,000-6,885
Rara NP (1976)	106	1,800-4,048
Total	***10,288***	
Wildlife Reserve (WR)		
Koshi Tappu WR (1976)	175	90
Parsa WR (1984)	499	150-815
Royal Suklaphanta WR (1976)	305	90-270
Total	***979***	
Hunting Reserve (HR)		
Dhorpatan HR (1987)	1,325	2,850-7,000
Total	***1,325***	
Conservation Area (CA)		
Kanchenjunga CA (1997)	2,035	1,200-8,598
Manaslu CA (1998)	1,663	1,360-8,163
Annapurna CA (1986, 1992)	7,629	1,000-8,092
Total	***11,327***	
Buffer Zone		
Royal Chitwan NP	750	
Royal Bardia NP	328	
Makalu Barun NP	830	
Langtang NP	420	
Shey Phoksundo NP	449	
Sagarmatha NP	275	
Total	***3,051***	
Total Area Protected	**26,970**	
(% of Nepal Territory)	**(18.32)**	

Source: Department of National Parks and Wildlife Conservation (January 2001)

(Sagarmatha National Park and Royal Chitwan National Park were declared World Heritage Sites in 1979 and 1984, respectively. Koshi Tappu Wildlife Reserve was declared a Ramsar site in 1987. Shey Phoksundo National Park is in the process of being included in the WHS list.).

Out of 118 ecosystems identified by Dobremez (1970) in different physiographic zones in Nepal, 80 are represented in the present protected areas system.

Shrestha & Joshi (1996) listed 246 endemic species of angiosperms not known to occur outside Nepal. Almost 90% of the endemic plants do not have a wide distribution in Nepal and are only known from their type collection. The mountain PAs lying between 82°-84° E and 28°-30° N contain the greatest number of endemic species (Table 3.2).

Table 3.2 Number of flowering plants and endemic species in protected areas

Protected Area	NUMBER OF SPECIES[1]	NUMBER OF ENDEMICS[2]
Lowlands		
Koshi Tappu WR	237	1
Parsa WR	919	0
Royal Chitwan NP	919	0
Royal Bardia NP	839	0
Royal Suklaphanta WR	700	0
Mid-hills		
Shivapuri NP	2,122	16
Dhorpatan HR	1,150	36
Khaptad NP	567	4
High Mountain		
Kanchenjunga CA	>3,000	11-23
Makalu Barun NP	3,073	7
Sagarmatha NP	1,074	11
Langtang NP	3,689	15
Manaslu CA	>2,500	NA
Annapurna CA	3,430	56
Shey Phoksundo NP	1,579	30
Rara NP	1,070	16

Source: [1]Shakya *et al.* (1997); [2]Shrestha & Joshi (1996).
NA=Not available

Several endangered species including rhinoceros, tiger, swamp deer, red panda, musk deer, and gharial have been studied and their status determined. However, the factors that threaten the existence of plants and animals still require extensive research. There is an urgent need to systematically study the biology of threatened plants and animals, identify factors threatening the species with extinction, and develop approaches to manage PAs more efficiently.

The National Parks and Wildlife Conservation Act, 1973, and its subsequent amendments, and the Buffer Zone Management Regulations, 1996, represent the most important legislative measures focusing on the needs of local communities as well as minimising impacts on protected areas to avoid parks and people conflicts. Buffer zones may include forests, settlements, agricultural lands, open spaces in villages, and many other land use forms. Buffer zones have been declared in six protected areas (and are proposed to be established in three more), covering 35.60% of the core zone. 144 VDCs are involved in sustainable use and conservation of biodiversity (Table 3.9).

Table 3.3 Buffer zones of parks and reserves

Protected Area	BUFFER ZONE AREA (km^2)	NO. OF VDCs WITHIN BUFFER ZONE	ESTIMATED POPULATION IN BUFFER ZONE
Royal Chitwan NP	750	37	242,000
Royal Bardia NP	328	17	69,000
Langtang NP	420	26	NA
Shey Phoksundo NP	449	8	9,185
Makalu Barun NP	830	12	32,000
Sagarmatha NP	275	3	13,000
*Koshi Tappu WR	136*	13	172,000
*Parsa WR	367*	17	126,000
*Royal Suklaphanta WR	153*	11	74,000
Total	**3,708**	**144**	**737,185**

* Proposed. NA=Not Available
Source: DNPWC/MFSC (1998/99)

3.2.2 POLICY AND LEGISLATION

Ecosystems and genetic resources are protected *in-situ* within the protected areas system of Nepal. The Department of National Parks and Wildlife Conservation's (DNPWC) mandate is to administrate and manage the PAs.

3.2.2.1 Legislation and regulations

Aquatic Animals Protection Act, 1961: This Act provides legislative protection of the habitats of aquatic species. However, no agency has been designated to administer and enforce the Act.

National Parks and Wildlife Conservation (NPWC) Act, 1973: The NPWC Act has been a key instrument in protecting biodiversity within the protected areas system. Section 3 of the NPWC Act prohibits hunting any animal or bird, building any house, hut or other structure, clearing or cultivating any part of the land, harvesting, cutting, burning or damaging any tree, bush or other forest product, and mining within national parks or protected areas. In spite of the absence of adequate data on the wild flora and fauna of Nepal, which makes comprehensive management and conservation difficult, Section 10 provides complete protection to 27 species of mammals, nine species of birds and three species of reptiles (Table 2.25).

The NPWC Act recognises six categories of Protected Area in Nepal, namely national park, conservation area, wildlife reserve, hunting reserve, strict nature reserve and buffer zone.

Out of 16 protected areas, 14 are directly managed by the DNPWC. The Annapurna Conservation Area and Manaslu Conservation Area are managed by a national NGO, the King Mahendra Trust for Nature Conservation (KMTNC). The different protected area categories represent the following percentages of the total PA land: national parks 38.54%, wildlife reserves 3.67%, hunting reserves 4.96%, conservation areas 42.43%, and buffer zones 10.40%. A rough analysis shows that 14.84% (3,957km^2) of the country's protected areas system are in the lowland (Terai and Siwalik Hills) regions, only 6.64% (1,770km^2) are in the Mid-hills and 78.52% (20,939km^2) in the high mountains.

Himalayan National Park Regulations, 1979: These Regulations have made special provisions for people living within national parks to collect natural resources for their daily requirements, such as firewood, leaf litter, small pieces of timber and fodder. The Regulations also allow people to continue to graze their domestic animals on park rangeland. However, no provision has been made for handing over parcels of parkland to be managed by the community (Sharma 1999). Despite this, communities can organise harvests and grazing plans so long as they are consistent with the park's objectives. They can also control or even stop "outsiders" from entering the park or reserve to harvest resources, and thus help reduce the pressure on the natural resources of the area.

Buffer Zone Management Regulations, 1996, and Buffer Zone Management Guidelines, 1999: The NPWC Act was amended to incorporate provisions for conservation areas and buffer zones. Subsequently, the Buffer Zone Management Regulations and Guidelines were approved to design programmes compatible with national park management and to facilitate public participation in the conservation, design and management of buffer zones. The amended NPWC Act makes provisions for 30-50% of the park (or reserve) revenues to be retained for community development activities in the buffer zone. The revenue is disbursed through a Buffer Zone Management Committee and a Users Committee. The Buffer Zone Management Regulations are the only regulations to promote community forestry programmes in the buffer zones and to improve the regeneration of forests by the community. Although private holdings can be within a buffer zone, land ownership is unaffected. Natural boundaries have been taken as the primary demarcation of buffer zones around the periphery of national parks and reserves. Factors taken into consideration for the demarcation of buffer zones include: areas likely to be affected by the existence of the PA, the geographical situation of the PA, the status of the villages and settlements located within the PA, and areas practicable and appropriate for management purposes (DNPWC/MFSC 1999).

The concept of a buffer zone calls for sustainable utilisation of forest resources and environmental conservation within the zone for community development. Legal provisions allow for buffer zones to be managed under community forest, religious forest, and private forest structures. However, these regulations need to be revised for today's context and must be made clear and easy to understand at the field level (Sharma 1999).

Implementation of the Buffer Zone Management Regulations is a natural outcome of previous policy and planning initiatives. The National Conservation Strategy (HMGN/IUCN 1988) emphasised the need for sustainable use of land and natural resources. It specifically pointed out that the forests outside of protected areas must also be protected from deforestation, that people should be made self-reliant in timber, fuelwood, fodder and other forest products, and that local communities should be given the responsibility of managing forests according to geographical conditions and social needs.

3.2.2.2 International conventions and other obligations

The World Heritage Convention: In 1972, the Convention for the Protection of the World's Cultural and Natural Heritage recognised that the physical deterioration or disappearance of any cultural or natural heritage site constitutes a harmful impoverishment to the heritage of all nations, and that therefore cultural and natural heritages need to be preserved as part of world heritage. Nepal has been successful in fulfilling its obligations towards the World Heritage Convention, primarily through the implementation of the NPWC Act under which the Royal Chitwan National Park and Sagarmatha National Park were established. Nepal has also proposed that Shey Phoksundo National Park be listed as a world heritage site based on its unique cultural and natural characteristics. The National Conservation Strategy recognised the need to reverse damage and destruction of cultural heritage, as well as encroachment on heritage sites, religious forests and sacred grounds.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES): Nepal became party to CITES in 1975. CITES has facilitated international co-operation to control international trade in endangered wild flora and fauna with the aim of reducing or eliminating trade in species whose numbers or conditions suggest that further removal from their natural habitat would lead to their extinction. The NPWC Act prohibits the removal or export of species listed under CITES without a licence. In order to establish decision-making authorities regarding CITES, HMGN designated the Natural History Museum (Tribhuvan University) and the Department of Plant Resources as the scientific authorities for wild fauna and wild flora, respectively. Similarly, HMGN designated the Department of National Parks and Wildlife Conservation and the Department of Plant Resources as the management authorities for wild fauna and flora, respectively.

The NPWC Act regulates national and international trade in species of all wild animals. Pursuant to Section 10 of the NPWC Act, the hunting of animals protected under Schedule 1 is prohibited throughout Nepal. Many of these species are also listed under CITES, Appendix I. Under the NPWC Act, it is illegal to collect, obtain or keep any part of a dead animal protected under Schedule 1 without a certificate, and such goods are prohibited from sale, purchase or disposal. Pursuant to Section 26, any person illegally killing, wounding, purchasing, selling or transferring a protected animal, or keeping as a trophy, selling or purchasing any part thereof, will incur a fine or imprisonment or both. The Ninth Five-Year Plan also emphasises the importance of CITES in protecting Nepal's endangered wild species of flora and fauna.

Ramsar Convention: The Convention on Wetlands of International Importance especially as Waterfowl Habitat, known as the Ramsar Convention, was signed in 1971 and came into force in 1975. It is an independent international convention designed to protect the wetland ecosystems from further destruction. It calls on all signatories to conserve wetlands, promote their sustainable utilization, and set aside special areas as wildlife reserve. Every country is required to designate at least one wetland for inclusion on the list of wetlands. The list of Wetlands of International Importance (LWII) is maintained by IUCN, in Gland, Switzerland.

His Majesty's Government of Nepal ratified the Ramsar Convention in 1987, and designated Koshi Tappu Wildlife Reserve (KTWR) for inclusion in the Ramsar site. KTWR is an important habitat for Nepal's last surviving population of wild water buffalo (*Bubalus bubalis arnee*).

3.2.3 MAJOR ACHIEVEMENTS

Buffer zone management: The Buffer Zone Management Regulations is the most important legislative initiative focussing on the needs of local communities who are most likely to be adversely affected by protected areas, and subsequently avoids conflicts between parks and people.

Management strategies: The DNPWC has been developing innovative park management strategies in collaboration with local residents, NGOs, INGOs, and donors. Major programmes in the protected areas include: the Makalu-Barun National Park and Buffer Zone, the Terai Arc Landscape Project, the Northern Mountain Conservation Project, CARE International's Buffer Zone Development Project, the World Wild Fund for Nature's Kanchenjunga Conservation Area Project, and the London Zoological Society's Wildlife and Domestic Veterinary Programme. Central to all of these programmes is the participation of user groups in the conservation and sustainable use of biological resources and the equitable distribution of benefits to local communities. The DNPWC also manages a long-term monitoring programme to assess numbers of wildlife species, population trends, and habitat requirements to provide a scientific basis for all management decisions on endangered species conservation.

Tourism: PAs support eco-tourism, and vice-versa, thus providing a leading source of foreign income for Nepal. Approximately 45.50% of tourists (191,617 out of a total of 421,188) visited protected areas in fiscal year 1998/99.

The Annapurna Conservation Area Project (ACAP): The ACAP began as a pilot project in a 200km^2 area of the Ghandruk Village Development Committee in 1986. By 1990, its work area had expanded to 16 VDCs, covering 1,500km^2. The ACAP was officially gazetted in 1992 and the King Mahendra Trust for Nature Conservation was given the responsibility of managing it for 10 years. The ACAP has evolved from an experimental Integrated Conservation and Development Project to the largest protected area (7,629km^2) in Nepal. The project serves as a model throughout Asia for integrating public participation in biodiversity conservation.

The Parks People Programme: The Parks People Programme is a demonstration by the MFSC and the DNPWC on how community institutions can function as partners in self-reliant, socio-economic development to support conservation and sustainable use of biodiversity in protected areas. The primary objective of the programme is to improve the socio-economic condition of men and women of buffer zone communities and to engage them in biodiversity conservation. The programme was launched in seven protected areas and buffer zones in the Terai and the Mid-hills.

The Makalu-Barun National Park and Conservation Area Project: The DNPWC implemented this project to demonstrate a new model for conservation. The project gives strict protection to the biodiversity of the park while developing sustainable use activities for the people who reside in the surrounding conservation area. The Makalu-Barun National Park and Buffer Zone is managed by the DNPWC.

The Tiger Conservation Action Plan: The Tiger Conservation Action Plan has been approved to recognise, restore, preserve and increase the effective land base that supports Royal Bengal tigers (*Panthera tigris tigris*) to maintain viable tiger populations in Nepal (DNPWC/WWF-Nepal 1999).

Increase in the populations of protected animals: The following populations have increased in numbers since they were given protected status:

- Rhinoceroses in Royal Chitwan National Park
- Tigers in all of the protected areas of the Terai, except Koshi Tappu
- Black bucks in Khairapur (near Royal Bardia National Park)
- Ungulates in Royal Chitwan and Royal Bardia National Parks as well as in other PAs too
- Wild buffaloes in Koshi Tappu Wildlife Reserve
- Musk deer in Sagarmatha and all mountain PAs
- Rhinoceroses translocated to Royal Bardia National Park and Royal Suklaphanata Wildlife Reserve
- Gharials reintroduced into rivers in Royal Chitwan National Park, Royal Bardia National Park and Koshi Tappu Wildlife Reserve
- The Red Data Book of the Fauna of Nepal (BPP 1995b) reports that a number of threatened mammals, such as Sambar Deer (*Cervus unicolor*), Gaur (*Bos gaurus*), Nilgai (*Boselaphus tragocamelus*), four-horned Antelope (*Tetracerus quadricornis*) and Ganges Hog Deer (*Axis porcinus*), are now found in national forests adjoining the Parsa Wildlife Reserve in Bara District.

***In-situ* conservation of threatened and endemic plants in PAs and adjoining areas**: Nepal allocated 26,696km^2 (18.32%) of its total land area and 67.80% of ecosystems as protected areas for effective *in-situ* conservation. This has been effective for the *in-situ* conservation of medicinal, food, timber and other threatened plants and their wild relatives. A few examples include different *Rhododendron* species and *Tetracentron sinense*, an endangered species, in Makalu-Barun National Park; *Larix himalaica*, a threatened species, in Langtang National Park; a good population of *Dalbergia latifolia*, a threatened and valuable timber plant, in Parsa Wildlife Reserve; *Pterocarpus marsupium*, a threatened and highly valuable medicinal plant, in Royal Suklaphanta Wildlife Reserve; *Gnetum montanum*, an endangered species, in Royal Chitwan National Park and in Seduwa, in the low-lying Arun Valley in Makalu-Barun National Park.

3.2.4 LESSONS LEARNED

The Wildlife Conservation Act, 1957, was the first Act to identify the importance of protecting wildlife and resulted in the creation of a Rhinoceros Sanctuary in Chitwan. The enactment of the NPWC Act in 1973 provided a regulatory mechanism for the conservation of natural areas and wildlife. Any kind of destruction, exploitation or removal of fauna or flora, and any kind of damage to habitat are now strictly prohibited. The Act, with four amendments to date, details various arrangements for the protection of endangered species of wildlife and their habitats, for the protection and management of protected areas, and for the regulation of consumptive and non-consumptive uses of biodiversity so that the welfare of the people is sustained.

The Constitution of Nepal, 1990, declares that the "State shall give priority attention to the conservation of the environment ... and also make special arrangement for the conservation of rare animal species, the forests, and the vegetation of the country [Article 26(4)]."

The DNPWC recorded several parks and people conflicts around the Rhino Sanctuary and in response, the buffer zone concept was developed.

Medicinal and aromatic plants are highly exploited in the mountains, and traders take advantage of the poverty of the local people. The Department of Forests tries to control illegal trade and allows sustainable harvesting of some species with special permits.

3.2.5 MAJOR CONSTRAINTS

There are still limitations on management capacity through insufficient staff, weak research infrastructure, lack of logistical support, inadequate financial resources and lack of incentive. Although it oversees the management of 18.32% of Nepal's land area, the DNPWC has only 22 technicians at headquarters and less than 1,000 nation-wide. With no logistical support or incentive, staff attendance in remote protected areas is poor. Furthermore, field-based staff are the least trained and the most inadequately funded among HMGN personnel.

Difficult terrain, harsh environmental conditions and a lack of facilities in the mountains make programme implementation difficult.

3.2.6 GAPS

Poor representation of Mid-hills ecosystems: The Mid-hills have the greatest ecosystem diversity in Nepal, but what is left of relatively undisturbed areas is seriously threatened by human activities and is insufficiently represented in the protected areas system. Conversely, there are fewer gaps in the protected areas system in the high mountain range, from Kanchenjunga to the east to Tinker in the west. Between the Kanchenjunga CA and the Langtang NP, exisitng gaps are narrow. The area between Kanchenjunga CA and Makalu Barun NP has been identified as potential landscape for a rhododendron reserve, covering the areas around the Milke Danda and Jaljale Himal. The gap between Makalu Barun/Sagarmatha NP and Langtang NP should be protected for its significant Gauri Shanker range.
Trans-boundary protected areas: Establishing new PAs adjoining existing ones in neighbouring countries is needed. Large total contiguous PAs, whether as separate protected areas grouped together (e.g. Chitwan and Parsa) or in different countries, is crucial to maintaining healthy populations of large mammal species.

Shared responsibilities for co-ordination: The responsibility for the management of PAs is shared between different organisations, and there is room for strengthening the roles and responsibilities. The DNPWC is responsible for their management and administration. The Royal Nepalese Army is responsible for surveillance and protection activities and works in collaboration with the DNPWC. The army protects biodiversity in national parks and wildlife reserves from wood smugglers, poachers, domestic animals, fires, and encroachment by the public. The Immigration Department is responsible for issuing trekking permits, including to national parks. The Ministry of Culture, Tourism and Civil Aviation is responsible for issuing mountaineering permits and for the development of auxiliary services and infrastructure to accommodate trekkers and tourists who visit high mountain national parks.

Implementation of management plans: Management plans have been prepared for some PAs, including Royal Chitwan NP, Langtang NP, Royal Bardia NP, Parsa WR and Koshi Tappu WR, and these now require effective implementation. Management plans for other PAs still need to be developed or upgraded.

Pressure on resources use: In Nepal, people interact with protected areas in numerous ways. There has been a growing conflict over land use rights and practices (Nepal & Weber 1993, 1995; Studsrod & Wegge 1995). The right to collect firewood and graze animals was denied in PAs in the Terai, while in for the collection of thatch grass, access was restricted by limiting the collection period to two-three weeks a year during the dry season. Grazing is allowed in mountain PAs however. As a result, parks and people conflicts are common in all the reserves of Nepal, but the extent of the conflicts vary in different reserves.

Livestock grazing in the park: Usually, a limited number of cattle and buffaloes may be grazed inside PAs in the hills. But encroachment by domestic animals has threatened the existence of the red panda in Langtang National Park and the pure wild water buffalo in Koshi Tappu Wildlife Reserve.

Illegal hunting: Hunting was banned after the establishment of protected areas except in the hunting reserve. However, cases of rhinoceros and tiger poaching in Royal Chitwan National Park, and occasional poaching of musk deer in Sagarmatha National Park and Shey Phoksundo National Park, are still being recorded.

Crop raiding and depredation: Crop depredation by wild animals in adjoining cultivated fields has occurred in all the protected areas. As a consequence, wild animals have often been poisoned.

Alien species: Different parts of Nepal, including protected areas, are suffering from invasion by alien species such as *Eupatorium adenophorum, E. odoratum, Lantana camera,* and *Mikania micrantha*.

Revision of the list of protected animals: The protected fauna list of the NPWC Act, 1973, which includes 27 species of mammals, nine species of birds, and three species of reptiles, has not been revised since 1973 in terms of population status, distribution, etc. The list also needs to be updated for inclusion of other species.

Tourism: High concentrations of visitors in a few protected areas (Royal Chitwan National Park, Annapurna Conservation Area, Sagarmatha National Park, and Langtang National Park), which are biologically fragile and already under stress from local populations, have accelerated negative environmental impacts (Wells 1993). Large amounts of garbage have been reported in Himalayan peaks and other mountain protected areas. While there are reasons to encourage tourism, there is a need to determine the carrying capacity of the protected areas.

Weak integration: At present, the policies and strategies of the Department of Soil Conservation and Watershed Management do not explicitly address mountain biodiversity conservation. The challenges of poverty, isolation, and environmental sensitivity are mutually reinforcing in mountain areas, and an integrated approach is necessary to overcome them. The level of understanding of the relationship between socio-economic and biodiversity processes in mountain areas is still very limited. There are large gaps in understanding sustainable agriculture, development of non-agricultural opportunities, the unique aspects of space and micro-environmental variation and their implications for biodiversity.

Indigenous knowledge: The indigenous knowledge of mountain peoples in forest management and traditional practices of ethnoecological relationships would contribute to biodiversity resource management in mountain ecosystems. Amongst several mountain ethnic groups, information about plants and animals is passed from one generation to the next through oral folklore and is often kept secret. Sometimes it is very difficult to extract information from these people, even with some form of payment (Rao 1991; Shengji 1996). There is an urgent need to identify and document indigenous knowledge through proper research approaches; ethnobiology has a great potential for contributing to Himalayan biodiversity conservation (Shengji 1996).

3.3 FORESTS

The forests of Nepal are classified into National Forests and Private Forests. Any forest, excluding private forests, whether marked or unmarked within a forest boundary, is a National Forest in Nepal. The category includes wastelands, uncultivated lands and unregistered lands surrounded by or adjoining forests, as well as paths, ponds, lakes, rivers, streams and riverine lands within forests. According to the Forest Act, 1993, there are five sub-categories of National Forest (see also Table 3.1):

Government-managed Forests: National Forests managed by HMGN with the main objective being production. The Department of Forests manages these forests.

Community Forests: National Forests handed over to a user group for development, conservation and utilisation for the collective benefit of the community.

Leasehold Forests: National Forests leased to any institution established under current law, industry or community, for the production of forest products, agroforestry, tourism or farming of insects and wildlife in a manner conducive to the conservation and development of forests.

Religious Forests: National Forests handed over to any religious group or community for development, conservation, and utilisation.

Protected Forests: National Forests declared by HMGN as protected in consideration of their special environmental, scientific or cultural significance. Forests in PAs also fall under this category, which are managed either by the DNPWC or by authorised NGOs.

Table 3.4 Classification of forests, management objectives and responsible institutions

FOREST TYPE	MANAGEMENT OBJECTIVES	RESPONSIBLE INSTITUTIONS
NATIONAL FOREST		
Forests managed by HMGN	Production of forest products	District Forests Offices
Community Forests	Production of forest products and multiple purpose use	Forest user groups
Leasehold Forests	Rehabilitation of degraded forests, production of forest products, tourism, wildlife farming	Leasehold groups, NGOs, Industries Religious institutions
Religious Forests	Protection of religious site	Dept. of Forests, DNPWC, NGOs
Protected Forests	Protection of wildlife, conservation of water, biodiversity and environment	
PRIVATE FOREST		
Forests or tree farms, land ownership of which does not belong to HMGN	Production of forest products	Individual person, industry, NGO

Source: Forest Act, 1993

3.3.1 NATIONAL AND LEASEHOLD FORESTRY PROGRAMME

National and leasehold forestry aims to develop and manage forest resources through government agencies or private sector leaseholders, complementing community and private forestry (HMGN/ADB/ FINNIDA 1988). All areas that have not been handed over to forest user groups as community forests or set-aside as leasehold forests and that are not religious forests are either Government-Managed Forests or Protected Forests. These forests are managed according to approved Operational Forest Management Plans. All responsibilities and rights of use of such forests remain with the Department of Forests.
Improving the productivity of natural forests, developing forests on degraded areas and protecting forests on both sides of rivers and streams and environmentally sensitive areas are the major activities of the national and leasehold forestry programme.

3.3.1.1 Policy and legislation

Forest Act, 1993: The Forest Act, 1993, accounts for all forest values, including environmental services and biodiversity, as well as production of timber and other products. The provisions relating to protected forests, community forests and leasehold forests will have long-term impact on the conservation and sustainable use of components of biological resources. Section 23 empowers the government to delineate any part of a national forest that has a 'special environmental, scientific or cultural importance' as a protected forest. The Department of Forests is required to prepare an operational plan for any protected forest. The inclusion of these terms in a legal document lends support to the conservation of biodiversity in areas that are located outside existing national parks and reserves (Belbase 1997). The government is empowered to grant any part of a national forest for the following purposes: (i) as a leasehold forest for raw materials required by industries (ii) to plant trees and increase the production of forest products for sale or use (iii) for tourism or agroforestry in a manner conducive to the conservation and development of forests.

The Environment Protection Act, 1996: After the establishment of the Ministry of Population and Environment, it assumed responsibility for environmental protection in different sectors. The Environment Protection Act, 1996, and the Environment Protection Regulations, 1997, have made Initial Environmental Examinations or Environmental Impact Assessments mandatory for development proposals involving forests, industry, roads, tourism, drinking water, solid waste management, and agriculture. However, a thorough analysis of these requirements shows that the Initial Environmental Examination and Environmental Impact Assessment guidelines are too complicated for many who should be applying them.

3.3.1.2 Major achievements

Operational Forest Management Plans have been prepared and partially implemented for 18 districts (Table 4.2), 17 of which are in the Terai and one in the Mid-hills.

Protection Forests: Wherever possible, forest strips of at least double the width of the particular river or stream in question have been set aside along both banks to protect the water quality and the land from erosion. Due attention is being given to the management of Protection Forests in the Siwalik Hills, where the natural process of regeneration is favoured for the improvement of the vegetation cover. This minimises the work the soil would generally require if artificial regeneration were to be applied. Nearly 60% of the forests in the 18 districts (Table 3.2) have been classified as Protection Forests and can complement biodiversity conservation.

Table 3.5 Districts with Operational Forest Management Plans

DISTRICT	FOREST AREA (HECTARES)				
	PRODUCTION	PROTECTION	CF POTENTIAL	TOTAL	ACTUAL CF AREA
1. Illam	1,496	39,280	41,150	80,926	11,715
2. Jhapa	10,513	1,167	7,877	195,567	8,470
3. Morang	15,264	37,569	2,667	55,500	46
4. Sunsari	11,866	11,504	1,495	24,865	85
5. Udayapur	4,145	98,719	16,967	11,9831	20,703
6. Sarlahi	6,849	14,206	2,273	23,328	119
7. Rautahat	15,869	2,170	2,939	20,978	205
8. Bara	25,959	3,273	3,197	32,429	159
9. Parsa	10,110	3,387	3,496	16,993	24
10. Makwanpur	1,876	87,652	50,994	140,522	13,575
11. Chitwan	5,614	20,416	4,870	30,900	4,742
12. Nawalparasi	20,846	80,950	8,962	11,0758	836
13. Rupandehi	7,014	18,533	6,459	32,006	5,790
14. Kapilbastu	32,616	29,933	8,316	70,865	223
15. Bankey	25,784	83,631	3,880	113,295	2,104
16. Bardia	14,792	14,681	4,273	33,746	1,706
17. Kailali	64,196	13,3128	12,400	209,724	5,255
18. Kanchanpur	23,536	31,165	2,999	57,700	114
Total	**298,345** (25.0%)	**711,364** (59.6%)	**184,214** (15.4%)	**1,193,923** (100.0%)	**75,871**

Source: Department of Forests 2002
CF=Community Forest

Model Forest Management in the Terai: The Sagarnath Forest Development Project of the Forest Products Development Board has been successfully operating production-oriented block forest management on about 13,000 hectares of forest land with the low stocking rate of 50m^3 per hectare in Sarlahi and Mahotari districts of the Terai (White 1986). The main objective of the project is to produce fuelwood by planting fast growing species. Plantation on about 11,500 hectares has been completed while maintaining natural forest on either side of the river and the East-West Highway within the project area. On the basis of a 10-year rotation, the eucalyptus plantation is producing 110-130 poles of 8-9m length and 84.2m^3 of fuelwood.

Leasehold Forest: The Hills Leasehold Forestry and Forage Development Project has been implemented in 26 Mid-hills districts: Panchthar, Terhathum, Bhojpur, Okhaldhunga, Khotang, Ramechhap, Sindhuli, Dolkha, Sindhupalchok, Kabhrepalanchok, Makwanpur, Chitwan, Dhading, Tanahu, Gorkha, Piuthan, Sallyan, Rolpa, Rukum, Dailekh, Jajarkot, Achham, Bajura, Doti, Dadeldhura and Baitadi to promote the leasehold forestry programme. The aim of the project is to identify potential forests and leaseholder groups for the programme. This is followed by the preparation of operational plans for these forests, the development of degraded forest lands and improvement of private lands of the leaseholder groups through the cultivation of fodder and fruit trees and forage grasses, terrace improvement, off-farm income generating activities and training. By the end of May 2002, over 7,000 hectares of National Forests had been leased to over 11,200 households (Table 3.6).

Table 3.6 Leasehold forests in the Mid-hills of Nepal up to the end of the 1998/99 fiscal year

Number of leaseholder groups	1,655
Number of households	11,253
Leasehold forest area (ha)	7,011
Percent of total leasehold forest area in the Mid-hills	0.32
Percent of total leasehold forest area in Nepal	0.13

Source: Management Information System record of Hills Leasehold Forestry & Forage Development Project 2002.

Conservation of Some Tree Species: HMGN is attempting *in-situ* gene pool conservation of Bijayasal (*Pterocarpus marsupium*) through tree improvement programmes as the availability of this tree is decreasing in its habitat in the western Terai/Bhabar mixed hardwood forests. The government is also trying to conserve *ex-situ* the gene pool of Satisal (*Dalbergia latifolia*), categorised as a vulnerable species by IUCN and protected by HMGN.

3.3.1.3 Lessons learned

The production oriented block management of forests on suitable sites in the Terai yields a larger quantity of forest products and generates substantially more income and employment opportunities to the local people than when the same area is left unmanaged. The participation of communities in the decision-making process and the equitable sharing of the benefits are crucial to the success of the block management forests in the Terai.

Degraded lands have the potential to produce considerable quantities of fodder through the cultivation of fodder trees and forage grasses and the application of simple techniques to significantly boost fodder production (FAO 1997).

3.3.1.4 Major constraints

The lack of financial and human resources is considered as the major constraint for the sustainable production of forest products, which is the main objective of HMGN for managed production forests. There are also policy constraints such as management practices that are oriented to the sustainable production of particular products that may have negative impacts on biodiversity. Likewise, budget allocations for the implementation of Operational Forest Management Plans are meant for silvicultural operations and the harvesting of forest products and there is a lack of programmes and financial and human resources for setting aside forest areas as protection forests.

3.3.1.5 Gaps

The Department of Forests and its District Forest Offices are responsible for the conservation and development of forests outside protected areas. Since the guiding management principles in government-managed national forests are the multiple use and sustained harvest of forest products, biodiversity conservation has received little priority.

Indigenous Biodiversity Conservation: The management objectives of national forests managed by the government are oriented either to producing timber with high commercial value or to cultivating fast-growing exotic species such as eucalyptus. Less priority has been given to biodiversity conservation in government-managed forests, even though a high proportion of these have been set aside as protection forests. Protection forests are located in the Siwalik Hills range and on the banks of rivers and their main objective is protection from landslides and river erosion. Programmes for biodiveristy conservation in the Operational Forest Management Plans of the above 18 districts (Table 3.5) have not yet been identified.

Incomplete baseline information: There are gaps in the baseline information on flora and fauna diversity including the biology, ecology, conservation status, and geographic and altitudinal distribution of rare and endangered species.

Delays in preparing Operational Forest Management Plans: In the Mid-hills, while community forestry is spreading at a modest rate, national forests, forests outside PAs, and forests not under community forestry should not be left unprotected from exploitation. Such forests are quite large in area and should be put under management according to Operational Forest Management Plans. Delays in preparing and implementing Operational Forest Management Plans for these forests means delays in implementing conservation programmes.

Extension strategy: A number of donor countries/organisations have been supporting the Department of Forests in the Mid-hills and high mountain regions in the promotion and implementation of community forestry programmes, the DNPWC with the conservation of wildlife, and the Department of Soil Conservation and Watershed Management (DSCWM) and with soil and catchment management. However, while several training courses have targeted local people for the smooth implementation of community forestry programmes, very little has been done in the southern districts of Nepal to improve the management skills of District Forest Office (DFO) staff and to raise awareness on the importance of proper forest management.

Poor management of large blocks of forests in the Mid-hills: Large blocks of forests in the Mahabharat Range of the Mid-hills and in the mountain regions that cover a number of VDCs within a district and spread over more than one district are not yet managed. The frequency of visits to these areas by DFO staff is low due to their remoteness. There are no programmes for the management of these large blocks of forest areas, other than the occasional visit by DFO staff in response to complaints. Extension of community forestry programmes in these areas is negligible. The sub-alpine (3,000-4,000m), alpine (4,000-5,000m) and temperate (2000-3,000m) forests rate as first, second and third respectively in numbers of endemic plant species (Shrestha & Joshi 1996). Proportionately, total PA coverage is highest in the mountain regions and lowest in the Mid-hills. Nevertheless, existing large blocks of forests in the Mid-hills have potential to be managed for biodiversity conservation, as they are water catchment areas. Special programmes involving local people need to be developed and implemented for the conservation of these forests. The benefits obtained from these forests should then be shared amongst the local people.

Time constraints for biodiversity conservation: In the Mid-hills, DFO staff time is spent either on community forestry or in administration, and not enough time is given to biodiversity conservation.

3.3.2 COMMUNITY AND PRIVATE FORESTRY PROGRAMMES

HMGN has recognised community forestry as a strategy to improve the condition of forests in the Mid-hills as well as satisfy the basic needs of forest products of rural people. Tamrakar & Nelson (1991) calculated that there are 3.5 million hectares with potential for community forestry in Nepal. Community forestry involves handing over use rights and management to local people who have traditionally used the forests and are willing to accept management responsibilities. HMGN's policy is to adopt community forestry for all accessible Mid-hills and high mountain forests as well as in some Terai districts.

The main components of the programme are the formation of user groups, the preparation of operational plans, plantations where appropriate, and training to strengthen the organisational capacity of user groups and to improve the skills of field staff and the users in forest management. Other components include seedling distribution, training and related activities on tree planting and management, and registration of private forests.

3.3.2.1 Policy and legislation

Community forestry in Nepal has evolved through policy restructuring and the strengthening of rules and regulations on local control over forest resources. The first legislation that encouraged involvement by local people in natural resource management was the National Forestry Plan of 1976. Community forestry was implemented, and later the Decentralisation Act, 1982 and the Master Plan for the Forestry Sector, 1988 specified provisional strategies for the phased handing-over of all accessible Mid-hills forests to user groups. The Forest Act, 1993 and the Forest Regulations, 1995 reaffirmed the government's policy of assigning more responsibility to local communities.

HMGN's current policy of is to promote community forestry in the Mid-hills, where forests are often of high environmental value, for soil stabilisation and catchment protection (HMGN 1993). The Ninth Five-Year Plan, 1997-2002 encourages local users to satisfy their daily needs in timber, firewood, fodder plants (Daleghans) and other forest products through the development of community forestry (HMGN-NPC 1998). Besides emphasising forest leasehold arrangements in the Terai, the Forest Act of 1993 also reinforces the legal status of religious forests, first recognised in 1976. The community is thus allowed to utilise forest products for religious activities.

3.3.2.2 Major achievements

According to the database of the Community and Private Forestry Division of the Department of Forests, over 854,300 hectares of forest were handed over to 11,095 forest user groups by the end of May 2002 (Table 3.4). Most activities have been undertaken in the Mid-hills with little attention to areas above 2,500m (BPP 1995g). The number and total area of registered private forests in the different physiographic regions of Nepal are shown in Table 3.8.

Table 3.7 Community forests in Nepal up to the end of May 2002

Number of Community Forestry User Groups	11,095
Number of households	1,208,943
Community forest area (ha)	854,389ha
Percent of total community forest area in Nepal	24

Table 3.8 Number of forest user groups and total area of community forests in the Mid-hills and Terai (up to May 2002)

PHYSIOGRAPHIC REGION	NUMBER OF FUGS	NUMBER OF HOUSEHOLDS	TOTAL AREA (HECTARES)
Mid-hills	10,689	1,106,015	805,379
Terai	406	102,928	49,010
Total	**11,095**	**1,208,943**	**854,389**

Source: HMGN-CFDP MIS Database (May 31, 2002)
FUG=Forest User Group

Table 3.9 Number of registered private forests and total area by physiographic region

PHYSIOGRAPHIC REGION	NUMBER OF FORESTS	TOTAL AREA (HECTARES)
High Mountain	55	23.99
Mid-hills	485	662.60
Terai	1,708	1,404.23
Total	**2,248**	**2,090.82**

Source: HMGN-CFDP MIS Database (January 06, 2000)

Nepal has demonstrated that community forestry is a viable strategy for the rehabilitation of abandoned and degraded lands through plantations and by fostering the return of a diversity of species. Community forestry has also contributed to an increase in natural regeneration. However, the improvement in forest cover near villages in the Mid-hills has resulted in an increase in numbers of wild animals, and attacks on domestic animals have been reported in many District Forest Offices.

3.3.2.3 Lessons learned

Initiatives on private land: Farmers take an interest in planting trees on their own land if seedlings of their choice are available. As a result of such plantations, suitable forest corridors have been created that foster the return of wildlife species such as leopards and sloth bears.

Maintenance of useful plant species: Forest user groups aim to produce a range of forest products, including many non-timber forest products. They are concerned about maintaining a whole range of useful plants within their community forests other than fuelwood and timber and therefore the natural diversity of community forests is maintained (Branney & Dev 1994). Compared with uncontrolled use, community forest management leads to lower levels of grazing within the forest, fewer incidences of fire, increased numbers of threatened plant species, and control of illegal hunting.

Incentives: Comparisons of community, private, leasehold, and government-managed forests indicate that incentive systems are very important for the management of forest. If people perceive benefits from new institutional arrangements or technological innovations, the adoption of these is widespread.

3.3.2.4 Major constraints

Scattered area: In the Mid-hills, forests are scattered in small patches of often less than 100 hectares and are surrounded by agricultural land and settlements. Heavy pressures from human and livestock populations in these forests for subsistence needs make biodiversity conservation very difficult. A critical issue is how to involve villagers in the management of the forests of the Terai and Siwalik Hills. Forests that are already handed-over, are in the process of being handed over, or that will be handed over to communities in these regions will have major implications for biodiversity conservation.

Population pressures: The population density of the Mid-hills is high, and there exists a close linkage between the farming systems and the forests. As such, there is intense human interaction with the vegetation. Community forests that are handed over to forest user groups vary in size from less than one hectare to over 500 hectares, with most being between 50-100 hectares in size. The average area per household is under 0.7 hectares.

Priority in meeting peoples' needs: Sustainable production of forest products is the main objective of community forests, which may have negative implications for biodiversity conservation. Many user groups allow unrestricted collection of dead wood and leaf litter from their community forest, yet these form important microhabitats for invertebrates, mosses, fungi and lichens, and their continued removal may lead to reduced biodiversity. Similarly, many user groups have included phrases such as "removal of unwanted species" in their forest operational plans, yet these species may be ecologically important and biodiversity may suffer as a result of their removal.

Communities have the right to manage their forest and determine management options. Managing a variety of plants and products demands prescriptions and control mechanisms that are acceptable to all members of the users group. User groups prefer options that are simple to follow and apply, and that provide quick and greater benefits to them.

3.3.2.5 Gaps

There is often a lack of information with which to prepare sound operational plans, and this lack of socio-economic as well as biophysical information hinders the development of plans that integrate biodiversity conservation issues.

Training programmes available under community forestry initiatives do not cover the importance and potential of biodiversity conservation in community forests.

3.3.3 NON-TIMBER FOREST PRODUCTS

Nepal has a wealth of non-timber forest products (NTFPs) because of its diverse ecosystems. NTFPs are harvested not only from forests, but also from pasturelands, grasslands, and fallow ground. For the marginalised farmer, the diversity of the non-farm environment has tremendous utility consisting of not only of timber for building and bedding, and fodder for livestock, but also valuable nutritional, medicinal, economic (subsistence and cash), religious and cultural resources (Daniggelis 1994). Exploitation of wild plants is therefore very high in areas of poor economic conditions to buffer periods of food scarcity.

The main components of NTFP programmes include: (a) immediate measures to solve problems regarding collection, marketing, and related concerns, (b) cultivation of medicinal and aromatic plants and other selected NTFPs, and (c) development of industries based on medicinal and aromatic plants and other NTFPs.

3.3.3.1 Policy and legislation

The National Conservation Strategy (HMGN/IUCN 1988) highlighted the necessity of establishing appropriate policies, regulations, and management approaches to ensure sustainable extraction of medicinal plants.

NTFPs (or Non-Wood Forest Products) constitute one of six forestry programmes in the Master Plan for the Forestry Sector, 1988, where seven marketed NTFPs are singled out for promotion, including medicinal and aromatic plants, Lokta paper, pine resin, katha (*Acacia catechu*), sabai grass, cane and bamboo. The Master Plan for the Forestry Sector highlights the need to increase the supply of medicinal plants and other minor forest products and to facilitate their conversion into useful commodities for local and foreign markets.

The Nepal Environmental Policy and Action Plan (NEPAP I) advocates that forestry research should address the utilisation of lesser-known forest species, which could include non-timber products (HMGN 1993). NEPAP II (HMGN/MOPE 1998) was the first policy document to recognise that previous policies had more or less ignored the important role of NTFPs as a source of income for rural communities. NEPAP II and the Ninth Five-Year Plan, 1997-2002 (NPC 1998) recommended that community-owned land that is suitable for purposes other than forestry be utilised under community management for the production of non-timber products.

Some NTFP plant species from Nepal are included in CITES appendices, and HMGN must determine their occurrence and the process for their utilisation (if they are not endangered). Conversely, research is required to assess the conservation status of other species and whether they should be included in the CITES list.

HMGN has given legal protection to 17 plant species and two forest products under the Forest Regulations, 1995 (amendment 2001). These include two NTFP species (*Kutki* and *Panch aunle*), which are prohibited for collection, use, sale, transportation or export, and eight plant species and one forest product prohibited for export (see Table 2.24).

3.3.3.2 Major achievements

Sustainable management of medicinal and aromatic herbs has been the subject of increased research and technical support since the 1990s. This is due to the realisation that the resource is being collected in an unsustainable manner in many parts of Nepal, particularly in the highlands, and that local people and the Nepalese economy are not receiving the potentially large economic benefits from their exploitation.

Training programmes on harvesting techniques, propagation of some NTFPs such as Lokta and *Chiraito*, and resin tapping have been initiated in many districts. The Herbs Production and Processing Company, Ltd., has launched a special programme for promoting NTFP cultivation and management in 25 remote districts, although it processes only a small fraction of the total harvest in the country owing to inadequate human resources and poor capacity. Humla Oil Pvt. Ltd. has been established to ensure the sustainable management of Jatamansi and equitable sharing of benefits amongst the local people in Humla district, who are benefiting from the local processing. Marketing links are being developed and user groups have been established as the first step in managing this resource in the wild.

The Forest Survey Division of the Department of Forestry Research and Survey has been documenting and quantifying NTFPs in different districts of Nepal.

Prior to the Forest Act, 1993, collectors could harvest any medicinal and aromatic plant, except for Yarsa gumba, from areas north of the Mahabharat range without a permit or licence (Yonzon 1993). The Forest Regulations of 1995, enforced in accordance with the Forest Act, 1993, categorised the number of NTFPs requiring licences for their collection. The royalty rates on a number of NTFPs have increased with the enactment of the Forest Regulations.

3.3.3.3 Lessons learned

There is a growing awareness at all levels, from local communities to authorities in the MFSC, that forests need to be managed for multiple uses rather than focusing only on tree management. NTFPs are a source of income to many poor people and to the Department of Forests, particularly in the Mid-hills and high mountains. Involving local people residing close to the natural resource is highly desirable in their conservation, especially if they are assured a fair share of the benefits from their sustainable use.

3.3.3.4 Major constraints

Identification and trade: Officials involved in the regulation of NTFP collection and export, such as District Forest Office personnel, Customs officials, Police, etc, have difficulty in identifying NTFP species, especially medicinal and aromatic plants (Kanel 1999a).

Lack of scientific identification: Many plant species that are traded internationally have not been properly scientifically identified. Some prominent examples are Amphi, Bompo, Dhawa, Halik, Hiunkhamar, Kaldana, Kawala, Mujoseda, Rishimarka, Sankhadurlabha, Sugandhapatta, Airi, and Tigedi (Kanel 1999a).

Controlling unsustainable harvesting: NTFPs, especially medicinal plants from which underground parts (root, rhizome, tuber) and bark are collected, are adversely affected by uncontrolled harvesting. For example, there has been drastic depletion of plants that were once very abundant, such as *Nardostachys grandiflora* (Jatamansi) from the Jumla area, *Rauvolfia serpentina* (Sarpagandha) from the Siwalik Hills region and *Asparagus racemosus* (Kurilo) mainly from the Terai. In addition, competition for collection leads to many plants being harvested before full maturity, thus hampering regeneration and affecting the quality of the product.

Fulfilling global demand: The medicinal plants of Nepal that are being used in traditional medicinal practised by local communities as well as in the Ayurvedic medical system for primary health care have also been harvested indiscriminately for export to meet international demands. Such plants include: Sarpagandha (*Rauvolfia serpentina*), Pipla (*Piper longum*), Harro (*Terminalia chebula*), Barro (*T. bellirica*), and Timur (*Zanthoxylum armatum*) from the tropical and subtropical zones of Nepal; Chiraito (*Swertia chirayita*), Bajradanti (*Potentilla fulgens*), Bojo (*Acorus calamus*), and Satuwa (*Paris polyphylla*) from temperate zones; Bikh (*Aconitum spicatum, A. heterophyllum*), Panch Aunle *(Dactylorhiza hatagirea*), Jatamansi (*Nardostachys grandiflora*), and Somlata *(Ephedra gerardiana*) from sub-alpine and alpine zones.

Lack of management technology on other Non-Timber Forest Products: NTFPs provide raw materials for many industries, such as Lokta bark (*Daphne bholua, D. papyracea*), Sabai grass (*Eulaliopsis binata*), Khar (*Saccharum spontaneum*) and Argeli (*Edgeworthia gardneri*) for making paper, pine resin for the resin and turpentine industry, Sal (*Shorea robusta*) seed oil used in the manufacture of soaps, paints, varnishes, and cocoa butter substitute, and bamboo and rattan for household and handicraft items. These resources are declining due to indiscriminate exploitation combined with habitat destruction.

3.3.3.5 Gaps

Weak policies and institutional support: Commercial collection of certain medicinal plants is taking place from the wild in large quantities and no comprehensive policies have been developed in this sector. Rules about when NTFPs can be harvested and traded have not been promulgated. The District Forest Officers and their subordinate staff are mostly involved in the collection of royalties. A functional network is needed to plan, promote, and supervise the entire sector at all organisational levels in the department. An integrated approach needs to be developed by creating mechanisms whereby a fair price is received by the collector/producer of the raw material while at the same time conserving the ecosystem.

Regulating commercial collection and export: The trade also includes plants for which collection, use, sale, distribution, transportation, and export is prohibited by the MFSC. Additionally, plant species such as *Rauvolfia serpentina*, *Nardostachys grandiflora*, *Valeriana jatamansii*, and lichens, which are prohibited for export in an unprocessed condition, are still being traded raw (Table 2.24). *Dactylorhiza hatagirea*, *Rauvolfia serpentina*, and *Nardostachys grandiflora* are also included in the CITES list for controlled trade. Orchid seeds and lichens are permitted to be collected from the wild only after an Initial Environmental Examination (MOPE 1997). When increasing demand results in commercial gathering of certain species in large quantities for national and international trade, pressures can quickly mount and cases of over-exploitation are common (Cunningham 1993; 1994).

Lack of documentation and monitoring: Little attention has been given to quantifying NTFP resources, documenting their biology and socio-economical value, or monitoring their conservation. No inventory exists for either government-managed or community forests, and therefore no sustainable management plan for NTFPs in these forests.

Lack of research and development: Research is hampered owing to the lack of adequate funding, qualified staff, equipment, and the gap in co-ordination. Research and development in medicinal plants started in 1961 with the establishment of the Department of Plant Resources (previously Department of Medicinal Plants), with its research units and herbal farms. This work focused mainly on botanical survey and herbarium enrichment, and less emphasis has been given to the introduction of plants in botanical gardens, phytochemical and biochemical investigation, multiple propagation of selected economic plants, and cultivation of certain species in herbal farms. Private enterprises also process different quantities of medicinal plants collected from the wild. At present, no serious work has been done for the cultivation and commercialisation of medicinal herbs and plants by either Government or the private sector, despite the government's policy to do so. Most harvesting is done from the wild, causing environmental damage.

Dubious nomenclature: Many plant species have more than two local names (including in the Forest Regulations, 1995). Furthermore, different royalty rates are set for different parts of the same plant.

3.4 RANGELANDS

3.4.1 POLICY AND LEGISLATION

NEPAP (HMGN 1993) was the first government document that recognised rangelands and the need to comprehensively manage rangeland ecosystems. NEPAP I recommends that rangeland management needs greater support to maintain existing biodiversity and sustain viable rural economies and livelihoods.

Management responsibility for rangelands is unclear. Rangelands are owned by MFSC while their utilisation by local communities implicitly associates them with the Ministry of Agriculture through pasture development and livestock improvement services. To complicate matters further, the Department of Livestock Services, Department of Agriculture, and Nepal Agricultural Research Council have also played significant roles in rangeland management. Moreover, significant northern rangelands are located within protected areas under the jurisdiction of the DNPWC. NEPAP I (HMGN 1993) proposes that a greater emphasis be placed on designing appropriate incentives and regulations for pastoralists to invest in rangeland development and sustainable livestock management practices.

Although there are no well-defined legislative measures to manage rangelands in Nepal, the Forest Act, 1993 implicitly covers rangelands. The Forest Regulations, 1995 do not explicitly deal with rangelands, but Rule 19 suggests licensing for grazing animals such as yaks, and Annexes 8 and 9 deal with pasture charges and licences for pasturage.

3.4.2 MAJOR ACHIEVEMENTS

The Department of Livestock Services has been promoting fodder and pasture development through various means, including production of fodder and pasture crops, seeds, planting implements, distribution of seeds and planting implements, and marketing facilitation (Table 3.9).

Table 3.10 Production of forage/pasture seeds by the Department of Livestock Services

REGION	Farm Site	Major Forage Species
Terai	Forage Development Farm, Janakpur	Berseem, Napier, Oat, Para, Saftal, Teosinte
	Forage Development Farm, Ranjitpur	Kudju, Maize, MP, Seratro, Stylo, Centro, Teosinte
	Forage Development Farm, Gaughat, Banke	Chari, Joint vetch, Oat
	Forage Development Farm, Geta, Dhanagadhi	Napier, Oat
Mid-hills	Livestock Development Farm, Pokhara	Oat, Teosinte
	Seed Development Farm, Chitlang, Makwanpur	Oat, Paspalum
High mountains	Livestock Development Farm, Jiri	Oat, Paspalum, Rye grass
	Livestock Development Farm, Solukhumbu	Local grass, Phurcha
	Livestock Development Farm, Panchsaya Khola	Oat, Paspalum

Over 7,242 hectares of high altitude pastureland have been developed and 2,000 hectares of private land have been transformed for various forage crops. Government and non-governmental organisations and the private sector have become active in the production of forage/pasture seeds and in other forage and pasture development activities.

The Nepal Agricultural Research Council has established a number of research centres: the National Pasture and Grassland Research Centre, Khumaltar, Lalitpur; the Regional Pasture Research Centre, Dhunche, Rasuwa; the National Sheep Research Centre, Jumla; the Agricultural Research Centre, Pakhribas; and the Agricultural Research Centre, Lumle. These centres have all been producing forage and pasture seeds. A number of farmers' groups are also involved in seed production.

3.4.3 LESSONS LEARNED

Awareness and social understanding of natural resource conservation and economic realities influence interest and initiatives in forage and pasture development programmes. However, attention needs to be given to the production of quality seeds.

Joint efforts between the Department of Livestock Services and the Department of Forests or the DNPWC are needed to improve grasslands both outside and within PAs.

3.4.4 MAJOR CONSTRAINTS

Protection of pastureland: Community pasturelands are considered as common property. As a result, there is no identifiable entity to accept management responsibility and most of the community pasturelands are overgrazed and deteriorating.

Traditional pastureland management: The traditional systems of pastureland management do not allow for the increasing number of livestock and the declining productivity of the pastureland.

Determining carrying capacity: Numbers of livestock per unit of pastureland are too high relative to the carrying capacity of the pastureland.

Pasture vegetation: The component of legumes, which is important for quality feed as well as for improving soil fertility, is very low.

High cost of development: Most pasturelands are situated on steep slopes and lack of trails or drinking water for livestock. Moreover, unwanted plants and weeds quickly invade improved pasturelands. The construction of trails and drinking water facilities and the eradication of weeds are costly and not carried out.

Lack of biological knowledge: Despite their extent and importance, the vegetation dynamics are not well known; there is a serious lack of information on ecological processes of grasslands at high altitudes (Miller 1989; 1993).

Poor representation of grasslands in the tropical and temperate zones: Grassland ecosystems of the subtropical and lower temperate zones are very poorly represented in existing PAs.

Poor infrastructure and extension staff: Major constraints regarding forage development include the lack of suitable and improved forage species for many rangeland areas, the lack of technologies for low-cost forage development, the high cost of forage seeds and fertilisers, insufficient extension staff, and poor communication between experts and managers.

3.4.5 GAPS

Gap in management: Political, socio-economic, and ecological transformations have cumulatively degraded many previously remote, pastoral areas and have placed heavy pressure on Nepalese herders. Institutional interactions between researcher, technician, farmer, and the public and private sectors to address these issues are still being developed.

Lack of inter-sectoral policy: As rangeland management is multisectoral because of its many uses, there is a distinct need for the MFSC and the Ministry of Agriculture to jointly develop, in consultation with local communities, rangeland policies and appropriate management strategies that reflect multiple use.

Management of high altitude rangelands/grasslands: Forage-related programmes of the past focussed on subtropical and temperate rangelands and neglected high altitude rangelands because of their remoteness, harsh climate, and sparse settlements. However, Nepal's high altitude rangelands must be given major focus as they contain valuable biological resources.

3.5 AGROBIODIVERSITY

The agriculture sector contributes nearly 42% of Nepal's Gross Domestic Product (GDP) and is the mainstay of the Nepalese economy. Agricultural resources fulfil both the immediate and long-term needs of rural communities. Of the more than 6,000 vascular plant species found in Nepal, about 550 species and subspecies have food value and 200 are cultivated species.

There are four major stages in the conservation of agrobiodiversity (crop and animal genetic resources): (i) survey and identification, (ii) characterisation, (iii) evaluation, and (iv) conservation. In addition to supporting and maintaining traditional agroecosystems, various *in-situ* conservation techniques are commonly employed as part of an overall agrobiodiversity conservation strategy.

3.5.1 CROPS

The Plant Genetic Resources Unit was established for food crops in 1984 at the Agricultural Botany Division of the Nepal Agricultural Research Council. Before that, collection and evaluation of vegetables was started in 1972 with the establishment of the Vegetable Development Division. Fruit germplasms have been maintained in 19 agricultural research centres and farms under the Nepal Agricultural Research Council and the Department of Agriculture since the 1960s (Upadhyay 1999).

Eleven major plant exploration missions have been undertaken in Nepal since 1938, in collaboration with international institutes. A total of 6,123 accessions of different crop species from Nepal are conserved at the International Agricultural Research Centre, National Institute of Agrobiological Resources, Japan, and with the United States Department of Agriculture, USA. More than 10,500 accessions of cereals, grain legumes, oilseeds, vegetables, and industrial and spice crops are preserved in these centres (Upadhyay 2000, pers. comm.). The Agriculture Botany Division has preserved 10,500 accessions of 30 genera in its gene bank, including cereals (6,069), grain legumes (3,375), oil seeds (537), vegetables (461), industrial crops (15), spice crops (35), and others (11).

3.5.1.1 Policy and legislation

In order to fulfil its international obligations towards the conservation of genetic diversity, Nepal has become a party to several international agreements and conventions. Following are the important conventions from the agrobiodiversity point of view:

- International Union for the Protection of New Varieties of Plants (UPOV), 1961
- Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), 1973
- Convention on Biological Diversity, 1992
- International Technical Conference on Plant Genetic Resources: Global Action Plan on Plant Genetic Resources, Leipzig, 1996
- World Trade Organisation (WTO) under the General Agreement on Tariffs and Trade (GATT), 1994 - Nepal has the status of observer of this obligation

Nepal is not rushing to enact any legislation or formulate any policy regarding the protection of plant breeders' rights as the Government is of the opinion that Nepal's farmers do not face any threat of competition in the near future from any foreign multinational seed company (Pant 1999). However, Trade Related Intellectual Property Rights allow governments to formulate their own plant protection legislation for commercial varieties to safeguard the interests of farmers and indigenous communities.

Other important aspects that have so far remained untouched by legislation in Nepal are Intellectual Property Rights and Farmers' Rights. Nepal enacted the Seed Act in 1988 to deal with the quality of seed production and its distribution to maintain crop diversity.

Nepal is a member of the Food and Agriculture Organisation's Commission on Plant Genetic Resources for Food and Agriculture, and has adopted the Global Plan of Action for plant genetic resources. The priorities of the Global Plan of Action for the Conservation and Sustainable Use of Plant Genetic Resources for Food and

Agriculture are: (i) *in-situ* conservation and development, (ii) *ex-situ* conservation, (iii) utilisation of plant genetic resources, and, (iv) development and capacity building of institutions.

Previous agricultural policy directives have implicitly acknowledged agrobiodiversity conservation; however, no formal agrobiodiversity policy exists. The NEPAP I (HMGN 1993) emphasises the importance of using organic fertilisers, providing farmers with a choice of techniques for sustainable agricultural development, and recognising agroecological zones for planning appropriate interventions and to acknowledge the different ecological and social values inherent in diverse farming systems.

The Agriculture Perspective Plan emphasises high-input agriculture on environmentally robust land as part of a strategy to increase production. As farmers' incomes rise, it then becomes desirable for farmers to take environmentally fragile land out of production, which is beneficial for biodiversity conservation. However, high-input agriculture requires liberal use of pesticides and fertilisers, and often results in environmental contamination and pollution. The Agriculture Perspective Plan recommends the judicious use of fertilisers and pesticides and greater use of integrated pest management to counteract the potentially negative impacts that fertilisers and pesticides can have on biodiversity. Of greater concern, however, is the fact that the high-input agriculture promoted in the Agriculture Perspective Plan relies on modern crop varieties that only respond to these inputs. With this emphasis, the Agriculture Perspective Plan ignores traditional farming systems that are the living repositories of agrobiodiversity in Nepal.

3.5.1.2 Major achievements

Evaluation of the performance of local landraces: Various commodity programmes have been evaluating the performance of local landraces. The following numbers of landraces of various crops have been characters: 680 rice, 713 finger millet, 322 barley, 216 soybean, 184 buckwheat, 146 lentil, and 35 bean landraces. Of the 680 rice landraces evaluated, 23 were recommended for improvement. Additionally, 50 landraces of maize were evaluated and characterised in the Koshi hill area, and 259 maize landraces were evaluated in observation nurseries at Kakani. However, almost all of these were found to be susceptible to *Puccinia sorghi*. Eighteen landraces of maize were collected from the Koshi hills and some of them, such as *Lekali Panheli* and *Lekali*, produced grain yields of over 4 million tonnes per hectare. Of the many local wheat landraces evaluated by the wheat programme and at other research centres, eight have been used in hybridisation. Some wheat landraces, such as *Dabde local*, flourish under low fertility and moisture-deficient situations (Chand 1988).

Maintenance of traditional germplasm accessions: More than 299 accessions of 18 traditional vegetables are maintained at the Agriculture Botany Division. 27 local landraces of potato are maintained at the Potato Research Programme. Twelve of these have been characterised. Adhikari (2000) documented a total of 174 mushroom species, of which 110 are edible, 13 are medicinal, 45 are toxic, and six species have other uses.

The National Grain Legume Programme has collected 1,242 specimens of germplasm from eight summer and winter legumes from various geographic regions of the country. Among the crop species, 275 lentil, 523 chickpea, 163 soybean, 76 grass pea, 85 pigeon pea, 28 black gram, 64 mung bean and 28 faba bean species were collected. One line of groundnut has been collected in Nepal, while 145 lines of groundnut have been collected from other countries, including 76 from the International Crops Research Institute for Semi-Arid Tropics (ICRISAT), 51 from the USA, 12 from the Upper Volta, and one each from Bhutan, Brunei, Ghana, Israel, Pakistan and Senegal.

Release of landraces*:* Many local landraces of oilseed and sugarcane have been collected and are being promoted and released. Survey results show that there are more than 102 local landraces of oilseed available in Nepal. More than 200 germplasm specimens of sugarcane have been collected from India and Nepal. Nineteen local landraces of 12 vegetable species have been either released or recommended in Nepal. Thirty varieties of rice, 15 of maize, 26 of wheat, six of barley, three of finger millet, five of chickpea, five of lentil, four of mustard, and six varieties of soybean have been developed and recommended by the Department of Agriculture for cultivation in different agroecological zones (DOA 1999). On-site experimentation with hill farmers in eastern Nepal has revealed that farmers grew as many as 18 vegetable varieties to evaluate their qualities and suitability under local conditions (Rijal *et al.* 1997). Similarly, Jyapu farmers around Kathmandu valley grow more than 36 improved and/or local varieties of vegetables to supply the market throughout the season.

Research stations: Nepalese agriculture has changed significantly in the past four decades from subsistence to commercial farming (Basnyat 1999). The country has improved crop yield, for example the rice yield increased from 1,978kg/ha to 2,391kg/ha over the last twenty years, at a rate of 1.9% per year. On one hand, local crops and livestock diversity is facing genetic erosion, but at the same time the country has introduced new crops, and new varieties and breeds of existing crops in Nepal, increasing the base of agricultural diversity. Nepal has established research stations in different agroclimatic zones, or development regions (Box 3.1). These research stations collect, evaluate, and help conserve agrobiodiversity.

Box 3.1 Agricultural Research Stations in Nepal

Eastern Development Region
Agricultural Research Station, Tarhara; Pakhribas Agriculture Center & Horticulture Center, Dhankuta

Central Development Region
Agricultural Research Stations at Parwanipur, Rampur, and Kavre; Jiri (Livestock); Rasuwa (Pasture); Trishuli and Godavari (Fisheries); Jitpur (Sugarcane); Rampur (Maize); Nawalpur (Oilseed); Belachapi (Tobacco); Khumatar (Potato)

Western Development Region
Agricultural Research Stations at Bhairahwa, Lumle, and Pokhara; Bandipur (Sheep and Goats); Marpha (Horticulture); Pokhara (Fisheries); Bhairahwa (Wheat)

Mid-western and Far-western Development Regions
Agricultural Research Stations at Nepalgunj, Doti and Jumla; Salyan (Ginger)

Human resource development: Another significant achievement in the field of agriculture is the number of trained personnel in the country. The Institute of Agriculture and Animal Science offers agricultural graduate degrees and recently started postgraduate programmes.

The Agricultural Perspective Plan: Nepal has prepared a 20-year Agriculture Perspective Plan covering all aspects of agriculture development, including agrobiodiversity conservation. In the last decade, Nepal has organised national, regional, and international conferences on biodiversity. Recent international conferences organised in the country include: the Regional Conference on Environment and Biodiversity (March 1994), the National Conference on Plant Genetic Resources (November 1994), the Global Conference on Livestock (August 1998), the International Conference on Environment and Agriculture (November 1998), the National Conference on Wild Relatives of Cultivated Plants in Nepal (June 1999), Biotechnology Application for Reforestation and Biodiversity Conservation (BIOREFOR) (December 1999).

3.5.1.3 Lessons learned

The adoption of high yielding varieties has resulted in the erosion of several landraces and breeds. Until these high yielding varieties have proven suitability, their use should be restricted. High yielding varieties have been found to be sensitive to pathogens and varying environmental conditions.

Traditional farmers use a wide range of plants for protecting their crops against pest infestation, both in the field as well as during storage. Timur (*Zanthoxylum alatum*), black plum (*Syzygium cumini*), tobacco (*Nicotina tabacum*), neem (*Azadiracta indica*), bakaino (*Melia azedarach*), marigold (*Tagetus erecta*), titepati (*Artemesia vulgaris*) and asuro (*Justicia adhatoda*) all have values in crop protection. In addition to the above-mentioned list, there are more than 23 other plant species which have been reported to have similar crop-protecting characteristics.

3.5.1.4 Major constraints

Present germplasm bank facilities are not adequate and require upgrading. There are financial, technical and personnel constraints at various commodity research stations.

3.5.1.5 Gaps

Realising that new crop varieties, with their dependence on chemical fertilisers and pesticides, will lead to the displacement of landraces, solutions to maintain local genetic diversity need to be sought through the promotion of appropriate agricultural policies and practices. Such measures will help rural communities to become and remain self-reliant and to maintain control over their production systems.

Plant genetic resources must be conserved because they are the building blocks on which the modern crop-breeding approach relies to develop new varieties. A well-defined scientific approach is urgently required to address several issues regarding agrobiodiversity. These include public awareness and ethnological issues, to explore the potential economic benefits that can be derived from agrobiodiversity, to examine the impact of external market forces on agrobiodiversity, and to evaluate the needs of institutions that have a mandate to conserve and develop agrobiodiversity.

Evolving international dialogue and global mechanisms to protect species and genetic diversity suggest that genetic resources of all forms are the patrimony of the countries in which they originate. The General Agreement on Tariffs and Trade and the protection of Trade Related Intellectual Property Rights have significant implications for agricultural biodiversity policy. The widespread appreciation and recognition of Intellectual Property Rights for the purpose of creating incentives for technological innovations, processes and products has implications for germplasm management. The exchange of seeds from one farmer to another could be curtailed, farmers may have to buy seeds from companies and pay expensive royalties, and access to germplasm by researchers could be limited. The post-CBD era has sensitised developing countries on the exchange of germplasm by providing sovereignty over Plant Genetic Resources. This is a shift from the earlier concept of Plant Genetic Resources being a common heritage of mankind.

Bio-prospecting is the systematic process of inventorying, sampling, collecting and testing biological material to search for economically and socially valuable genetic and biochemical resources in nature. Gene-rich but technology-poor countries must increase their bio-prospecting technology if they are to use their biodiversity in a sustainable manner (Riley and Rao 1994). In Nepal, genes identified from a few crops govern important traits. For example, *Pauder*, local wheat, has cold-induced sterility tolerance genes (Joshi & Sthapit 1995). *Ekle* rice has zinc deficiency tolerance genes, *Chhomrong Dhan* (rice) has cold tolerance genes, and *Ghorlikharka*, local sarasin (*Brassica* species), has the highest oil content (Rijal & Chand 1993; Joshi *et al*. 1996b). Many more valuable genetic and biochemical resources in cereals, legumes, fruits, and vegetables and their wild relatives remain to be discovered.

The necessity of having a national co-ordinating body, such as a National Biodiversity Unit (NBU), to deal with agricultural biodiversity is urgent. This institution should also have a mandate to formulate agricultural biodiversity policy, to promote agrobiodiversity monitoring, conservation, and use, and to clarify national policy regarding bio-prospecting. This proposed policy-making body should co-ordinate a transparent system to implement national policy, to regulate plant exploration and exchange, and to co-ordinate joint ministry and NGO activities for promoting agrobiodiversity conservation. In addition, institutional roles and mandates regarding agrobiodiversity conservation should be clarified in national policy. This body should also co-ordinate and facilitate effective communication among relevant actors and improve documentation systems to facilitate the work of government agencies, INGOs, NGOs, the private sector and grassroots institutions, including farmers groups, involved in agricultural biodiversity conservation and sustainable use.

National level expertise in agrobiodiversity research, conservation, and management is insufficient and baseline information on the agrobiodiversity of Nepal is incomplete and limited in scope. Furthermore, current planners and policy-makers undervalue indigenous knowledge and traditional agricultural practices.

Curricula at all levels of agricultural management lack orientation towards agricultural biodiversity conservation and sustainable use. Since agricultural biodiversity has a direct bearing on human survival, it is in the public interest to be aware of the value of agricultural biodiversity and the potential threats of its irreversible loss.

For management of agricultural biodiversity to be successful, effective utilisation of the expertise of both male and female farmers is essential. The recognition of gender issues and indigenous knowledge systems, especially amongst the most marginalised groups, must be included in participatory research and management systems.

3.5.2 LIVESTOCK

The Agriculture Perspective Plan does not mention the conservation of livestock genetic resources. However, identification, characterisation, and evaluation of production and reproduction performances of different breeds of livestock and poultry are underway in the Animal Breeding Division and other research stations under the Nepal Agricultural Research Council. The Department of Livestock Services has three ongoing projects. These are: (i) the Third Livestock Development Project, to improve livestock productivity, expand agroprocessing and marketing initiatives, and for institutional strengthening and organisational development, funded by the Asian Development Bank; (ii) the Strengthening of Veterinary Services for Livestock Disease Control Project, which aims to eradicate rinderpest and reduce the incidence of other diseases, funded by the European Community; and (iii) the Hills Leasehold Forestry and Forage Development Project, to improve conditions for families living below the poverty line through livestock development, forestry and pasture development in the degraded forest lands of Nepal, funded by the International Fund for Agriculture Development. However, not one of these three projects addresses conservation issues regarding indigenous animal genetic resources.

The concept of conservation of indigenous animal genetic resources is fairly new to Nepalese planners and policy-makers. Farmers in some areas used to conserve superior productive animals by keeping the male calves of very productive animals for breeding. A population census of *lulu* cattle, together with attempts to measure their production under farmers' management, was recently initiated (Joshi & Rasali 1996).

Conservation measures and use of *yak*, *lulu* and *achhame* cattle have been proposed in the Ninth Five-year Plan of His Majesty's Government of Nepal. One of the stated goals in this Plan for the livestock sector is to increase productivity of these indigenous breeds by 25% through breeders' groups of 8,000 households, comprising women and poor farmers in the districts of Solukhumbu, Mustang, and Achham.

3.5.2.1 Policy and legislation

The objectives of the Livestock Health and Livestock Service Act, 1998, are to develop and maintain animal husbandry to produce healthier food and to produce, distribute, export and import healthier animals, animal products and/or animal product substances.

Section 3 of the Act empowers HMGN to establish permanent or temporary quarantine check-posts in any part of the country by publication of notification in the Nepal Gazette.

Section 6 of the Act requires imported animals, animal products, or animal product substances to be quarantined for a prescribed period of time for examination. If the animal dies during quarantine, the Quarantine Officer must order the importer to dispose of the dead animal. The importer is not entitled to claim for compensation if the animal dies in quarantine.

Section 7 of the Act requires the Quarantine Officer to provide a certificate to the importer after examination in the format prescribed in the Regulations.

Section 8 stipulates that the conditions to be followed while importing or exporting animals, animal products, and/or animal product substances will be as prescribed in the Regulations promulgated under the Act. Further, Section 9 obliges the importer to put his/her products through quarantine. Section 10 of the Act empowers

HMGN to prohibit the importation of diseased animals, animal products, and/or animal product substances by publication of notification in the Nepal Gazette.

Section 11 of the Act empowers the Quarantine Officer to deny importation of animals, animal products, and/or animal product substances into Nepal if:

a) the officer detects that the animal, animal product, and/or animal product substance is infected with a communicable disease;
b) the importer does not provide a certificate stating that the animal, animal product, and/or animal product substance is free of all communicable diseases;
c) animals die from a communicable disease, whether or not the importer provides the certificate mentioned in (b);
d) a vehicle infected with a communicable disease is used to transport the animal, animal product, and/or animal product substance.

Section 14 of the Act requires the importer to remove or destroy the animal, animal product and/or animal product substance on receipt of such order. The Quarantine Officer may personally remove or destroy the animal, animal product, and/or animal product substance if the importer refuses to do so. All costs incurred during removal or destruction of the animal, animal product, and/or animal product substance by a Quarantine Officer must be reimbursed by the importer.

Under section 17 of the Act, a person wishing to establish an industry based on biological materials, such as poultry, fish, or animal food or meat processing, must obtain permission from the concerned authority.

Section 18 of the Act requires that a person wishing to export or import biological materials, including chicks, fingerlings and animal feed, must obtain permission from and pay prescribed fees to the concerned authority.

Under section 19 of the Act, a person who wants to sell or distribute biological materials, including chicks, fingerlings and processed meat, is required to obtain permission from and pay prescribed fees to the concerned authority. Quality and measurement standards for the sale and distribution of biological materials, including chicks, fingerlings, and processed meats, shall be observed.

Aside from the Livestock Health and Livestock Service Act, 1998, there is no legislation regulating animal breeding and no law to protect or conserve domestic animal genetic resources. HMGN has no effective programme for the management and utilisation of well-adapted indigenous livestock. However, crossbreeding has been widely conducted in Nepal since 1960 to upgrade poorly producing cows and buffaloes without the recent studies on the genetic potential of indigenous genotypes. Both the National Conservation Strategy and NEPAP I recommend the implementation of a strategy that stresses multiple use of livestock and optimisation of productivity while minimising over-grazing and loss of soil fertility as central tenets of the nation's livestock development strategy. However, conservation of indigenous livestock and their genetic resources is not mentioned in either document.

Despite such inadequacies, existing breeding guidelines adopted by the Department of Livestock Services that deal with artificial insemination and crossbreeding with exotic breeds address the concern of indigenous breeds. The guidelines are as follows: (i) *Parkote* and *lime* buffalo will be conserved and maintained in some pocket areas; (ii) productivity of *yak*, *lulu* and *achhame* cattle will be improved through group-breeding schemes to conserve and maintain their populations; (iii) bull exchange programmes between user groups will check inbreeding; (iv) productivity of the *Khari* goat will be increased through a selective breeding scheme and an improved overall management system; (v) no exotic breed will be introduced to increase the productivity of *Bhyanglung* and *Lampuchhre* sheep, or of *Chyangra* and *Sinhal* goat, and a selective group-breeding scheme will be followed to improve productivity of the pure line; (vi) ram and buck exchange programmes between farmers will reduce inbreeding; and (vii) indigenous pig breeds, such as *chwache* and *hurrah*, will be conserved in pocket areas.

Nepal has recognised that domesticated and cultivated species are an important component of biological diversity. The Government (HMGN 1998), with the assistance of the Food and Agriculture Organisation (GCP/RAS/144/JPN), has prepared a national policy document on management and utilisation of farm animal genetic resources. Although there is no legislation regarding animal breeding, conservation of farm animal genetic resources has been incorporated into the proposed Veterinary Act, which is currently awaiting approval.

3.5.2.2 Major achievements

Improving socio-economic conditions: In Nepal, livestock provides 31% of total agricultural output. This is expected to increase to 45% over the next twenty years (APP 1995). As the cereal deficit continues to worsen, conservation of genetic resources in livestock production systems, which are growing at a faster rate than crop production systems, may become a priority. Livestock and poultry contribute to national food security, fibre, power, fertiliser, fuel, transportation, and income resources. While the water buffalo is the most important economic animal, Nepal's seven million cattle are the most useful to farmers and thus are bred by all socio-economic groups in all agroecological regions of the country (ASD 1995/96).

Selection of environmentally suitable indigenous breeds: The breeds of livestock and poultry in Nepal have been developed over hundreds of years through selection and thus bear various traits of economic and environmental importance. For example, hill cattle are resistant to diseases like foot-and-mouth disease, internal parasites, and harsh climatic conditions. Therefore, only indigenous breeds may be able to cope with multiple challenges over the long term.

Cross-breeding and livestock improvement: Modern transportation and use of germplasm have made it possible to change production systems in Nepal, by either transporting live animals or transporting their germplasm. Exotic breeds with high milk yields or specialised production systems have been utilised to meet the needs of the growing human population. Examples include Jersey and Holstein cattle crossbred with Nepali hill cattle, Mural buffalo crossbred with local buffalo, and several exotic breeds of pigs crossbred with *chwache* and *hurrah* pigs. However, one of the consequences of crossbreeding is a gradual decline in genetic variability within domestic animal populations, and therefore livestock production systems may become unpredictable with environmental changes, adverse nutritional conditions, or prevalence of disease or parasites.

Cultural conservation of livestock: Indigenous breeds, the product of natural selection and human effort, are not commercial. Indigenous breeds do, however, have cultural functions. For example, *chwache* pigs maintained by the Limbus in eastern Nepal form a valuable part of their culture. Similarly, *jhopkyos* are multipurpose animals conserved by the Sherpas, used as beats of burden, as draught animals, and for their meat. The *baruwal*, *dhorel* sheep, and *sinhal* goat are well adapted for migration. However, few males are used for breeding amongst indigenous breeds, which also suffer from inbreeding, reducing genetic variability.

3.5.2.3 Lessons learned

Selection and distribution of the various indigenous breeds of animals raised in different parts of the country is guided by socio-economic values, ethnocultural preferences, climate, management systems and, in some cases, marketability. Year-round feed supply and social preferences are two major factors determining the choice of animal and livestock management system used in rural areas. Therefore, conservation of livestock genetic resources incorporating both preservation and sustainable use of farm animals exists mainly in small farming systems where farmers own few animals but keep several species (Shrestha 1984, 1998). These farming systems are characterised by small land holdings and low use of technology and inputs. Livestock production in rural areas, which is mainly subsistence-oriented, is a risk reduction strategy, due to their remote locations and isolation from market services (Wilson 1995).

3.5.2.4 Major constraints

From an institutional standpoint, there is need for a focal point to facilitate effective management and sustainable use of indigenous animal genetic resources and endangered breeds of livestock.

3.5.2.5 Gaps

The importance, value, and utility of local breeds and strains have to be established and evaluated so that they may contribute to overall livestock development. Some order of priority must be established, which may be based on genetic merit, contributions to local subsistence, cultural values or other reasons.

Livestock conservation through *in-situ* management primarily deals with stock numbers and their maintenance cost. *In-situ* conservation has two distinct disadvantages. Firstly, genetic drift occurs faster in smaller populations; secondly, fewer males than females may cause fixation of some genes. Sufficient numbers of breeding units, a number of which must be renewed annually, are needed to maintain inbreeding at about 0.2% per year (Smith 1984). Therefore, a controlled mating system is important in small populations to keep inbreeding effects to a minimum.

Drawing genetic traits from a shrinking pool of breeds to keep pace with changing climatic and soil conditions and to develop resistance to pests and new diseases is a difficult challenge. Eradication of animal diseases is not being attempted and exotic diseases (*e.g.* bovine-rhinotrachitis, theileriasis, anaplasmosis, degnala and buffalo pox in cattle and buffalo, avian influenza, mareks, LBD, ILT, Salmonellosis, EDS-76 in poultry) are being introduced through imported animals. These emerging diseases are threatening indigenous domestic and wild animal populations (Singh *et al.* 2000).

However, *ex-situ* conservation can overcome some of these difficulties. There is no danger in *ex-situ* conservation from genetic drift or semen collection techniques for cattle, buffaloes, pigs, goats, sheep, and poultry. *Ex- situ* methods include storage of frozen cells in either haploid form (sperm or ova) or diploid form (embryo).

Lack of information or databanks on indigenous livestock breeds hampers management and formulation of appropriate breeding policies. A comprehensive description of the characteristics of each breed and established crossbred populations of livestock is necessary. It is also important that provisions be made to connect the data bank to a regional data bank, such as the one maintained at the Food and Agriculture Organisation's Regional Office in Bangkok, to assist in identifying sub-populations of the same breeds in different countries of the region. This will contribute to the formulation of breeding programmes extending beyond Nepal's boundaries.

Cryopreservation of livestock breeds needs to be strengthened. Planning and implementation of cryogenic storage for all breeds is vital, as is dissemination of information and training. The National Agricultural Research Council has all the prerequisites to become a national focal point for the collection and storage of genetic resources, including embryos, semen, and tissues.

3.6 WETLANDS

Wetlands in Nepal are suffering and very little data is available about wetland degradation and conservation. Since the formation of the DNPWC, some valuable wetlands have been given protection within PAs. In addition, ten wetland sites in the Terai have been identified for urgent conservation action by the Biodiversity Profiles Project (1995a); these are listed in Table 2.21.

3.6.1 POLICY AND LEGISLATION

Although Nepal became a signatory of the Ramsar Convention in 1988, a well-defined wetland policy and management plan is still overdue. However, a national policy on wetlands was drafted in 2001 and submitted to MFSC for approval. Wetlands were not addressed by the Nepal Conservation Strategy, the Fifth Five-Year Plan, or the Master Plan for the Forestry Sector. NEPAP-I states that wetlands in Nepal have often been overlooked as an important habitat type and that many wetlands are suffering from land and water pollution while others have been drained and converted to agricultural land. NEPAP prioritised the need to identify and protect biologically significant marshes, wetlands, and water bodies. In order to achieve these goals, NEPAP recommends conducting a study to assess the biological diversity of endemic terrestrial and aquatic plants and animals that occur outside protected areas on farmland, pastures, rangeland, forests, rivers, lakes and ponds (HMGN 1993). NEPAP is an effective initiative for the protection of wetlands and provides a good policy foundation upon which the NBS proposes to build.

Unless otherwise identified, wetlands belong to the State. However, analysis indicates that the ownership of these lands is held by different government agencies for specific purposes. In some cases the lands are owned by the government, but usufructs belong to intermediaries or tenants (IUCN-Nepal 1996). There are many wetlands where the local VDC and DDC use the wetland resources. Four types of wetland ownership occur in Nepal:

1. State ownership - wetlands lying within forest areas are owned by the MFSC.
2. Gazetted land ownership - wetlands lying in protected areas.
3. Corporate ownership - Rampur Ghol is owned by the Institute of Agriculture and Animal Science, and the Harahawa river floodplain wetland is owned by the Lumbini Development Trust. Ponds inside cultural heritage precincts fall under the Guthi Sansthan. Wetlands registered under autonomous organisations fall under this category.
4. Private ownership - small ponds built for aquaculture and fisheries and deep-water rice fields owned by individuals upon payment of government land revenue. This is also called fee simple ownership. Such ownership is inheritable and transferable.

Tenancy practices in wetlands, which are under communal ownership, involving use, occupation or dwelling on a rental basis, are administered by local institutions such as VDCs, governmental agencies and DDCs. Common tenancies found in the Terai are:

(a) *contract tenancy* - where usufruct is given to the highest bidder for a fixed period of time (1-15 years); (b) *community tenancy* - this tenancy is common in the Terai where wetlands are managed by communities; (c) *seasonal tenancy* - owners cultivate the land during the main growing season and lease it out to tenants for particular purposes such as growing vegetables or setting up temporary markets during other times of the year; (d) *Batai tenancy* - tenants rent land and produce from the land is shared equally between landlords and tenants; (e) *Kamaiya tenancy* - tenants rent land and provide labour inputs while the landlords provide all other inputs (*e.g.* oxen, seed, manure, and fertiliser) and produce from the land is shared equally; (f) *Share cropping* - the most popular tenancy system in the hills and mountain regions – produce from the land is shared equally between tenant and landlord, and payment is made in cash or in kind.

Wetland-related issues are addressed in various pieces of legislation, the salient statutes of which are summarised below:

Aquatic Animals Protection Act, 1961: The Aquatic Animals Protection Act, 1961 is one of Nepal's oldest pieces of legislation which recognises the value of wetlands and aquatic animals. Under this Act, it is an offence to introduce poisonous, noxious or explosive materials into a water source or destroy any dam, bridge, fish ladder, or water system with the intent of catching or killing aquatic life. It defines 'private water' as a lake, pond, ditch, pool or reservoir that is on land used by a person paying land taxes, but it does not designate the wise use or management of privately owned wetlands. Although the Aquatic Animals Protection Act has been in effect for some time, there is no designated agency to administer or enforce it (Belbase 1997; Chapagain 1997). The Act was amended in 1998 to prohibit the use of unsafe pesticides, sometimes used for catching aquatic life.

National Parks and Wildlife Conservation Act, 1973: Schedule 1 of the NPWC Act identifies certain waterfowl, including the saurus crane, black stork and white stork, as being fully protected. This Act has been amended four times since 1973, and a Fifth Amendment is in progress. However, the protected wetland species list needs to be updated.

Soil and Watershed Conservation Act, 1982: To combat degradation of valuable land from flooding, water-logging, salinity in irrigated areas and acceleration of siltation in storage reservoirs, and to properly manage the catchments of Nepal, the Soil and Watershed Conservation Act empowers the Government to declare any catchment area protected. The Act outlines the essential parameters necessary for the proper management of catchment areas, including rivers and lakes.

Water Resources Act, 1992: Section 3 of the Water Resources Act states that ownership of water resources within Nepal 'shall be vested in the Kingdom'. The Act appears to embody a public trust doctrine vesting ownership rights and jurisdiction over water bodies to HMGN. The Act strives to minimise environmental damage to wetlands, especially lakes and rivers, through environmental impact assessments. Section 8 (1) of the Act requires any person or corporate body wishing to survey or use specific water resources to apply to the appropriate authority and submit a detailed economic, technical and environmental report.

Electricity Act, 1992: Section 24 of the Electricity Act states that while generating, transmitting or distributing electricity, it is forbidden to negatively impact the environment by causing soil erosion, flooding, landslides, or air pollution. This Act prohibits blocking, diverting or placing hazardous or explosive materials in rivers, streams, or any water source.

3.6.2 MAJOR ACHIEVEMENTS

Wetlands have been recognised as one of the important ecosystems that harbour about 25% of the biodiversity of Nepal. Koshi Tappu Wildlife Reserve is the only Ramsar site in Nepal included in the List of Wetlands of International Importance. A preliminary survey of the wetlands system of Nepal was conducted in 1988 by IUCN. Other inventories have been carried out by IUCN (Bhandari *et al.* 1994), and for the Biodiversity Profiles Project (BPP 1995a).

3.6.3 LESSONS LEARNED

No protected area can survive without the support of local people. As such, to allow grazing of buffaloes and additional harvesting of grass in the Koshi Tappu Wildlife Reserve is being considered. Moreover, buffalo grazing and harvesting of certain grass species can maintain a desired stage in succession (Davies 1994).

3.6.4 MAJOR CONSTRAINTS

There is no institution with a clear mandate for wetland management in Nepal. Weak institutional co-ordination hampers the conservation and sustainable use of wetlands, while anomalies in existing laws contribute to an ineffective legal and policy framework. Furthermore, multiple ownerships of wetlands makes uniform policy and management prescriptions problematic.

3.6.5 GAPS

Inventory of wetland sites: Although IUCN has identified 242 wetland sites in Nepal, the biodiversity of these wetlands is, for the most part, still unknown. Identification of significant national and international wetland sites in the hills and mountains is needed to prioritise projects to conserve wetland biodiversity. Given the importance of wetland biodiversity and the benefits they provide to disadvantaged people, developing monitoring mechanisms to measure spatio-temporal changes in wetlands and to determine the rate of degradation as a result of human use is crucial. It will be necessary to generate time series data and information on factors that impact wetlands in order to maintain healthy wetlands on a long-term basis. Additionally, it is necessary to periodically update the existing inventory database and to determine the minimum data set needed to manage critical sites.

Lack of integrated wetland management: To focus only on the bodies of water is not sufficient for their conservation. No specific programme exists for the integrated management of catchments of critical wetland sites. It is also necessary to manage the catchments of nationally important lakes and to monitor their sedimentation.

Lack of awareness and community participation: The lack of awareness about the ecological functions of wetlands amongst communities who depend on wetland resources contributes to their degradation. Although wetlands provide alternative livelihoods to many people, they have become resources that are openly accessible to all with no concern for their conservation, which could be managed through the formation of user groups. The capacity of technical staff to manage wetlands in a sustainable manner with the participation of local stakeholders needs to be built.

3.7 MOUNTAIN BIODIVERSITY

Mountain biodiversity has never been specifically catalogued or addressed in past conservation plans, although eight protected areas representing 63 ecosystems are located above 3,000m in the High Mountains.

The DSCWM is mandated to "declare, operate, develop, protect, and conserve critical watersheds". At the district level, the DSCWM is represented by a District Soil Conservation Office. The DSCWM currently has District Soil Conservation Offices in 55 districts of Nepal, although it did have plans to cover all 75 districts under the Ninth Five-Year Plan.

The objectives of the DSCWM are to:

(i) Contribute to maintaining ecological balance by reducing pressures from natural disasters, such as floods and landslides, through proper management of the country's important watersheds.

(ii) Assist in maintaining land productivity by implementing soil conservation programmes in an integrated watershed management approach. In line with overall Government policy, the DSCWM implements all soil conservation programmes with the participation of people and user groups.

Biodiversity conservation in the mountains must be integrated with soil, water, and biodiversity conservation. Nepal is initiating integrated catchment management projects to protect soils, waters, and natural vegetation on which the majority of Nepal's population depends. These activities are implemented in co-ordination and co-operation with Government staff and local farmers. The Bagmati Watershed Project is a prime example of this effort. The project has not only brought significant benefits for villagers in terms of a stronger rural economy, solidarity amongst the villagers, and a well managed resource base, but has also provided a strong foundation for future conservation and development.

In the Siwalik Hills of Siraha and Saptari districts, catchment conservation ponds are being constructed and maintained for multiple uses. These conservation ponds retain rainwater and help in conserving the soil and water. They also recharge the groundwater of the Terai.

Multiple use plants, such as bamboo and fodder trees, are being planted to control erosion and for land reclamation. Local varieties of grasses are also being planted for stabilising soils and conserving water.

The integrated mountain catchments conservation programme is being implemented with the active co-operation of local villagers. User committees implement the programme while technical staff provides advice and supervision. The official policy is to empower local villagers to implement integrated catchment conservation.

The programmes of the DSCWM have great potential for contributing to mountain biodiversity conservation. Integrated catchment management through the active participation of local people is a viable option that can contribute to mountain biodiversity conservation by improving ecosystem health and the economic condition of the people inhabiting catchment areas.

The programmes of the DSCWM are:

- Land productivity conservation activities, such as on-farm conservation, plantation of grasses and Multipurpose Tree Species, and agroforestry.
- Natural hazard prevention activities, including treatment of gullies and landslides, torrent control, stream bank protection, and rehabilitation of degraded land using bioengineering methods.
- Infrastructure protection activities, such as stabilisation of slopes, roadside erosion control, trail improvement, protection of canals, and conservation of water sources.
- Community soil conservation activities, including training, study tours, and exhibitions.
- Income generating activities.
- Action research activities to assess the status of rare and indigenous plant species used in forestry, soil conservation, fertility enhancement, and agriculture.
- *In-situ* conservation of agrobiodiversity through traditional farming practices.

In addition to the DSCWM, the DNPWC is also involved in the management and conservation of biodiversity through the establishment and management of mountain protected areas.

The programmes of the DSCWM focus on integrated participatory management of critical sub-catchments, although they also benefit mountain biodiversity and ecosystems (Box 3.2). Mountain biodiversity is highly endemic and unique.

BOX 3.2 Participation of User Groups/Communities in Catchment Management

Participation of user groups has been a cornerstone of successful government and NGO initiatives in catchment management for over 20 years in Nepal. In 1975, the Tinau Watershed Project developed a catchment management plan with beneficiaries participating in the planning and implementation of project activities. In 1985, the Begnas Rupatal Watershed Management Project, with the support of the Dutch Government through CARE, capitalised on the Decentralisation Act to form user group committees. A sister project of the Begnas Rupatal Watershed Management Project was initiated in the Upper Andhi Khola catchment of Syangja in 1992 with a similar approach, and is particularly well known for applying the Participatory Community Problem Analysis approach to map village resources and plan grassroots activities. HMGN began a District Soil Conservation Programme in Parbat and Tanahun districts in 1990. Although it institutionalised a subsidy policy to encourage participation, the mechanism for ensuring people's participation was left open to accommodate various approaches. The Inter-Regional Project for Participatory Upland Conservation and Development in Bhusunde Khola catchment area in Gorkha district is unique in that it focuses on the socio-economic aspects of the participating community by incorporating gender analyses and participatory assessments in the very initial stages of project planning.

The following catchment management projects are also implemented with the active participation of local people:

- Community Development and Forest Watershed Management Project (JICA)
- Soil Conservation and Watershed Management Component of the Natural Resource Management Sector Assistance Programme (DANIDA)
- Bagmati Integrated Watershed Management Project (EU)
- Soil Conservation and Watershed Management Component of the Nepal/Australia Community Resource Management Project (AUSAID)
- Soil Conservation and Watershed Management Component of the Environment and Forest Enterprise Activity Project (USAID)

3.7.1 MAJOR ACHIEVEMENTS

Establishment of ICIMOD: The International Centre for Integrated Mountain Development (ICIMOD) in Nepal is committed to mountain development, sustainable resources use and biodiversity conservation. ICIMOD has matured into an international clearinghouse for the accumulation, generation, and dissemination of knowledge on all issues concerning mountain biodiversity and development. ICIMOD played an important role in ensuring the inclusion of a special chapter on mountain ecosystems in Agenda 21 (ICIMOD 1999).

Biodiversity conservation: Progress has been made in conserving biodiversity in mountains. Habitat conservation is the most effective means of protecting most species, genetic variability and ecological diversity, and large areas of natural habitat have been protected in mountains, in the form of national parks, conservation areas and one strict nature reserve.

World Heritage Sites: Nepal has two natural world heritage sites. Sagarmatha National Park, which has the highest peak in the world (8,848m), and the Royal Chitwan National Park were declared World Heritage Sites in 1979 and 1984 respectively.

Eco-tourism: Mountains provide an excellent source of revenue for HMGN through eco-tourism.

4 MAJOR THREATS FACING NEPAL'S BIODIVERSITY AND THEIR ROOT CAUSES

The biological resources of Nepal are identified and quantified in Chapter 2. Chapter 3 analysed protective and management mechanisms already in place in Nepal. This chapter deals with weaknesses, gaps, difficulties, and other problems in conserving Nepal's biological diversity. First, a list is presented to determine the major threats to biodiversity; this is then followed by an analysis of their immediate and root causes.

4.1 MAJOR EXISTING AND EMERGING PROBLEMS

4.1.1 WEAKNESSES, GAPS, DIFFICULTIES, AND OTHER PROBLEMS

In the extensive array of mechanisms for the protection of biodiversity, great reliance is placed on the Protected Areas System of Nepal. Table 4.1 below summarises the problems known to be affecting specific Protected Areas (PA) in Nepal, and the significance of each PA.

Table 4.1 Biological and cultural significance of protected areas and their major problems

Protected Area	Physiographic Location	Biological and Cultural Significance	Major Problems
Royal Chitwan National Park	Terai – Siwalik Hills	Sal, Sal-pine, riverine grassland, rhinoceros, tiger, leopard, wild dog, sloth bear, crocodile, gharial, king cobra, Bengal florican. World heritage site, Balmiki ashram.	Collection of firewood, grazing, crop-raiding by wild animals, rhino & tiger poaching, environmental pressure from tourism, factory effluent pollution.
Royal Bardia National Park	Terai -Siwalik Hills	Sal, pine, acacia, sissoo, grassland, wild elephant, tiger, sloth bear, hispid hare, Gangetic dolphin, black buck, crocodile, gharial.	Poaching, hunting, grazing, fishing using explosives and poison, hydropower plant construction.
Koshi Tappu Wildlife Reserve	Terai	Acacia, sissoo, riverine forest, grassland, wild water buffalo, Gangetic dolphin, otter, wild boar, python, gharial, leopard, swamp francolin & richest water fowl diversity. Ramsar site.	Grazing, genetic erosion of wild buffalo population, over-fishing, high tension electrical transmission, irrigation canal, flooding, siltation.
Royal Suklaphanta Wildlife Reserve	Terai – Siwalik Hills	Sal, acacia, sisso, extensive grassland, elephant, swamp deer, tiger, hispid hare, Bengal florican.	Collection of wood, grazing, crop-raiding by wild animals.
Parsa Wildlife Reserve	Terai – Siwalik Hills	Sal, acacia, pine, mixed hardwood, riverine vegetation, elephant, tiger, sambar deer, leopard, giant hornbill, king cobra, cobra, python. Kailash parbat (Shiva temple).	Collection of wood, poaching, grazing.
Shivapuri National Park	Middle Mountain	Main watershed of Kathmandu Valley. Schima, castanopsis, oak, type locality of many nepalese plants, leopard, wild boar, langur, rich bird species diversity, habitat for relict Himalayan dragonfly.	Collection of firewood and fodder, grazing, deforestation.
Langtang National Park	Mid-hills – High mountains	Sal, oak, blue pine, hemlock, fir, birch, rhododendron, 15 endemic plant species, red panda, snow leopard, clouded leopard, wild dog, musk deer, thar, goral. Gosainkunda lake pilgrimage site.	Poaching for musk deer, crop raiding by wild boars, refuse and garbage, collection of medicinal plants.
Rara National Park	High Mountains	Blue pine, fir, birch, musk deer, leopard, red panda, impeyan pheasant, high altitude wetland.	Grazing, collection of firewood and medicinal plants.
Khaptad National Park	High Mountains	Oak, fir, conifer, musk deer, leopard, black bear. Ashram of late khaptad baba (sage), Shiva shrine, Khaptad daha - a shallow lake.	Grazing, crop depredation by wild boars, firewood collection, fires in the chir pine forest.
Sagarmatha National Park	High Mountains - High Himalaya	Blue pine, fir, juniper scrub, alpine meadows, red panda, snow leopard, goral serow, musk deer, black bear, Indian muntjac. World heritage site.	Environmental pressure from tourism, waste disposal, tree felling, heavy grazing by yak and sheep.
Makalu Barun National Park	High Mountains - High Himalaya	Sal, castanopsis, oak, rhododendron, orchids, high species richness, snow leopard, red panda, musk deer.	Excessive human encroachment, slash-and-burn agriculture, poaching for bears, collection of medicinal plants.

Protected Area	Physiographic Location	Biological and Cultural Significance	Major Problems
Dhorpatan Hunting Reserve	High Mountains - High Himalaya	Fir, hemlock, spruce, birch, junipers, grassland. Game hunting reserve.	Over grazing, grass burning, firewood cutting.
Annapurna Conservation Area	High Mountains - High Himalaya	Hill sal, alder, oak, birch, junipers, Tibetan plateau, 56 endemic species of angiosperm, blue sheep, musk deer, thar, red panda, pheasants. Extensive tourism.	Environmental deterioration, cultural deterioration, tourism pressures, collection of wood, hunting, waste disposal.
Kanchenjunga Conservation Area	High Mountains - High Himalaya	Rhododendron, birch, blue pine, larch, magnolia, oak, snow leopard, red panda, musk deer, blue sheep.	Slash & burn, poaching, collection of medicinal plants.
Manaslu Conservation Area	High Mountains - High Himalaya	Oak, blue pine, larch, birch, snow leopard, musk deer, blue sheep, red panda, Himalayan thar.	Poaching, collection of firewood and medicinal plants.
Shey Phoksundo National Park	High Mountains - Trans Himalaya	Tibetan plateau ecosystem, oak, spruce, fir, birch, 30 species of endemic plants, blue sheep, musk deer, red panda, snow leopard. Religious Bhuddist site.	Grazing, poaching for musk deer, hunting for blue sheep, collection of medicinal plants.

Table 4.2 incorporates the above problems with the weaknesses, gaps, difficulties, and other problems that threaten biological diversity in Nepal, and which are discussed in Chapter 3.

Table 4.2 Weaknesses, gaps, difficulties and other problems, and the likely threats they pose to biological diversity in Nepal (greater degree of threat indicated by more ✔)

Weaknesses, Gaps, Difficulties and Other Problems	Threat to: Ecosystems	Species	Genetic Diversity
Difficult terrain, harsh environmental conditions and a lack of facilities in the mountains	✔✔	✔	✔✔
Introduction of alien species	✔✔	✔	✔✔
Slash and burn agriculture, grass burning	✔✔	✔	✔✔
Incomplete baseline and other information	✔	✔✔	✔✔
Lack of clear conservation objectives in forest management plans	✔✔	✔	
High impact of tourism	✔✔	✔	
Weak policies and weak institutional support for managers	✔✔	✔	✔
Illegal collection of medicinal plants (including harvesting in excess of permit limits)		✔✔	✔
Lack of inventory, survey, monitoring and assessment		✔	✔✔
Abandonment of traditional pasture management approaches	✔		✔✔
Low priority accorded to biodiversity conservation work	✔	✔	✔✔
Inadequate financial, technical and staff resources in scientific establishments	✔	✔	✔
Unclear institutional mandates	✔	✔	✔
Lack of awareness and community participation	✔	✔	✔
Excessive market demands leading to unsustainable harvesting		✔✔	
Deforestation and conversion to agriculture	✔✔		
Illegal tree felling for timber and fuel	✔✔		
Market forces causing a depletion of genetic resources			✔✔
Loss of traditional, indigenous pastoral knowledge			✔✔
Dilution of genetic resources through introduced races			✔✔
Out of date legislation and regulations	✔	✔	✔
Lack of research and development		✔	✔
High tension power transmission lines	✔	✔	
Lack of training in basic scientific and technical aspects		✔✔	
Fishing with poisons or explosives, over-fishing		✔✔	
Fire	✔✔		
Undetermined carrying capacities	✔✔		
Absence of certain key ecosystems within the protected areas network	✔		
Lack of inter-sectoral and inter-agency co-ordination mechanisms	✔		
Lack of integrated management of some protected areas	✔		
Delays in preparing Operational Forest Management Plans	✔		
Unskilled staff in extension work on biodiversity conservation	✔		
Irrigation dams and distribution canals	✔		

Weaknesses, Gaps, Difficulties and Other Problems	Threat to: Ecosystems	Species	Genetic Diversity
Flooding and siltation	✔		
Hydro-electric plant construction and power generation	✔		
Solid and liquid waste disposal	✔		
Illegal grazing in protected areas	✔		
Illegal hunting, poaching		✔	
Raiding of domestic crops by protected species		✔	
Poor management of large blocks of forests in the Mid-hills	✔		

Some of the likely negative outcomes that arise from the weaknesses, gaps, difficulties, and other problems identified above directly threaten biodiversity, and these are usually easy to identify and address. However, some of the problems only indirectly affect biodiversity, which nevertheless pose serious threats. Two very serious indirect threats to biodiversity are lack of sensitivity and awareness among the general public and inefficient management of natural resources.

4.1.2 MAJOR THREATS TO BIODIVERSITY

Before attempting to determine the immediate and root causes of the threats to biodiversity, it is useful to discuss the three major levels of biodiversity threatened. With little difference between them in magnitude of impact, these are:

- the threat of ecosystems loss,
- the threat of species loss, and
- the threat of loss of genetic resources.

Each is discussed briefly below, bearing in mind that the distinction between ecosystems, species, and genetic resources can sometimes be very hazy. It must also be remembered that often an impact on one of these three elements also has an impact on the other two.

4.1.2.1 The threats of ecosystems loss

Loss of ecosystems can be a result of direct or indirect impacts. Direct causes include the conversion of the natural environment (forest, grassland, wetland, hill country, or mountain) to agriculture, horticulture, plantation forest, residential or industrial development, roads, and other infrastructure developments. The greatest threat comes from the need of subsistence farmers to extend their agricultural activity, and the perception that this is best achieved through the conversion of forests and other "virgin" lands.

Habitat Loss and Deforestation

Nepal has approximately 4,268,000 hectares of forest (29% of the country's total land area), and 1,562,000 hectares of scrubland (10.6% of total land area). The latest available statistics reveal that forest area decreased at an annual rate of 1.7% between 1978/79 and 1994, whereas forest and shrubland together decreased at an annual rate of 0.5%. The decrease in forest area was not uniform through the different physiographic zones (Table 4.3). In the Terai, forest area decreased at an annual rate of 1.3% from 1978/79 to 1990/91, whereas in the hill areas it decreased at a rate of 2.3% per annum from 1978/79 to 1994.

Some areas classified as forests may have only a few trees per hectare, and only 15% of forests have a crown cover greater than 70%. Uncontrolled grazing and frequent fires limit regeneration and undermine the future status of forest areas. Reforestation of 13,500 ha/year has been targeted by HMGN, but only 5,300 ha/year was achieved in 2001.

Table 4.3 Changes in forest and shrubland in Nepal between 1978/79 and 1990/91

Year	Forest (% of total land area of Nepal)	Shrubland (% of total land area of Nepal)	Total	Source
1978/79	38.0	4.7	42.7	Land Resource Mapping Project
1990/91	29.0	10.6	39.6	NFI

Source: HMGN-DFRS (1999)

Forests are also under increasing pressure from growing human populations and their demands for fuelwood, timber, leaf litter, and other forest products, the impacts of excessive numbers of livestock, and the construction of roads, dams, settlements, etc. When the continued removal of forest products exceeds the capacity of the forest to regenerate, degradation ensues. If unchecked, this process will turn forests into wastelands. Deforestation and forest degradation have already reduced the availability of timber, fuelwood, leaf litter, fodder, and forage. This has depressed rural incomes and contributed to soil erosion and loss of soil fertility, damaged ecosystems, and degraded catchments.

It has been estimated that an annual loss of Rupees 11.55 billion occurs as a result of deforestation (Table 4.4).

Table 4.4 Estimated annual financial losses (in Nepali Rupees – Rs.) due to deforestation

Phusiographic Zone	Annual deforestation (ha)	Deforestation loss (Rs./ha)	Total loss due to deforestation (million Rs.)
Hills & Mountains			
Deforestation	41,000	125,000	5,125.0
Degradation	54,200	42,000	2,276.4
Terai			
Deforestation	8,300	500,000	4,150.0
Total			**11,551.4**

Source: Kanel (2000, unpublished)

The Government of Nepal is gradually handing over management of forests back to villagers, who largely depend on forest products for their survival. Progress is slow, not just because trees take time to grow, but also because attitudes are slow to change (Sattaur 1987). Contrary to general belief, deforestation of Nepal's Mid-hills of is not a recent occurrence, and deforestation was well underway in the region by the late 18th century (Sattaur 1987).

Pine was the most widely planted species in the Mid-hills. Unfortunately, pine is of little value to farmers. It is useful as construction timber, but timber only ranks fourth on a farmer's priority list. Fodder and bedding material for livestock and fuel are what the people need most (Sattaur 1987). Any attempt to remove the threat of deforestation through reforestation must be based on reliable data, including what tree species are most useful for the local population.

Threats to rangeland biodiversity

There are enormous pressures on rangeland ecosystems. According to some estimates, there are nine times more grazing animals than the land can viably support. This high grazing pressure depletes palatable plant species, especially legumes. With its extremes of wind, rainfall, and temperature, arid mountain rangeland is especially prone to the process of desiccation that can be caused or accelerated by overgrazing.

Most rangeland ecosystems located in arid regions and high mountain pastures are relatively susceptible to degradation because they are less resilient to disruptions than subtropical ecosystems. Moderately degraded rangelands can usually be restored over time through integrated management systems. Severely degraded rangelands may require both investment and improved techniques to make them economically viable and ecologically restored.

Threats to protected areas

There are many conflicts and threats that affect the entire Protected Areas System in Nepal. A few examples are discussed below:

Grazing is a year-round threat to many of the protected areas in the Terai, whereas it is usually only a seasonal threat to the high elevation pastures of the Himalayas. In either case, overgrazing is prevalent. The level of livestock grazing is also one of the most serious threats to the ecological integrity of the Mid-hill and highland PAs. Management responsibility for the northern rangelands is unclear.

Poaching for high value products for international markets, such as musk glands from musk deer, is fundamentally different in scope and in degree from the occasional poaching of wild animals to supplement rural diets. The former is considered a much greater threat and a higher priority for action. In spite of a number of measures taken to prevent poaching of wildlife, frequent reports are published of poachers caught in possession of wildlife parts. The main species poached in the Terai are the Royal Bengal tiger and the one-horned rhinoceros, and musk deer in the high mountain.

Illegal timber harvesting of commercial tree species is a constant threat. Tourism in and around PAs continues to develop in a haphazard and ad hoc manner. Uncoordinated private sector initiatives have enabled outsiders (non-Nepalese) to reap substantial benefits from tourism with very little benefit trickling down to the local communities. The PAs have been increasingly threatened by infrastructure development projects such as roads, irrigation canals, and hydroelectric dams. Land dedicated to PAs can no longer remain pristine if the surrounding areas are not suitably developed with proactive planning. Although environmental impact assessments are mandatory, a few industries discharging harmful effluents are built too close to PAs. Established industries with their increasing production capacities are unrestrained and continue to pollute river systems running through parks.

Other issues transcend technical government offices and are perhaps most difficult to solve. Political influences are strong and people in power have many means at their disposal to circumvent rules and regulations, in this case, the National Parks and Wildlife Conservation Act. If anything, political powers and influences have increased since the start of the modern multiparty political era in 1990, and park or reserve managers are powerless to stop certain excesses and are forced to turn a blind eye to irregularities. Such cases have become increasingly harder to control and are virtually impossible to prosecute.

Habitat degradation also occurs as a result of inadequate management of protected areas and their buffer zones. Management capacity and expertise is limited, and while management staffs of PAs are enthusiastic and committed, they lack the training and resources to do a proper job. They also lack operational plans to guide them in their management activities.

Threats to wetland biodiversity

Wetland biodiversity is under threat from encroachment of wetland habitat, unsustainable harvesting of wetland resources, industrial pollution, agricultural runoff, siltation, and the introduction of exotic and invasive species into wetland ecosystems.

Encroachment on wetlands is primarily due to: (i) drainage for irrigation, reclamation, and fishing; (ii) filling-in for solid waste disposal, road construction and commercial, residential, and industrial development; (iii) conversion of sites for aquaculture; (iv) construction of dams, barrages, and other barriers for controlling water flow; (v) groundwater extraction using high-powered pumps, and digging ditches in sites where there is no inflow of water; (vi) discharge of sediments and pollutants from nearby areas; (vii) grazing; and (viii) removal of soil from the site.

This encroachment has resulted in a number of negative impacts, including reduction of wetland areas, deposition of silt and sediment, and eutrophication caused by agricultural runoff and/or industrial effluents.

Unsustainable practices include over-fishing and the indiscriminate use of poison and dynamite to kill fish. The introduction of exotic fish species has also been recognised as a possible threat to native species. Poaching is a major threat to crocodiles, particularly the gharial and mugger crocodiles found in the Kali Gandaki River and in the major tributaries of the Narayani River.

The number of fish species in the Bagmati River has declined from 54 to 7 within a decade as a result of the inflow of industrial sewage. The high concentration of organic matter and chemicals in effluents has killed fish and destroyed the plant life they depend on (Shrestha *et al*. 1979; Sharma & Pantha 1992).

Empirical evidence collected from a rapid reconnaissance survey of 163 wetland sites and their resources revealed that the wetlands of the Terai are vulnerable to many threats, including the proliferation of exotic species. *Eichhornia crassipes* (water hyacinth) threatens the survival of several wetland ecosystems in the Terai, as it forms a dense mat blocking sunlight penetration under water and ultimately changing the chemistry of the water (IUCN-Nepal 1996).

About 66% of the wetlands of the hills and mountains are threatened by siltation. A further 62% show problems due to agricultural runoff. In addition to agricultural runoff, they also suffer from factory effluents, washing and sewage emissions, and domestic effluents. Finally, dredging and drainage threaten almost two-thirds of these wetlands.

Threats to mountain biodiversity

Poverty, ecological fragility, and instability of high mountain environments, deforestation, poor management of natural resources, and inappropriate farming practices are the primary threats to mountain biodiversity. The cumulative impacts of these threats result in accelerated soil erosion, catchment degradation, and loss of biodiversity.

One of the greatest threats facing Himalayan flora and fauna is over-exploitation and poaching for trade. Of the many species threatened with extinction, three wildlife species (Himalayan black bear, *Selenarctos thibetanus*, Brown bear, *Ursus arctos*, and the Himalayan musk deer, *Moschus chrysogster*) are poached for certain organs that fetch enormous amounts of money through illegal international trade. It has been estimated that for every male deer that yields one musk pod, four deer are killed.

Mountain communities often suffer from economic and legal marginalisation due to low soil fertility, small plots of arable land, climatic vagaries, and higher caloric requirements related to the lower oxygen content in the air. Access to the benefits available to other segments of society are also often curtailed and limited because of their location far from the seats of power in the capital. Mountain communities rely on small-scale production systems resulting in higher production costs.

4.1.2.2 The threat of species loss

Over-exploitation of biological resources

The natural and semi-natural forest habitats are mostly distributed in two management systems - protected areas and national forests. Approximately 70% of the forests of the Terai–Siwalik Hills zone are national forests and the rest are within protected areas (Joshi *et al.* 1996b). The Mid-hills forest ecosystems are inadequately represented in protected areas and are considered threatened. Forest habitats outside the PAs include a number of forest types under the jurisdiction of the Department of Forests. However, these habitats are rapidly degrading due to over-exploitation.

Felling of Sal (*Shorea robusta*), Khair (*Acacia catechu*), Simal (*Bombax ceiba*), Satisal (*Dalbergia latifolia*), and Bijaysal (*Pterocarpus marsupium*) in the Terai, collection of biomass such as leaf litter, fodder, and fuelwood in the hills, collection of Lokta and medicinal and aromatic plants, heavy lopping of oak trees for fodder, and cutting of blue pine trees in high altitude forests for roof shingles and timber for house construction all have negative impacts on forest biodiversity in these regions. It is widely believed that harvesting of medicinal plants is no longer sustainable in many areas.

A majority of Nepalese people depend largely on forest resources for their subsistence. They use forest products for fuel materials, timber, shelter, medicine, food, and fodder. Over 75% of the energy resources and over 40% of fodder needs are met through forest resources (HMGN/ADB/FINNIDA 1988). A threat to these biological resources is also a threat to the social and economic well being of these people.

Threats to forest biodiversity

Despite the conservation benefit provided by the PAs network, biodiversity loss in Nepal continues unabated. The most critical threat to biodiversity is habitat destruction. The Nepal Conservation Strategy raised the alarm that if Nepal were to lose its remaining humid tropical forests, an estimated ten species of highly valuable timber trees, six species of fibre trees, six species of edible fruit trees, four species of medicinal herbs and fifty species of other trees and shrubs would be lost forever. In addition, the habitats for 200 species of birds, ten species of mammals and twenty species of reptiles and amphibians would be severely affected. Shrestha *et al*. (1998) reported that 68% of plant species were lost when 41% of the density and 50% of the tree biomass were lost in Riyale, Kabhrepalanchowk. Similarly, Shrestha *et al*. (2000) reported that a 78.2% plant species loss occurred when 83.1% of the density and 80.1% of the tree biomass were lost in the degraded forests of Chitrepani, Makwanpur district, as compared to natural forests.

Threats to endangered plants and animals are increasing due to the high commercial values in local and international markets for specific plants and animal parts. In Nepal, 56 mammal, 226 bird, 25 reptile, nine amphibian, 35 fish, and 142 butterfly species are threatened with extinction locally.

Threats to Non-Timber Forest Products (NTFPs)

The most critical threats to all NTFPs are deforestation, habitat degradation, and unsustainable harvesting. The most common NTFPs that are traded on a large scale (over 100 tonnes/year) are Pine resin (khoto), Sal seed, Kutch, Ritha, Timur, Dalchini and Tejpat, Sabai grass (or Babiyo), Lokta, Satawari (or Kurilo), Chirayito, Jatamansi, Padamchal, and Sugandhkokila (Malla *et al*. 1993).

The collection and trade of these valuable natural resources has generated considerable employment opportunities in remote areas where the majority of people are poor. Trade in NTFPs and medicinal plants is the basis of the livelihoods of a large number of rural people, and their collection is likely to continue for a long time to come. However, their collection is unregulated and indiscriminate. Unsustainable harvesting has reduced the quantity and quality of many NTFPs in the wild. However, despite considerable anecdotal evidence suggesting that over-harvesting of medicinal plants is occurring, quantitative data are lacking. Without such data, it is impossible to analyse and assess the effects of harvesting on plant populations in natural communities or to design appropriate conservation and management plans.

4.1.2.3 The threat of loss of agrobiodiversity and genetic resources

The genetic resources of Nepal are in a state of depletion. This is primarily due to the destruction of natural habitat, over-grazing, land fragmentation, commercialisation of agriculture and the extension of high-yielding crop varieties, indiscriminate use of pesticides, population growth and urbanisation, changes in farmers' priorities, and lack of awareness among policy makers and planners about the importance of agrobiodiversity.

Rice landraces are being replaced or discontinued through the introduction of modern varieties that have high yield potential (Rijal *et al*. 1997). Key reasons for the erosion of rice landraces are: (i) changes in suitable habitats; (ii) under-valuing of landraces and no institutional support for their conservation; (iii) government policy of extending modern varieties for increasing total biological return; (iv) lack of promotional activities for landraces; and (v) failure of research systems to improve upon the existing landraces. Nepal's traditional agroecosystems and the agrobiodiversity found within them are also threatened by agricultural policies that favour centralised control and subsidies for high-input agriculture. The Ninth Five-Year Plan (1997-2002) has identified the need for sustainable agricultural development without jeopardising the natural environment.

As with crop diversity, the biggest threat to livestock diversity is the decline and degradation of traditional farming systems. Under current policies and economic pressures, it is impossible for ordinary farmers to conserve or preserve traditional breeds, strains, and populations of domesticated animals.

4.2 IMMEDIATE AND ROOT CAUSES

The weaknesses, gaps, difficulties, and other problems faced by Nepal in conserving biological diversity have been collated and analysed above, and the major threats they pose have been identified. Some of the symptoms of these problems may need immediate attention due to the severity of their impact. However, addressing the symptoms does not remove the problem and any benefits are likely to be short-term. More long-term, sustainable benefits will be obtained by addressing both the immediate and root causes of the problems. Following a general discussion of the main perceived causes of the problems of biodiversity degradation in Nepal, this section undertakes a preliminary causal chain analysis for each of the three major causes of threats, socio-economic, natural and anthropogenic, in an attempt to discover the root causes. The Nepal Biodiversity Implementation Plan that will arise from this Strategy will repeat this exercise more thoroughly, and with the participation of critical stakeholders.

4.2.1 SOCIO-ECONOMIC CAUSES

Nepal is one of the least developed countries of the world. With an estimated annual per capita income of US$ 210, open natural resources such as land and forests are the main sources of livelihood for a large proportion of the population.

Poverty is intimately related to environmental degradation and loss of biodiversity. World-wide, the poor do not have access to non-natural resources. They depend on their own direct exploitation of natural resources. Poor people have no choice but to engage in unsustainable uses of natural resources, and Nepal is no exception. Some 44% of people in rural areas and 23% in urban areas live below the national poverty line (World Bank 1999). A large number of poor families have small farms and over two-thirds of rural households own less than half an hectare of land (APP 1995; HMGN-NPC 1999). Most of the people in these groups collect and sell forest products to survive from one day to the next. In efforts to increase production, poor farmers expand cultivation into highlands that are not suitable for agriculture. The result is accelerated soil erosion, land degradation, declining productivity of farmland, and sedimentation in downstream areas.

Until the late 1980s, the forests of Nepal were considered as a major source of revenue, and people used to say *Hariyo Ban Nepal Ko Dhan*, or 'the green forests of Nepal are her wealth'. However, agriculture has always been the main source of livelihood of the rural people, who make up 90% of the country's 23 million people. With the growing population, more trees were cut to export logs to India for foreign exchange and more forests were cleared to increase land for food production, which also provided employment.

The fast population growth (see Table 4.5) has led to a rapid increase in demand for fuelwood (more than 90% of Nepal's energy needs are met through the combustion of biomass), timber, fodder, and land to grow more food. These heavy pressures are destroying forest ecosystems and habitats and driving some species of plants and animals to a threatened existence.

Over a few years, the Terai has changed from being a densely forested and sparsely populated area to a sparsely forested and densely populated region. The suppression of malaria through the Rapti Valley Development Programme in Chitwan Valley in 1956, the establishment of the Nepal Resettlement Company in 1964 and the Resettlement Department in 1969 dramatically increased migration of people from the hills to the Terai. Forests were cleared and converted to agriculture (Soussan *et al*. 1995), and the process is continuing today.

Table 4.5 Population change in the different regions of Nepal between 1971 and 2001

Region		1971 (% of total population)	1981	1991	2001	Population Change 1971 - 2001	
						Absolute Increase	% Increase
Mountain	Population	1,138,610	1,302,896	1,443,130	1,690,000	+ 551,390	48.4%
	% of total population	(9.9%)	(8.7%)	(7.8%)	(7.3%)		
Mid-hills	Population	6,071,407	7,163,115	8,419,889	10,271,400	+ 4,200,000	69.2%
	% of total population	(52.5%)	(47.7%)	(45.5%)	(44.2%)		
Terai	Population	4,345,960	6,556,828	8,628,078	11,252,800	+ 6,906,800	159.0%
	% of total population	(37.6%)	(43.6%)	(46.7%)	(48.5%)		
Total		**11,555,983**	**15,022,839**	**18,491,097**	**23,214,200**	**+11,658,200**	**100.8%**
Growth rate (% per annum)		2.07	2.66	2.08	2.27		

Source: CBS 1998; 2001 figures are from 2001 provisional Census

4.2.2 NATURAL CAUSES

Landslides in the hilly regions not only damage the landscape but often cause loss of life and property. Seventy-five percent of the landslides in Nepal occur naturally (MOPE 1998). However, Laban (1979), who analysed landslides triggered by both natural and anthropogenic causes in the Mid-hills, discovered that natural large landslides occur at a frequency of 0.2/km^2, but that this increases to 2.8/km^2 in areas of human interference. Landslides mainly occur during the monsoon (June-September) when the topsoil gets soaked with rainwater. Hill roads are very susceptible to landslides, and according to one estimate, about 400-700m^3 of landslides per square kilometre occur on hill roads every year.

Topsoil erosion has been one of the factors contributing to declining plant productivity. Soil erosion is caused by natural as well as anthropogenic actions. The steep slopes, tectonic instability, and relatively young age of the Himalayas all contribute to high natural erosion (Jha 1992). Soil loss in non-degraded forest areas tends to be below 1.0t/ha/yr, whereas in more degraded areas it is over 4.0t/ha/yr and can go up to 200t/ha/yr in critical areas. Every year, 1-2mm of fertile topsoil is lost throughout Nepal, leading to desertification and low productivity.

4.2.3 ANTHROPOGENIC CAUSES

4.2.3.1 Pollution

Toxic substances and other pollutants affect biodiversity at the ecosystem level by disturbing vital ecological processes and modifying the species composition of plant and animal communities. On a local and regional scale, significant populations of lichens, bryophytes, algae and freshwater life, particularly fish, have been eliminated, and air pollutants pose a serious threat to many birds and mammals. But there is no known case of pollutants being the main cause of a species disappearing altogether. Plants have varied responses to air pollution, and Jha *et al.* (1997) have recorded a reduction in the flowering period of roadside trees (*Callistemon citrinus, Grevillea robusta, Jacaranda mimosaefolia,* and *Melia azedarach*) because of pollution. In the last two decades, the Mid-hills in general and Kathmandu in particular have witnessed increased numbers of mosquitoes and other insects mainly as a result of pollution.

4.2.3.2 Fire

In several habitats, fire plays a critical role in the health of ecosystems and in maintaining their biological diversity. In the central region, fires are common in the *Pinus roxburghii* and *Shorea robusta* forests of the Terai and Mid-hills during the dry months (March to May). Fires are only occasional in *Quercus* (oak) forests. Forest fires in Nepal are perhaps less severe than in other countries, but are still capable of doing considerable damage, especially to young plantations (Jackson 1994).

Very few fires are naturally caused in Nepal. Karkee (1991) found that 40% of forest fires in the Mid-hills are started by accident and 60% are started deliberately. Accidental causes include carelessness with cigarettes and matches, fires which are set to clear for cultivation and which then burn out of control, smouldering charcoal left by charcoal burners, fires set to smoke out wild bees when collecting honey and which go out of control, etc. Fires are also set deliberately in forests to kill trees so that the dead wood can then be collected and used for firewood, to induce new grass growth for cattle grazing, to clear land for farming, to make firewood and fodder easier to collect, and for hunting. Fires are also sometimes started maliciously by people with a grudge or complaint against the forest owner or manager.

The Department of Forests has recognised fire as a serious threat to ecosystems and biodiversity, and has allocated some budget for fire control. However, there is no systematic and complete record of forest fires or their impacts in Nepal.

4.2.3.3 Overgrazing

Uncontrolled overgrazing by livestock directly affects the species composition and productivity of the grassland vegetation. Due to relative preferences for different plant species, overgrazing allows an increase in the populations of those species undesirable or unpalatable to the grazing animals. Overgrazing by domestic and wild animals may arrest succession or even reverse it. Overgrazing also causes changes in the diversity of the fauna. The loss of grass cover reduces insect populations, which in turn changes the bird life. Birds found on grazed grasslands are largely seedeaters, while those on non-grazed grasslands are insectivores. Overgrazing also affects the quality of the grazers themselves. Some of the effects of overgrazing on the grazers include low body weight, poor health, low milk production. Reasons for overgrazing in Nepal include too many animals on limited grazing land (more cattle than the land's carrying capacity), and lack of organised fodder production and pasture management.

4.2.3.4 Introduction of alien species

Some species have disappeared from Nepal over the past years. However, the total number of species has increased due to the deliberate or accidental introduction of exotic species. Immigration of species is also rising with increased human movement. The introduction of three fish species (*Salmo guirdneri, S. trutta* and *Oncorhychus rhodurus*) from India, England and Japan between 1971 and 1975 (Shrestha 1994) is an example of a deliberate introduction. Similarly, new fruit species (e.g. strawberries and grapes) have been introduced in Nepal in the last three decades.

There are over one hundred non-native plant species that are so well established that they have become weeds in Nepal. *Eupatorium adenophorum, Lantana camara, Mikania micrantha, Bidens pilosa, Amaranthus viridis, A. spinosus, Cassia tora*, and *C. sophera* are so common that they have changed the species composition of fallow and cultivated lands. The introduction of *Eucalyptus*, *Pinus* and *Populus* species has also affected the composition of Nepal's biodiversity.

4.2.3.5 Illegal trade and hunting

Control of illegal trade in plant and animal species, their parts or products, is a world-wide concern these days. The illegal trade is directly correlated with demographic factors, potentials for profit, and lack of adequate resources for law enforcement.

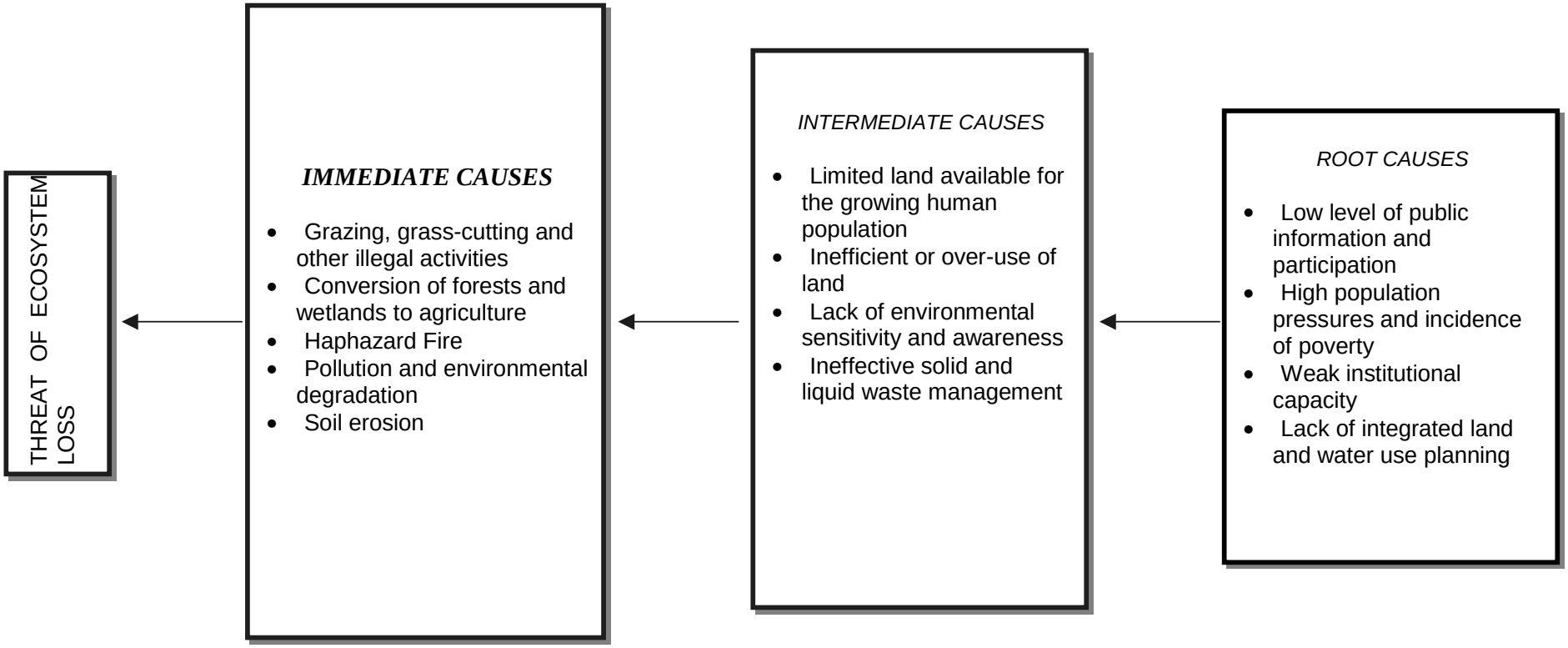
Reports of illegal hunting from some parts of Nepal are common. Poaching of wildlife and illegal collection of rare, threatened and endangered plant species has always been a serious problem in and outside PAs in Nepal. Fish stocks are over-exploited from the rivers, dolphins, pheasants, and ungulates are hunted for their meat, and carnivores are hunted for their pelts and bones. Sloth and Himalayan black bear gall bladders, rhinoceros horns, and tiger bones are smuggled out of Nepal. Poaching of one-horned rhinoceros and royal Bengal tigers is frequently reported (BPP 1995i). Penalties (fines and imprisonment) set by the NPWC Act (1993 amendment) for killing or trading in wild animals have been effective in deterring poachers, but the high price for gall bladders, rhinoceros horns and tiger bones on the international market encourages poaching of these species. Similarly, the growing demand for certain endangered plants like Panch Aule (*Dactylorhiza hatagirea*) and Yarsa gumba (*Cordyceps sinensis*) on the domestic and international markets has created a serious threat to these plant species.

Nepal is a signatory to CITES, the Ramsar Convention and the Convention on Biological Diversity. These Conventions as well as national legislation prohibit or limit trade in endangered and rare species, their parts or products within and outside the country. The Royal Nepalese Army is involved in protecting national parks and reserves. However, they do not have the jurisdiction to protect wildlife outside these PAs. Illegal trade in some of the high-value medicinal plants and wildlife species continues to be a threat to the long-term conservation of these species.

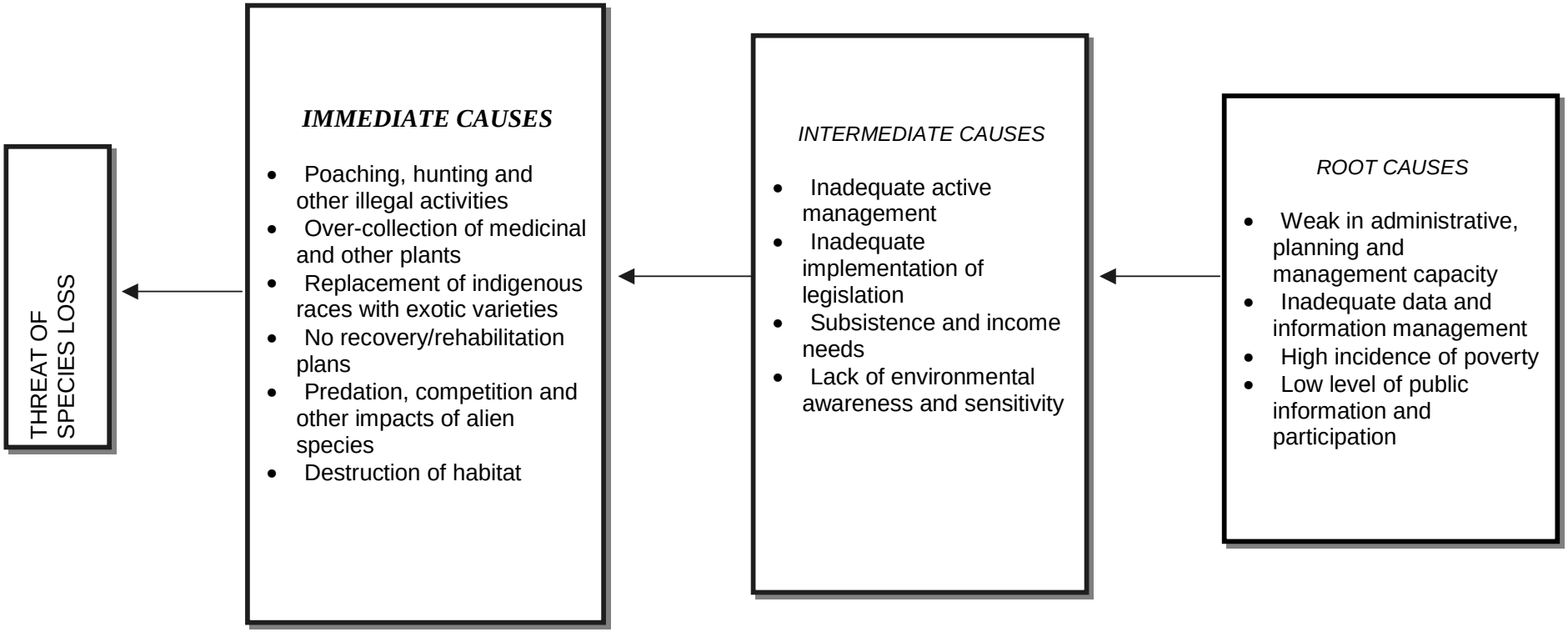
The International Trust for Nature Conservation (ITNC), in collaboration with the Royal Chitwan National Park management, provided financial support to the government's Anti-Poaching Unit in the early 1990s to control and discourage poaching. The Anti-Poaching Unit was assigned the task of patrolling national parks and reserves and collecting information on poaching activities from villages scattered around PAs. With the support from WWF-Nepal, two additional anti-poaching units were formed in January 1993. One of these is active along the north-western border and the other in the eastern area of Royal Chitwan National Park. Rhinoceros mortality reached a peak in 1993, both due to natural causes and poaching. Between 1992-1997, a total of 76 poachers were caught in relation to rhinoceros and tiger poaching and trade. HMGN, in collaboration with ITNC, WWF-Nepal Program, KMTNC and Buffer Zone Development Committee has established anti-poaching units in different national parks and reserves.

4.2.4 PRELIMINARY CAUSAL CHAIN ANALYSIS

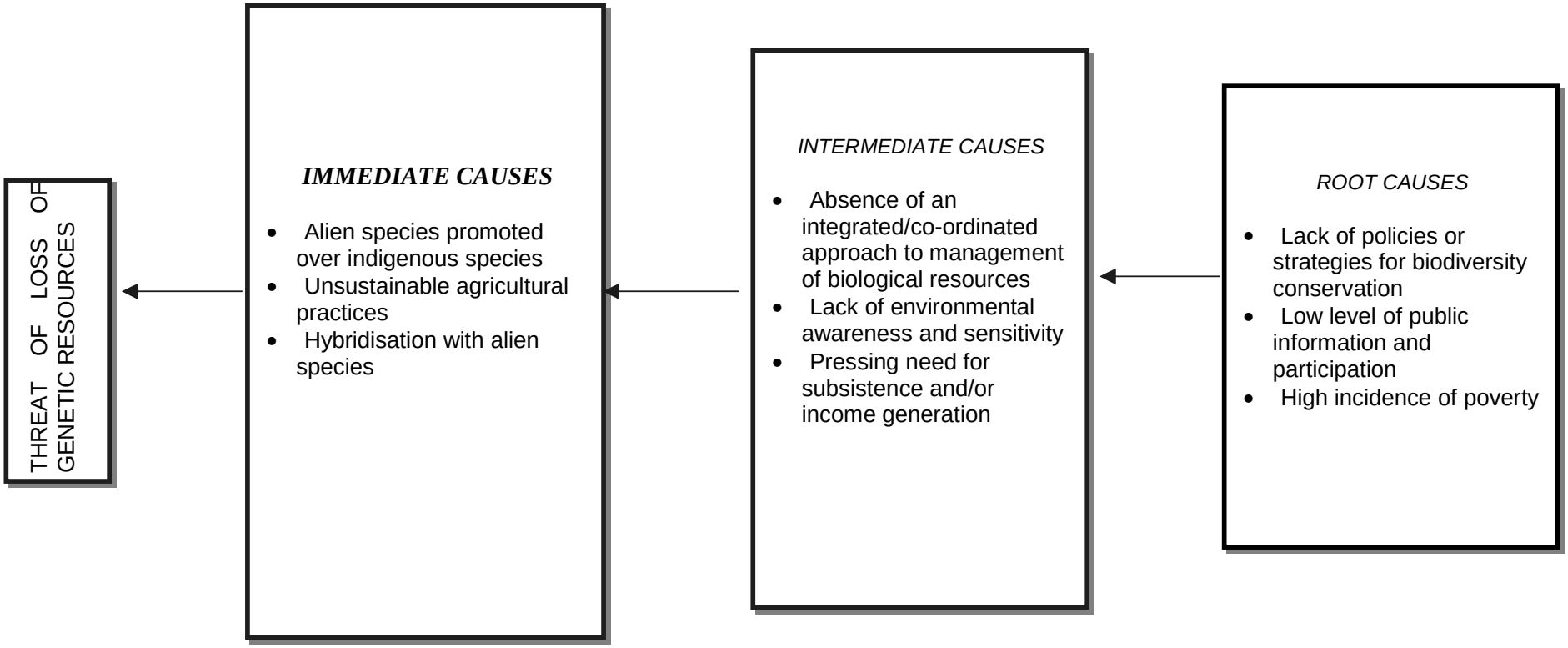
4.2.4.1 Root causes of the threats to ecosystem loss



4.2.4.2 Root causes of the threats to species loss



4.2.4.3 Root causes of the threats to genetic resources loss



It must be stressed that the above causal chain analysis is very preliminary, and the Nepal Biodiversity Strategy Implementation Plan will provide an opportunity for the analysis to be reviewed with the broad participation of stakeholders, including local communities. However, the results obtained above are very indicative of some of the origins of the threats to biodiversity in Nepal. These can be summarised as follows:

- Low level of public awareness and participation
- High population pressures and incidence of poverty
- Weak institutional, administrative, planning and management capacities
- Lack of integrated land and water use planning
- Inadequate data and information management
- Lack of policies or strategies for biodiversity conservation

These and any other fundamental problems that are identified through a broader-based analysis hold the key to the successful conservation of biodiversity in Nepal. Some more proximate causes might attract higher priority for action for a number of reasons, and may well lead to an improved situation. However, until the fundamental problems and root causes are addressed, such successes are not likely to be sustainable and the problems will reappear.

5 STRATEGIES TO CONSERVE BIODIVERSITY

Despite several problems and constraints, Nepal has achieved some significant successes in the protection and management of its biodiversity. The NBS will be helpful in obtaining a more cohesive and strategic thrust and direction in meeting clear national objectives for conserving the country's rich biodiversity. One fundamental element of this strategy is the consolidation and continuation of efforts that have been successful in the past; these are discussed first in this chapter. This chapter broadly highlights major strategies that Nepal will adopt to conserve, in the years to come, its exceptionally rich life spread over the different ecological realms.

5.1 Cross-Sectoral Strategies

5.1.1 Landscape Planning approach

The NBS will strive towards an improvement in the degree of representation and the effectiveness of the Protected Areas System and adjoining areas for the protection of biodiversity. The NBS recognises the need for a comprehensive approach that will aim to conserve forests, soil, water, and biological diversity while at the same time meeting the basic needs of people who are dependent on these resources for their livelihoods. To this end, the NBS has adopted the landscape planning approach to protect and manage biodiversity on a sustainable, long-term basis. Declaring buffer zones around national parks and reserves in view of developing compatible land use patterns adjacent to PAs to simultaneously address the growing needs of the people and the rapidly decreasing natural cover is an effective initiative in landscape conservation. Efforts will be made to link PAs with wildlife-friendly corridors.

5.1.2 Integrating local participation

It has been realised that conservation programmes will work only if the basic needs of local people are met, which include being able to grow enough food, effective health care, and basic education. Once these basic needs are met, local people may be responsive to conservation. However, communities in Nepal have a long history of protecting certain forested areas for their own benefit, and after the political change in 1990 and the introduction of democracy, decentralisation, and peoples' participation in development activities increased. To enhance responsiveness and promote ownership of conservation programmes by communities, the active involvement of local people will be sought in conservation management systems.

5.1.3 Institutional Strengthening

The National Biodiversity Unit established under the MFSC will be strengthened to cover all forest biodiversity and to be integrated into cross-sectoral agencies/organisations, in particular with the Ministry of Agriculture. This latter needs to help develop a comprehensive database of Nepal's agrodiversity.

5.1.4 *In-situ* Conservation

The most important means of conserving biodiversity is to conserve natural habitats that maintain and allow the recovery of viable populations of species naturally. As the primary approach for biodiversity conservation, *in-situ* conservation addresses the conservation of ecosystems, wild species, genetic diversity, human-created plant varieties and animal breeds. It also addresses the rehabilitation and restoration of degraded ecosystems, both within and outside protected areas, and the prevention, control and eradication of alien species that threaten ecosystems. *In-situ* conservation is more effectively maintained from a landscape planning approach. Priorities will be given to species richness, taxonomic diversity, and endemism.

5.1.5 Strengthening the National Biodiversity Unit

Systematic databases on conservation, utilisation, management, and monitoring have been prepared by various organisations. A high priority will be given to strengthening the existing National Biodiversity Unit and for full participation by all key stakeholders to bridge the information gap for comprehensive biological inventories and monitoring schemes.

5.1.6 Increasing Support for Biodiversity Research and Conservation

Large amounts of financial resources will be needed for biodiversity conservation. Since such expenditures are really investments for future ecological, economic and social security, especially in developing countries, high priorities will be given to increasing financial and technical support for biodiversity research and conservation. This can be done through partnerships and collaborative approaches with relevant line agencies. The CBD obligates developed countries to provide new and additional financial resources to developing countries and requires that this shall operate within a democratic and transparent system of governance.

5.1.7 Endorsing Indigenous Knowledge and Innovations

Humans are intimately linked to biodiversity, and any efforts to conserve biological diversity and the sustainable use of its resources must take into consideration human culture. Indigenous knowledge of biodiversity is a well organised, dynamic system of investigation and discovery that yields information beneficial to its long-term conservation. Indigenous knowledge and innovations pertinent to the conservation of biodiversity will therefore be fully acknowledged and used wherever possible, at the same time providing optimum benefit to local indigenous communities in a sustainable manner.

5.1.8 Cross-Sectoral Co-ordination and Implementation of Policies

Co-ordination and implementation of policies for conservation and sustainable use of biological resources requires their integration into national decisions. For this, Nepal will (a) develop anticipatory policies for the conservation of biological diversity and the sustainable use of its components; (b) establish better co-ordination between relevant agencies and different levels of government; and (c) re-assess national income to take into account the depletion of biological resources.

5.1.9 Enhancing National Capacity

Biological research and conservation management cannot effectively take place without adequately trained human resources. Realising this, priority will be given to institution building, human capacity building, and the transfer of hard and soft technology to effectively conserve and utilise components of biodiversity.

5.1.10 *Ex-situ* Conservation and Biotechnology

Ex-situ conservation refers to the conservation of components of biodiversity outside of their natural habitats, particularly animal and plant species whose existence in their natural habitat is below the minimum viable population and whose survival is imperilled. Emphasis will be given to establishing new botanical gardens, zoos, gene banks, etc., in different eco-regions with legal provisions for exchanging materials (components of biodiversity) with relevant international institutions.

5.1.11 Securing Intellectual Property and Farmer Property Rights

Intellectual Property Rights (IPRs) allow private individuals/entities to own, control, regulate access to, and appropriate benefits accrued from a resource of their discovery/creation. The role of IPRs in biodiversity conservation is ensured through a number of treaties and conventions, including the CBD. Nepal will ensure the IPRs of farmers and local communities through appropriate strategies and legislation.

Similarly, farmer's rights in Nepal will focus on rights arising from past, present and future contributions in conserving, improving and making available plant genetic resources, particularly those at the origin of diversity in Nepal. These rights will be vested in the international community as trustee for present and future generations of farmers and for supporting their continued contributions.

5.1.12 Biodiversity Prospecting

Biodiversity prospecting is the exploration of biodiversity for commercially valuable genetic and biochemical resources. Nepal needs to select national priority areas in bio-prospecting for focused research and development. For this, rules of conduct will be developed and enforced, and efforts will be made to control the export of large quantities of crude plants collected throughout the country for meagre quick profits. In addition, national and local capacities will be developed and international collaboration will be sought wherever possible.

5.1.13 Environmental Impact Assessment

The Environment Protection Act, 1996, and Environment Protection Regulations, 1997, obligate HMGN to undertake environmental impact assessments of its proposed projects that are likely to have significant impacts on biodiversity with a view to avoiding or minimising such impacts. Emphasis will be given to ensure effective implementation of existing rules and regulations regarding environmental impact assessments.

5.1.14 Women in Biodiversity Conservation

The vital contribution of women to the management of biological resources and to economic production generally has been misunderstood, ignored, or under-estimated. Rural women in Nepal are often the most knowledgeable about the patterns and uses of local biodiversity. Therefore, the role of women in biodiversity and natural resource management will be fully recognised and given their due consideration, and their participation in decision-making will be sought.

5.1.15 Developing Eco-tourism

Tourism in Nepal is concentrated mainly in a few protected areas (Royal Chitwan NP, Annapurna CA, Sagarmatha NP, and Langtang NP), which intensifies negative environmental impacts in these PAs. The potential for developing sustainable tourism in other PAs as well as other areas of natural and cultural heritage will therefore be explored and promoted. Efforts will also be made to seek maximum involvement of local people in promoting sustainable tourism.

5.1.16 Increasing Conservation Awareness

Biodiversity conservation demands public support and participation. An understanding and appreciation of the importance of conservation and sustainable use of biological resources is therefore crucial. For this, conservation awareness campaigns will be promoted through different media and fora, such as radio, newspapers, posters, workshops, seminars, and school curricula so that both managers and users of natural resources understand the linkages between conservation and sustainable use.

5.1.17 Biodiversity Registration

Biodiversity registration aims to: (a) document the rich traditional knowledge of indigenous peoples, (b) share local knowledge of bioresources with other communities in the country and abroad for mutual benefit, and (c) conserve local traditional knowledge for the sustainable utilisation and equitable sharing of the benefits of natural resources through the active support and participation of local communities. National biodiversity registration will be initiated with recognition of indigenous knowledge, to avoid misappropriation of local farmers' crop varieties and of all genetic resources, and to ensure equitable sharing of benefits in the future. The programme will in the long-run help to validate the information thus recorded, create a network of databases, provide pertinent information on trade and exploitation, and monitor biodiversity and management plans.

5.2 Sectoral Strategies

5.2.1 Protected areas

5.2.1.1 New Models of Protection and Management

Until now, conservation of threatened species in Nepal entailed the establishment of PAs guarded by the Royal Nepalese Army. This approach is still largely applicable in the Terai to respond to the enormous human and commercial pressures on the Terai/Siwalik Hills PAs. However, reliance on the army alone for protecting PAs should be reduced given the high cost of mobilising the army. New models of PA management have been developed in the highlands and mountains, in the Annapurna, Kanchenjunga and Manaslu Conservation Areas, where the army is not involved. Efforts will be made to extend this approach to other PAs. A management information system will be established for all PAs.

5.2.1.2 Inadequate Co-ordination

Inadequate co-ordination between certain institutions and organisations with the DNPWC and between the DNPWC and other Government offices is apparent. There is very little cross-sectoral co-ordination of projects and programmes within the government in general. Effective cross-sectoral co-ordination will be established for the conservation of biodiversity in and around PAs.

5.2.1.3 Capacity enhancement

Emphasis will be given to effectively use the Research and Training Centre for Protected Areas to regularly train staff and local communities in integrated landscape conservation and management. DNPWC staff's capacity to conserve and manage biodiversity will be strengthened.

5.2.1.4 Representation of all ecosystems in PAs

The Mid-hills have the greatest ecosystem diversity of all of Nepal's physiographic zones. However, the remaining undisturbed ecosystems are seriously threatened by increasing human activities and are insufficiently represented in the PA system. Priority will be given to establishing new PAs to incorporate these ecosystems, which have a rich biodiversity and which are not represented within the existing PA system. Existing PAs and their buffer zones will be extended where applicable.

5.2.1.5 Biodiversity Inventories

The biodiversity of the existing PAs has not been comprehensively studied at ecosystem, species, and genetic levels. A comprehensive survey of the biodiversity of PAs will be urgently undertaken to assess the status of diversity and its ecological significance.

5.2.1.6 Exchange of Information

There is little exchange of information on biodiversity within Nepal. Scientific papers published in journals in languages other than Nepali or English are not easily accessed. The inadequate flow of information often leads to duplication of work. A mechanism will be developed to strengthen existing information networks and to make the information more user-friendly.

5.2.1.7 Species Conservation Plan

A species conservation plan that focuses on keystone species has not been given due priority. The loss of such species from an ecosystem impacts the survival of other species within the ecosystem. Species conservation action plans will be developed and implemented targeting keystone species in all the PAs of the different physiographic zones. The plans will emphasise population surveys, monitoring, protecting key habitats, and relocation and restoration of certain species.

5.2.1.8 Management of Protected Area Tourism

The high concentration of tourists in certain PAs has brought about negative environmental impacts. To address these issues, an Integrated Tourism Management Plan will be developed and implemented. Involvement from the private sector will be encouraged.

5.2.2 Forests

5.2.2.1 Forest Rehabilitation

Most areas important for biodiversity are not pristine but have been influenced by human activities. Emphasis will therefore be given to revitalise the degraded ecosystems and to restoring the flora and fauna.

5.2.2.2 Inventory of Flora and Fauna

A comprehensive inventory of the flora and fauna, including micro-organisms, will be undertaken through out the country. Emphasis will be given to the Terai and Siwalik Hills, whose flora and fauna have not been as well explored as in other parts of the country, in particular the lower groups of life.

5.2.2.3 Ecosystem Network and Representation

The most effective way of maintaining biological diversity is to protect a representative array of ecosystems. Therefore, a network will be designed to represent all ecosystems in Nepal with particular emphasis on: (i) tropical evergreen forests, (ii) far-eastern subtropical forests, (iii) lower temperate broad-leaved forests, and (iv) subtropical broad-leaved forests located in the west of the country. These forest types would be best represented in the districts of Kaski, Lamjung, Tanahu, Lalitpur, Udayapur, Taplejung, Sankhuwasabha, Bhojpur, Terathum, Dhankuta, Ilam, Morang, and Jhapa, which have a rich biodiversity, especially of mammals and birds.

5.2.2.4 Understanding Forest Resilience and Biodiversity

Understanding forest resilience and monitoring biodiversity are vital for the sustainable use of community forests. Steps to maintain biodiversity to support subsistence agriculture and livestock management will be undertaken. Forest biodiversity will be maximised to increase the ability of local organisations to undertake sustainable development efforts.

5.2.2.5 Local Participation

The community forestry approach requires more discussion amongst all levels of management, including government, NGOs, INGOs, donors, politicians, and forest user groups. The role of local people, particularly women, in forest biodiversity conservation will be recognised and integrated from the onset of biodiversity conservation programme planning and implementation.

5.2.2.6 Strengthening Management Practices

A major weakness of community forestry is that not all forest users were equally represented in community forestry management. Adequate attention will be paid to identify all users and to inform them of their rights and responsibilities. The involvement of disadvantaged groups and women in community forestry management will be ensured.

5.2.2.7 Sustainable Harvesting

It is expected that eventually, all the Mid-hill forests will be managed as community forests by the communities themselves. However, some forest management practices have negative implications for biodiversity, such as the removal of undesired species and their replacement with monocultures, and collection of all dead trees and branches and of leaf litter. Forest user groups will be given training to manage blocks of forests, as they are officially divided, on a rotational basis, which will allow sufficient time for plant regeneration in 'fallow' forests. Technical knowledge will be provided in sustainable harvesting of forest resources.

5.2.2.8 Non-Timber Forest Products

It has been observed that all levels of management, from user groups and individual farmers to forestry staff, customs officials and other organisations working with NTFP resources, do not have adequate information to work with. A baseline survey of NTFPs will be undertaken for their better understanding and management.

5.2.1.9 Religious Forests Management

Religious forests often provide important refuge for wildlife. A biodiversity inventory of religious forests will be made to identify important clusters or significant areas with high conservation values. An overall management plan will be formulated and implemented to manage these areas.

5.2.3 Rangelands

5.2.3.1 Need for a National Rangeland Policy

There is lack of clear rangeland policy in Nepal. Policies for pastoral areas will acknowledge the efficiency of traditional pastoral practices and seek to understand range resource dynamics and current land use practices. Incentives will be established to encourage herders to adopt better technologies and practices. In order to better integrate biodiversity conservation with range livestock development, rangeland policies will emphasise multiple-use management practices.

5.2.3.2 Conservation of Rangeland Biodiversity

Conservation of rangeland biodiversity will focus on (a) research on range wildlife ecology and wildlife habitat, wildlife-livestock interactions, and indigenous pastoral management, (b) awareness campaigns and environmental education, (c) management of stoking rates/sale of unproductive animals, (d) rehabilitation of overgrazed ranges, (e) creation of a biodiversity database, (f) control of illegal hunting, (g) introduction of improved forage, (h) incorporating indigenous knowledge into development plans, (i) creating off-farm employment opportunities, (j) promoting appropriate land ownership rights/legislation tenure, and (k) establishing practical monitoring systems.

5.2.3.3 Pastoral Development and Management in the Himalayas

Pastoral development and management in the Himalayas will include: (a) capacity building of professionals and locals, (b) creating opportunities for the two-way exchange of information between pastoralists and professionals, (c) developing programmes to study traditional pasture systems and perceived problems, (d) improving forage/fodder resources, especially in winter, (e) improving people's participation and community organisations, (f) conducting applied rangeland research, (g) determining the extent and severity of rangeland degradation, (h) distributing available technology to pastoral areas, (i) developing seed and gene banks, and (j) developing snow-melt water collecting techniques.

5.2.3.4 Forage Development through Integrated Management Planning

Pastoral development will take place in the context of the following priority actions: (a) establishing forage and hay crops, (b) developing appropriate technologies for fodder conservation, (c) using fallow and marginal land for forage cultivation, (d) establishing hay meadows, (e) improving profitability of livestock rearing and crops, (f) supporting seed production of forages, (g) integrating food-forage crop systems, (h) promoting silage technology, (i) conducting improved feeding demonstrations, (j) testing winter forage species, (k) conducting training on forage conservation, (l) establishing forage production user groups, (m) emphasising year-round forage production, (n) introducing forages with low water and mineral requirements, (o) creating agencies to distribute forage seeds to pastoralists, (p) promoting stall-feeding, (q) conducting research to identify forages for high altitude zones, (r) introducing improved varieties of livestock, and (s) strengthening indigenous management systems and trans-boundary co-operation with China.

5.2.4 Agrobiodiversity

5.2.4.1 Participatory Plant Breeding

Participatory plant breeding ensures that local landraces are fully integrated into breeding strategies. Participatory plant breeding has been proved to be one of the most effective innovative approaches for increasing the diversity of rice varieties in Nepal. A high priority will be given to adopt participatory plant breeding approaches for other important crops in Nepal.

5.2.4.2 Participatory Variety Selection

With participatory variety selection, farming communities can identify their preferred crop varieties/landraces suitable for specific environments. Thus, participatory variety selection will be promoted to best address the needs of communities while strengthening on-farm conservation of indigenous crop genetic resources.

5.2.4.3 Gene Bank

An inventory of valuable plant genetic resources will be maintained within communities, and the information shared between areas with similar growing conditions to facilitate germplasm exchange. Valuable germplasm will be conserved in gene banks to allow easy access by small farmers. Gene banks will provide communities with direct access to germplasm, which will be conserved through use.

5.2.5 Wetlands

5.2.5.1 Management of Wetlands

Strategies to promote the sustainable safeguarding of wetland habitats will cover the following activities: (a) development and implementation of a unified national wetland policy and legislation, (b) research on wetland resources to make scientific data available – field-based, participatory research would be more beneficial at the outset, (c) identification of critical wetland habitats and declaring them protected areas, (d) updating and improvement of the existing wetlands directory and database, (e) identification of an institution responsible for co-ordinating the wise use and conservation of wetlands, and to work on resolving land-use conflicts, (f) adoption of a bioregional approach to wetland habitat and resource management, (g) encouragement of participation by user groups and community-based organisations in a collaborative management of the resources, (h) conducting demonstration projects to promote wise use of wetland habitats and resources, and (i) raising awareness in wetland conservation.

5.2.6 Mountain Biodiversity

5.2.6.1 National Mountain Policy

A unified mountain law may not be desirable or even possible in Nepal, since community forestry regulations devolve rights, responsibilities, and benefits to local user groups. However, a national mountain policy will be developed to lay the foundation for mountain biodiversity management principles, which can later be

elaborated into legal rules. Mountain livestock genetic resources, an important source of cold tolerance and productivity adaptation, will be documented.

5.2.6.2 Integrated Management

Indigenous mountain peoples posses invaluable knowledge regarding the conservation and sustainable use of biodiversity. Legislation will be developed to effectively address the biogeographical, economic and cultural realities of mountain domains in order to promote the well being of people dependent on mountain resources and to foster and ensure community-based strategies for mountain biodiversity conservation.

5.3 Commitments to address the most serious threats to biodiversity

With the development of this Biodiversity Strategy, the Government of Nepal is indicating commitment to conservation of biological resources and their diversity in Nepal. This Strategy, while documenting successful mechanisms already in place towards this end, also provides a platform for the development of new policies and initiatives to address existing gaps.

One of the first activities to come out of this Strategy will be the formulation of an implementation plan. The National Biodiversity Strategy Implementation Plan (NBSIP) will have a five-year scope and should be incorporated in the National Development Plans. The NBSIP will target the root causes of the major threats to biodiversity identified in this strategy after these have been confirmed through a broad, participatory consultation process.

It is recognised that local authorities can be very effective in biodiversity conservation and sustainable use. If biodiversity considerations are not devolved to local government decision-makers, central government efforts are likely to remain ineffective. It is not possible for central government ministries and departments to ensure the sustainable use and conservation of the biological diversity of Nepal's 75 districts without the active involvement of local government bodies.

In order to involve local government, a District Biodiversity Committee (DBC) will be established on a trial basis in each of selected districts. These districts will be those with a rich biodiversity and where traditional farming methods are still applied. The Committees will be chaired by the DDC Chairperson and will have representation from VDCs, members of the municipalities and relevant district level government agencies. The District Forest Officer will serve as member secretary and the District Forest Office as the secretariat. Over time, similar committees will be set up in all districts. The initial goal will be to raise awareness of and train local authorities in biodiversity conservation and management by providing them with hands-on experiences. Once their capacity has been built, they are expected to be able to protect their constituents' rights and biological capital.

5.4 Criteria for ranking existing threats and prioritising action

According to Hagen (unpublished), the CBD COP identified the following priority areas for consideration by countries developing Biodiversity Strategies and Action Plans:

- Development of integrated national strategies for the conservation of biological diversity and the sustainable use of its components;
- Strengthening the conservation, management and sustainable use of ecosystems and habitats identified as priorities by national Governments in accordance with Article 7;
- Identification and monitoring of wild and domesticated biodiversity components, in particular those under threat, and implementation of measures for their conservation and sustainable use;
- Capacity building, including human resource development and institutional development and/or strengthening, to facilitate the preparation and/or implementation of national strategies, plans for priority programmes and activities for conservation of biological diversity and sustainable use of its components;

- Development of innovative measures that create economic incentives for biodiversity conservation and that compensate local communities that incur opportunity costs associated with its conservation;
- Strengthening the involvement of local and indigenous people in the conservation and sustainable use of biodiversity;
- Conservation and sustainable use of threatened coastal and marine resources and of the biodiversity of environmentally vulnerable areas such as arid and semiarid and mountainous areas;
- The conservation and sustainable use of endemic species; and
- The integration of social dimensions, including those related to poverty, into the conservation and sustainable use of biodiversity.

However, it is acknowledged that not all the above will apply to all countries, and even where they may, Governments are still faced with making decisions on the basis of relative priorities. The following, also from Hagen (unpublished), is a list of potential criteria that may be used or built upon for setting priorities:

Scientific and Ecological Criteria

- Give priority to ecosystems with the highest species diversity;
- Give priority to ecosystems with the highest levels of endemism;
- Give priority to ecosystems that include rare, endangered, and/or threatened species, especially of higher animals and plants;
- Give priority to ecosystems that are the most pristine;
- Give priority to the conservation of unique ecosystems that do not exist elsewhere;
- Give priority to the conservation of areas large enough to maintain viable populations of key species of animals and plants (most population ecologists agree that when a population falls to around 50 individuals, it is in imminent danger of disappearing);
- Seek to conserve representative areas of all types of ecosystems within a country;
- Give priority to natural areas that play key ecological functions (such as critical watersheds); and
- In general, at the species level, give priority to the conservation of higher plants and animals.

Socio-Economic Criteria

- Give priority to natural areas and species of higher economic value;
- Give priority to the conservation of wild and primitive relatives of crop plants and domesticated animals;
- Give priority to natural areas and species of particular cultural/historical/religious interest; and
- Give priority to ecosystems and assemblages that give Nepal its unique ecological character.

6 MECHANISMS FOR ACTION

6.1 THE ROLE OF GOVERNMENT

Being the focal point of the Convention on Biological Diveristy, the overall responsibility for implementing the NBS will lie with the MFSC. The relevant ministries and departments are responsible for implementation of their sectoral biodiversity plans. The National Biodiversity Co-ordination Committee (NBCC) will facilitate inter-sectoral co-ordination during NBS implementation and oversee monitoring and evaluation.

The National Biodiversity Unit (NBU), under the Environment Division of the MFSC, will act as the secretariat for the NBCC and will serve as the forum for information exchange between government line agencies, NGOs, and the private sector during implementation of the NBS. The NBU will also prepare status reports to be submitted to the Secretariat of the CBD at five-year intervals.

The Ministry of Population and Environment will also play an important role in the long-term implementation of biodiversity conservation in Nepal through the application of the Environment Protection Act, 1996, and Regulations, 1997. The rigorous application of environmental impact assessments will be essential for eliminating and mitigating potential threats to biodiversity arising from development projects. However, the MOPE needs to put more emphasis on enforcement of mitigation measures as prescribed in the EIA reports and monitoring such activities, and taking action against those violating the prevailing laws.

The Department of Plant Resources and the Department of Forest Research and Survey, in collaboration with various research institutes, will continue to conduct flora and fauna inventories and research e.g. on biodiversity assessment and monitoring.

The NBS will be implemented through project activities outlined in the periodic Nepal Biodiversity Implementation Plans (NBIP). The first 5-year NBIP will be for the years 2002 – 2007. Effective implementation of the NBS will require the creation of the following two bodies:

- National Biodiversity Co-ordination Committee (NBCC)
- Thematic Sub-Committees (TSC)

These and a Biodiversity Co-ordinator (BC) are discussed below. The relationships between these organisations are presented in the organogram at the end of this chapter.

6.2 ORGANISATIONAL STRUCTURE FOR IMPLEMENTATION OF THE STRATEGY

6.2.1 THE NATIONAL BIODIVERSITY CO-ORDINATION COMMITTEE

A National Biodiversity Co-ordination Committee (NBCC) will be established, composed of one senior level representative from each of the relevant government ministries, the private sector, civil society, and major donors – 12 to 15 members in all. The minister of MFSC, the lead ministry for the CBD, will chair the NBCC and the secretary of the MFSC will be the member secretatry of the NBCC. Advisors and other participants will attend as observers by invitation in the NBCC meeting. The NBCC will meet every six months, more frequently if required, and business will be conducted on consensus.

The primary task of the NBCC will be to develop policies for consideration by Government and provide institutional, political, and operational guidance for the implementation of the NBS through the NBIP. It will be the NBCC's responsibility to ensure that projects and activities remain within the Strategy framework according to the objectives adopted herein. The NBCC will also provide oversight for all components of the Implementation Plan and facilitate co-operation between projects across different sectors and the donor community.

A Biodiversity Co-ordinator will ensure that the NBCC achieves its goals (see below). The co-ordinator will attend meetings. The Co-ordinator will be responsible for NBCC policy implementation and direction, and for keeping the NBCC informed on progress with all aspects of NBS implementation.

The NBCC will be accountable to the Government through the lead minister. It will approve and publish the Annual Biodiversity Report for Parliament and the Nepali People, which will include:

- a comprehensive report on progress over the previous year
- a report on projects completed
- an evaluation of projects ongoing
- new projects to be initiated
- a report on the work envisaged over the following year

This annual report could form the basis of Nepal's Report to the Conference of Parties of the CBD.

The work of the NBCC will be funded through the Biodiversity Trust Fund or any other source agreed upon by the committee.

6.2.2 THEMATIC SUB-COMMITTEES

The NBCC will establish five sub-committees to address the five Biodiversity Themes identified in the CBD, namely:

- Forest Biodiversity - including Protected Area ecosystems and species (*in-situ* and *ex-situ*)
- Agricultural biodiversity
- Sustainable use of biological resources
- Genetic resources
- Biosecurity

Each sub-committee will be made up of 3-4 members and will be chaired by a senior official of that sub-committee. NBCC may nominate 1-2 technical experts in each of the TSCs. The chairperson of each sub-committee will be a member of the NBCC; however, additional, valuable expertise may be brought into the committees.

The tasks of each sub-committee are to:

- ensure that the theme for which they are responsible is adequately addressed in the work envisaged in the Implementation Plan;
- serve as a clearinghouse for ideas, proposals and initiatives on the particular theme;
- serve as a forum where the comparative merits of proposals can be debated and from where a consensus view can be taken to the plenary NBCC;
- serve as the expert group in the particular theme for matters of policy, direction, etc., (technical and advisory aspects).

Each Thematic Sub-Committee will meet at least every six months, prior to the NBCC meeting.

6.2.3 NATIONAL BIODIVERSITY UNIT

The National Biodiversity Unit (NBU) under the Environment Division of the MFSC manages the implementation process of directions and policies provided by the NBCC and according to the NBS and NBIP.

The NBU is a small team of professionals led by the Biodiversity Co-ordinator under the Environment Division. It is responsible for day-to-day administration, and management of programmes including financial resources, co-ordination between Thematic Sub-Committees and projects, monitoring, reporting on progress, providing support and technical advice to project managers, information management, etc on behalf of the Government. The NBU will be composed of the Bio-diversity Co-ordinator, assitant Biodiversity Officer, secretary, an administrative assistant, a public relations officer, a data and information expert, and other clerical and support staff as required.

6.2.4 BIODIVERSITY CO-ORDINATOR

The Biodiversity Co-ordinator will be the head of NBU and will serve as manager under the supervision of the chief of the Environment Division, to work on the implementation process. This is a full-time Government position from the MFSC with executive authority and adequate flexibility. The Biodiversity Co-ordinator will be an experienced person in the field of biodiversity conservation and environmental protection and management. The Co-ordinator will be a recognised person for his/her accomplishments and have credibility and the respect of colleagues and the conservation community. The Co-ordinator will have excellent interpersonal skills and have effective oral and written communication ability with politicians and senior decision-makers as well as with scientists, technical experts, industrialists, educators, NGOs, community leaders, special interest groups, the private sector, donors and the general public. The Biodiversity Co-ordinator is accountable to the Government, the NBCC and the Chief of the Environment Division. The Biodiversity Co-ordinator has ultimate responsibility for delivery of the NBS outputs and for its ultimate success, but can only achieve this with full support and collaboration from everyone involved in the implementation of the NBIPs.

6.2.5 THE ROLE OF NON-GOVERNMENTAL ORGANISATIONS

The non-governmental community will continue to be a central player in biodiversity conservation in Nepal during implementation of the NBS.

The King Mahendra Trust for Nature Conservation, UNDP, IUCN-Nepal, The Mountain Institute, and WWF-Nepal will join HMGN in the implementation of integrated conservation and development projects and in other specific areas. Concerned national NGOs and community-based organisations will be mobilised to undertake conservation and development activities. ICIMOD will contribute its expertise in the implementation of integrated mountain development programmes.

6.2.6 THE ROLE OF UNIVERSITIES AND RESEARCH INSTITUTES

The Institute of Science and Technology, the Institute of Forestry, and the Institute of Agriculture and Animal Sciences of Tribhuvan University will be engaged in biodiversity research, either independently or in collaboration with government line agencies. The Royal Nepal Academy of Science and Technology, among other research institutions, will support the implementation of biodiversity conservation programmes.

The National Agriculture Research Council, the National Agriculture Research Institute and the National Animal Science Research Institute will address genetic diversity in crop and livestock species.

The centres such as musk deer research at Godawari and the Centarl Zoo (to some extent) will serve as *ex-situ* centre for the conservation of endangered fauna. The Botanic Garden and Conservatories (eg. Brindavan, Tistung and Mai Pokhari) will serve as *in-situ* and *ex-situ* centres for plant conservation.

6.3 PUBLIC PARTICIPATION

6.3.1 THE ROLE OF THE PUBLIC

There is a strong commitment to make the implementation of the NBS a participatory one. Public participation will be based on effective public information and education campaigns aimed to raise environmental sensitivity and awareness.

In addition to the usual invitations for dialogue, submissions, and objections, it is planned to involve the public at the planning stages of resource use as well as in the bioresources management process. This will avoid confrontational situations and transform opposition into co-operation. Projects under the NBSIP will present real and practical opportunities that will be made available for public participation, and will identify any barriers and how they will be overcome.

It has been realised that conservation programmes will work only if the basic needs of local people are met, which include being able to grow enough food, effective health care, and basic education. Once these basic needs are met, local people may be responsive to conservation. However, communities in Nepal have a long history of protecting certain forested areas for their own benefit, and after the political change in 1990 and the introduction of democracy, decentralisation and public participation in development activities have increased. To enhance responsiveness and promote ownership of conservation programmes by communities, the active involvement of local people will be sought in conservation management systems. The NBS will foster empowerment of local people by making them integral actors in conservation planning and implementation.

Efforts to minimise human impacts on PAs have historically focused on guard patrols and penalties for encroachment and illegal activities. The NBS recognises that successful management of PAs ultimately depends on co-operation and support from local people. Equally important, the NBS will ensure that disadvantaged people barred from exploiting resources from a PA on which they traditionally depended will be provided with alternative means of subsistence. Most national parks of the world would not last very long if handed over entirely to local people (Anonymous 1996). There needs to be a balance between national and local needs. The NBS will seek to do this through community-based conservation by delineating buffer zones around park boundaries as areas where both conservation and development-related activities will be implemented, and by adopting new approaches to management that reflect greater participation by local people in both fields (Wells & Brandon 1993).

6.3.2 ESSENTIAL ELEMENTS OF PUBLIC PARTICIPATION

The NBS has adopted the following elements (CORE 1995) as essential for public participation:

6.3.2.1 Rights and responsibilities

Meaningful public participation in decision-making is both fair and essential. This reflects a change in how public participation is perceived, particularly for developing an effective approach to managing land use conflicts. Greater public participation should not be a privilege granted at the discretion of decision-makers - it is a fundamental right that in the past has received inadequate recognition.

HMGN has acknowledged people's right to participation in land use and resource management decisions by approving the Buffer Zone Management Regulations, 1996, and the Buffer Zone Management Guidelines, 1999. Key points in the legislation are that:

- 30-50% of the revenue derived from national parks will be made available for community development in the buffer zone, channelled through the Warden and the Buffer Zone Development Committee
- the basic community structure for participation in development and other activities will be the User Committee

6.3.2.2 Public participation policy

People will be involved in decision-making and have a significant impact. When participation is called for, the appropriate form may range from a simple exchange of information to extensive public negotiations.

Forest Management The community forestry programme works through a community-based approach for the conservation of forests by forging partnerships between village-based user groups, user committees and specialised community functional organisations. These are based on self-reliance and contribute to the conservation of forests and resources found within them. Forest user groups manage community forests according to the MFSC's operational plan.

Management of Terai and Siwalik Hills Forests A Cabinet decision made by HMGN in May 2000 provides guidelines for the management of Terai and Siwalik Hills forests. A collaborative forest management approach is to be applied to allow forests and their biodiversity to improve through natural processes. The Siwalik Hills zone, which occupies 12.8% of Nepal's total area, has been plagued by complicated institutional, natural and anthropogenic problems (Oli 1999), the most serious of which are soil erosion, degradation of catchment areas, and diminished productivity. This high-risk area will be managed as a Government-managed Protected Forest by maintaining permanent ground vegetation cover. Soil conservation and watershed management programmes will be implemented in an integrated manner. 25% of the income generated by the communities from the forest will be provided to local government bodies (VDCs and DDCs) to implement local development activities, and the central government will collect 75% as revenue.

6.3.2.3 Framework for participation

While the overall goal of integrated conservation development projects is to conserve biological diversity, specific project activities focus on people and their attitudes. Most integrated conservation development projects emphasise local participation by encouraging people to become active and make use of their capacities, to be social actors rather than passive subjects, to manage resources, make decisions and take control of activities that affect their lives (cf. Wells & Brandon 1993). The NBS will continue with integrated conservation development projects. Where guard patrols and policing is required to ensure responsible behaviour, the NBS will facilitate a more co-operative relationship between PA management and local people through public participation, making enforcement more acceptable by local communities.

The NBS has adopted the successful elements of the Parks and People Programme, implemented by the DNPWC with UNDP's financial and technical assistance since 1994, whose goal is participatory biodiversity conservation in buffer zones. The NBS will further the objectives of improving the socio-economic well-being of buffer zone communities and conserving biodiversity surrounding the PAs. Community mobilisation has been adopted as one of the most powerful measures to initiate people-centred conservation programmes by empowering buffer zone communities to be self-reliant and to undertake development and conservation activities. The NBS will support the Parks and People Programme's policy on the formation of separate groups for men and women to ensure active participation by women (DNPWC/PPP 1998).

Key policies of the Parks and People Programme on public participation that have been adopted in the NBS include:

- the empowerment and mobilisation of women for the conservation of natural resources and community development
- the formation of user groups under each user committee in order to guarantee fair representation within the committees, particularly the participation of women and people from lower castes

6.3.2.4 Protected Areas and Buffer Zone management

The establishment of PAs places restrictions on the use of resources found within them. Economic and other incentives can encourage community support and participation, thus eliminating or reducing pressures on PA resources and opposition by communities dependent on natural resources to the establishment of PAs.

A buffer zones is "a zone peripheral to a national park or equivalent reserve where restrictions placed upon resource use or special development measures are undertaken to enhance the conservation value of the area" (Sayer 1991). Buffer zone development is primarily focused on improving the socio-economic well being of local communities surrounding PAs whilst restricting access to the PA. Open access to PA resources is not sustainable in the long run (Sharma 1991). Conservation programme are designed to meet local needs and reduce the dependency of local people on PA resources by developing an alternative natural resource base in the buffer zone. This strategy includes organising local communities into users groups, improving their skills, providing opportunities for income generation activities, encouraging individual savings, and providing access to credit. Green enterprises, including eco-tourism, are promoted with strategies to minimise negative environmental impacts and to maximise socio-economic benefits at the local level.

6.3.2.5 Ecosystem landscape management

In the Ninth Five-Year Plan (1997-2002), emphasis has been placed on proper land use management for higher economic benefits by increasing agricultural productivity as well as maintaining a healthy environment. It is indispensable to protect biodiversity, forests, and water, and to ensure sound land use according to the particular social and economic circumstance and the quality and capacity of the land. Therefore, the programmes in the Ninth Five-Year Plan have emphasised greater public awareness of land use issues.

6.3.3 INVOLVING NGOS AND CIVIL SOCIETY

HMGN reiterates that the protection and management of biological diversity in Nepal is seen as the Government's responsibility on behalf of the people of Nepal. However, while accepting the lead role, HMGN welcomes the participation of NGOs and civil society to complement its work in partnership.

The role of NGOs has become increasingly important in local, people-oriented development activities and in extending services and facilities at the grassroots level. However, only a few NGOs are well organised, have sufficient resources and are effective. As in the Ninth Five-Year Plan, the NBS emphasises mobilising NGOs to contribute to socio-economic development projects and encourages their activities in the poor, remote regions of the country.

Local people and commercial enterprises harvest significant quantities of medicinal herbs and other NTFPs from the wild, including from PAs. Given the rich biodiversity of Nepal, the NBS recognises the potential for commercialisation of these natural resources, for example ornamental plants (both plants and seed) or the production of allo cloth and lokhta paper. The challenge is to provide guidelines, incentives, and controls to ensure the sustainability of these enterprises and to directly benefit PAs (McNeely 1999).

6.4 FINANCIAL RESOURCES

6.4.1 Nepal Trust Fund for Biodiversity

The proposed Nepal Trust Fund for Biodiversity, with capital from a number of sources (GEF, bilateral, multilateral, private sector and the Government), has been entrusted to the "Design Working Group", which is composed of representatives from the MFSC, the DNPWC, the King Mahendra Trust for Nature Conservation, The Mountain Institute, IUCN-Nepal, and WWF-Nepal. The Fund will be constituted as a legal, autonomous, and tax-free entity by a specific Act of Parliament. The Board of Directors will be independent from the Government and fully empowered to manage the Fund's capital and investment income.

The primary objective of the Fund will be to provide financial and technical support to government agencies, NGOs and other institutions involved in biodiversity conservation in Nepal to enable them to undertake appropriate activities and projects both within and outside of PAs. Priority will be given to existing biodiversity programmes of national and global significance that are under-funded. To this end, the Fund will support conservation education, training, applied research, sustainable income generation activities, poaching prevention and control, women-focused programmes, indigenous knowledge and practices, and policy development in accordance with national priorities (outlined in the NBS). The Fund will provide grants and raise funds, and will advocate for and promote biodiversity conservation.

The Board of Directors will consist of representatives from HMGN, local government, the private sector, national and international non-governmental conservation organisations, one donor agency, two independent biodiversity conservation experts, and one financial investment expert. The Board of Directors will be responsible for the overall management and direction of the Fund, and for setting Fund policy, electing the Chairperson, Executive Director, and Investment Manager, recommending amendments to the relevant Act, determining the Executive Director’s duties and powers, approving project activities and the annual budget, and monitoring and evaluating the extent to which the purpose and goals of the Fund are being met. The Board of Directors will call on experts for advice on technical, financial, fundraising, and legal matters.

The administration of the Fund will be entrusted to the Executive Director and a small administrative unit. An internationally qualified investment manager selected by the Board of Directors will assure the financial management of the Fund’s assets.

The Executive Director, in co-ordination with the Board of Directors, will regularly monitor and evaluate the activities funded by the Nepal Trust Fund for Biodiversity as well as the internal management of the Fund. Independent professional accountants will audit the Fund on an annual basis and, in addition to the annual programme review, external evaluators will conduct routine programme evaluations every year or two.

6.4.2 Other funding mechanisms

Management and operational expenses for PAs are covered by funds from various sources, including income generated from park entrance fees and from the DNPWC’s annual operating budget). Expenses for other ecosystems, such as forests, agricultural lands and wetlands, and for other conservation activities, are covered primarily by the regular Government budget. In order to generate more budgetary resources for conservation activities, biodiversity resource valuation studies will be undertaken. Income from these studies will be incorporated into the national income accounting system and will be used to justify increased budgetary allocations for the country’s conservation programmes.

Additional funding from external sources is also important. These sources will be tapped to support, in particular, conservation of ecosystems and species of global importance. In general, international donors are more inclined to extend funding assistance to biodiversity projects if they benefit not just to the country but a greater segment of the global community. One key element that enables Nepal to secure funding assistance from the international donor community is the fact that the country is signatory to several international conventions and agreements that provide mechanisms for funding assistance to countries in need of assistance in their conservation efforts. Examples include: the Convention on Biological Diversity, the Ramsar Convention on Wetlands, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, and the World Heritage Convention.

Nepal is also strengthening its links with different funding institutions such as the World Bank, the United Nations Development Programme, and the Global Environment Facility.

6.5 MONITORING AND PROGRESS INDICATORS

The NBS is putting in place an effective monitoring and evaluation process, based on measurable indicators, to assess its progress. This will be done in a transparent and accountable manner.

Monitoring will enable management to assess the progress of implementation and take timely decisions to ensure that progress is maintained according to schedule. It is an internal activity and an integral part of day-to-day management. Evaluation assesses overall programme effectiveness and impact, both anticipated and unforeseen (Kanel 1999b). The strategic objective of monitoring and evaluation of activities under the NBS is to measure the extent to which the three principles of the CBD are being achieved, namely:

- Conservation of biodiversity;
- Sustainable use of its components; and
- Fair and equitable sharing of benefits.

6.5.1 Biodiversity Monitoring

Biodiversity monitoring will include the following elements:

Monitoring of Habitats The Department of Forest Research and Survey will continue to periodically monitor changes in forest cover and density throughout the country. The outcome of the survey will be helpful in understanding the dynamics of habitat change in Nepal.

Monitoring of Ground Conditions Each PA will develop its own monitoring programme according to the guidelines provided by the DNPWC.

Monitoring of Indicator Species Some key species will be periodically monitored in forests, grasslands, agricultural lands, and wetlands. Surveys will be conducted by the Ministries of Forest and Soil Conservation, Agriculture, Water Resources, and Population and Environment in collaboration with relevant government and non-government organisations and academic institutions.

Monitoring of Benefit Sharing Periodic assessments will be carried out to find out the kinds of products and services used by various stakeholders. Individual projects will have a strong component on the monitoring of products/services and the actual benefits shared by different subgroups of stakeholders.

Monitoring of Management The effectiveness of the PA and conservation programme management regimes will be monitored ensure that natural resource use is sustainable. Each management plan will include a monitoring component whereby management procedures will be monitored and periodically evaluated.

Monitoring of Physical Parameters The Department of Soil Conservation and Watershed Management will monitor the level of soil and water erosion in the different agroclimatic zones of Nepal. The Ministry of Population and Environment will monitor indicators such as air pollution. Other departments and institutions will be involved in assessing parameters such as water pollution, and levels of carbon dioxide and greenhouse gases.

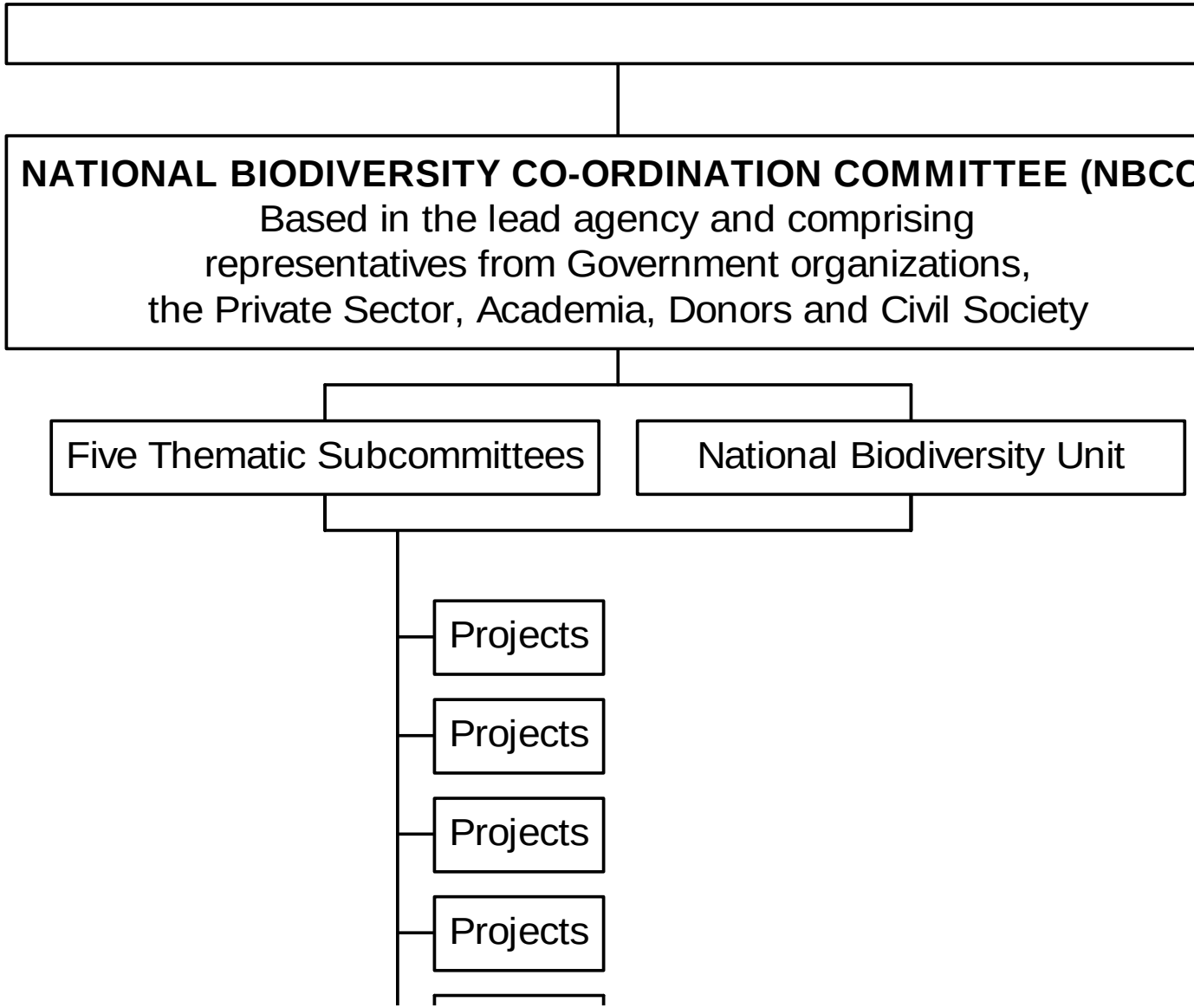
6.6 TRANSPARENCY AND ACCOUNTABILITY

It is acknowledged that the NBS will be implemented on behalf of HMGN and the people of Nepal. All those involved in its implementation will be accountable to the National Biodiversity Co-ordination Committee, which, through its open procedures and public annual reports, is accountable to HMGN and the People of Nepal. To this end, implementation of the NBS will be participatory to the extent possible, with all meetings open to the public and the media.

While the NBCC's annual report will serve as the main mechanism for accountability, reporting on aspects such as monitoring, assessments, financial management, effectiveness, etc, will be done on a regular basis.

It is also a commitment of the NBS that *bona fide* public representations made to the NBCC will be seriously considered and accounted for

CO-ORDINATION AND IMPLEMENTATION FRAMEWORK FOR THE NEPAL BIODIVERSITY STRATEGY AND IMPLEMENTATION PLAN



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