4. Organization of the BAP

The Biodiversity Action Plan for Bhutan is organized into an Introduction and five chapters. Chapters One and Two represent an inventory of what Bhutan has at present (spring, 2002) in terms of biodiversity and efforts to conserve it. The last three chapters represent the Action Plan proper. On the basis of the information in the first two chapters of the BAP, chapters three and four present the actions that need to be done to conserve and sustainably use the biodiversity. The last chapter presents options for actions that Bhutan can take to realise additional benefits from its biodiversity.

The Introduction – Part I provides a discussion of biodiversity and its values; the process by which the BAP II was developed along with discussion of the nature and organization of BAP II and the BAP as a "living document", i.e., an ongoing process. The Introduction also includes a section on Bhutan's achievements in biodiversity conservation in the period since publication of BAP I.

The Introduction -- Part II provides an orientation to Bhutan; the nation's unique approach to environment and development; the Buddhist perspective on biodiversity; and the presentation of "wild" versus "domestic" biodiversity in the BAP.

Chapter 1 focuses on the biodiversity itself. It provides an inventory and assessment of what is known about the biodiversity, its status and trends, its special features and significance, the threats to it, and the urgency of conservation and sustainable development.

Chapter 2 focuses on what is being done to conserve or sustainably use the biodiversity. It describes what is being done, evaluates the strengths and weaknesses and identifies what are the areas where more needs to be done to improve the situation.

Chapter 3 is the first part of the Action Plan proper. It specifies the direct actions needed for the conservation and sustainable use of the biodiversity itself, covering ex-situ and in-situ measures.

Chapter 4 specifies the measures that are essential to support the direct actions described in Chapter 3. These essential supporting actions include measures such as policy and law, institutions, research, capacity building and public awareness.

Chapter 5 presents options for actions (additional to and in more detail than those in the previous two chapters) which Bhutan can take to realise additional substantial but sustainable benefits from its biodiversity resources. The actions covered include such areas as ecotourism, bioprospecting, and carbon storage.

5. PRINCIPAL ACCOMPLISHMENTS SINCE THE ORIGINAL BAP

Since publication of BAP I in 1998 significant parts of the Action Plan have been accomplished. The principal accomplishments are listed briefly below. They and others are discussed in more detail in the BAP II, particularly in Chapter 2, but also to some degree elsewhere throughout the BAP.

1. Strengthening Government Institutions To Conserve Biodiversity

In BAP I, there was a strong recommendation to establish an integrated National Biodiversity Program within the MoA as an operational level program, and mechanism to improve the co-ordination, efficiency and effectiveness of Bhutan' efforts in biodiversity conservation. Particularly given that the biodiversity related responsibilities in Bhutan were scattered among different institutions often causing overlaps in activities and difficulties in co-ordination, goal setting, planning and cooperation.

Establishment of the National Biodiversity Center (NBC)

In order to improve the nations' efforts towards a mechanism for biodiversity conservation, an integrated national biodiversity program called the National Biodiversity Center was formally established as a non-departmental agency under the MoA in late 1998. The NBC has a mission to oversee and ensure the implementation of the Biodiversity Action Plan and to promote the effective conservation, sustainable utilization and ensure equitable sharing of benefits arising from the conservation and the sustainable utilization of the nations rich biological resources.

The NBC is vested with the following institutional mandates:

- Co-ordinate Bhutan's biodiversity related activities and serve as a national focal institute.
- Facilitate national decision-making on biodiversity concerns, cutting across sectors, divisions and institutions;
- Guarantee a national balance between conservation and sustainable utilization of biological resources in general, and between in situ and ex situ conservation in particular;
- Assure a participatory approach to building national consensus on biodiversity around complex issues and resolving conflicting situations;
- Facilitate sub-regional, regional and international cooperation; and
- Assure continuity of biodiversity related activities over time.

These broad-based directives are in agreement with the long term development goals of the RGoB. This would mean that the ecological, economical, social, cultural and aesthetic values of biodiversity are recognized in the nation's planning and policies and in the prioritization and the deployment of financial and other resources.

There are currently various projects being implemented under the NBC regarding ex-situ and in - situ conservation efforts towards wild and domestic biodiversity in the nation (details in Chapter 2. Section 2.4.3)

Establishment of a National Biodiversity Management Board (BMB)

A National Biodiversity Management Board was formalized on the 2nd of August 2000, with 13 members representing a cross-sectoral body comprising of important stakeholders involved with biodiversity management. The board was formed to have the executive authority over the National Biodiversity Center and to advise on, review or reform any national policies, projects and actions taken regarding the nations biological resources.

The mandates of the BMB are to:

- Oversee the implementation of the Biodiversity Action Plan
- Develop national policy framework that foster the sustainable use of biological resources and the maintenance of biodiversity
- Strengthen capacity for sustainable conservation and utilization of biodiversity
- Create conditions and incentives for effective biodiversity conservation.
- Catalyze conservation actions through international co-operation and national planning.

Since its establishment the BMB has met three times. The TOR and the executive charges of the BMB are further elaborated below in Chapter 2, section 2.4.4

Strengthening of the Nature Conservation Division (NCD)

The Nature Conservation Section has been upgraded to the Nature Conservation Division with increased authority and responsibilities. An effort has been made to increase staff and provide for expanded training opportunities to increase capacity. The NCD now has three sections, (1) Management Planning and ICDP (Integrated Conservation and Development Program) Section, (2) the Inventory and Data Management Section, and (3) Species Conservation, Research and

Monitoring Section. Each national park's management is now structured in the same way. In addition to the annual protected area conferences, NCD holds quarterly meetings for protected area managers and NCD staff to keep up to date on activities and developments.

2. Strengthening Direct Conservation Efforts For Wild Biodiversity

2.1. In Situ Conservation Efforts

Establishment of Protected Areas as on-the-ground entities and Completion of Management Plans.

Since the first BAP, Bumdeling Wildlife Sanctuary and Thrumshingla National Park have been established as on-the-ground entities with a park manager, wardens and park staff. There are now five fully functional protected areas (including Jigme Dorji National Park, Jigme Singye Wangchuck National Park and Royal Manas National Park). Management plans for RMNP, JDNP, TNP, and BWS have been prepared and approved, and a one-year plan for JSWNP has been prepared. There have been substantial additional actions to strengthen the protected area system, including expanding the boundaries of Thrumshingla National Park and Bumdeling Wildlife Sanctuary, and completion of infrastructure in most of the protected areas. A program of annual national parks conferences has been instituted. The aim of the conferences is to encourage exchange of information between various protected areas, to present technical papers, assess the progress in the implementation of management plans and to share and discuss problems experienced by park staff and seek common solutions, while learning from each other's experience.

Biological corridors- Linking Protected Areas

Declared as a "gift to the earth from the people of Bhutan' by Her Majesty the Queen Ashi Dorji Wangmo Wangchuck in November 1999, a total area of 9% (approximately 3804 sq.km) was declared as biological corridors to link the various protected areas. The designated corridors have been granted full recognition by the Royal Government.

The objective of designating these areas was to allow the movement of wildlife between otherwise isolated protected areas. Biological corridors are not strictly protected areas and need not be included within the Protected Area Network. The areas would have low intensity land uses such as Forest management Units, Community forests, agricultural lands and riparian corridors.

Park Self Assessment conducted in 2001.

Using a format based on IUCN procedures, self-assessment of all operational PAs except Royal Manas National Park was conducted during July and August 2001. The main objectives were to help provide guidance to NCD and Protected Areas under the 9th Five Year Plan; to help set priorities for donor support; to review the progress and constraints of protected area management; and to help NCD sections plan for necessary assistance to the Protected Areas.

Integrated Conservation and Development Programs (ICDP)

A common feature among all the protected areas is the presence of local communities living in villages in and around the protected area. As a result of the complex park-people relationships, any protected area policy and management decision has an effect on the local communities and their way of life. Integrated Conservation and
Development Programs (ICDP) are a tool to reduce the impacts on biodiversity of the PA resources use by local communities, make resource use more sustainable, reduce resource use in the core areas of the PAs while at the same time serving to improve the living conditions of the local population.

2.2. Ex Situ Conservation Efforts

Royal Botanic Garden, Serbithang (RBGS)

The RBGS was established on 2nd June 1999 to commemorate the 25 years of golden reign of His Majesty King Jigme Singye Wangchuck, the fourth King of Bhutan. The 28 acres of garden space is to be designed to explore and exhibit the therapeutic value of the plants. The focus will be on plants of economic significance such as those useful for food, fibre, cosmetic and industry, including those species that are endangered.

3. Strengthening Direct Conservation Efforts for Domestic Biodiversity

3.1. In Situ Conservation Efforts

Agro-biodiversity Conservation Project

This project, implemented by NBC's Agro-Biodiversity Section, aims to (a) conserve and sustainably use plant genetic resources (PGR) for food and agriculture and (b) assist on-farm conservation techniques.

Biodiversity Use and Conservation Asia Program (BUCAP)

This project is complimentary to the Agro-biodiversity project in terms of PGR on-farm conservation with emphases on rice and maize crops

3.2. Ex Situ Conservation Efforts

National Gene Bank

The National Gene Bank is currently being constructed by NBC to act as future reservoir of plant genetic resources in the country. H.E. Lyonpo Kinzang Dorji, Minister of Agriculture, laid the foundation stone on 18th June 2001.

4. Strengthening Efforts in Essential Supporting Measures

4.1. Strengthening Human Resource Development

Capacity Building for Protected Area Management

Capacity building of Bhutanese nationals through in-country and overseas training has been given high priority by the MoA. BTF funds many short term as well as long term training programs for NCD and park staff. In addition to this individual protected areas also have funds allocated from their respective donor projects to train park staff as well as park partners.

A number of park staff have undergone training in various aspects of wildlife management, survey and monitoring techniques, RRA, PRA, ICDPs, Forest fire protection and control, Environment and development, bird censusing, biodiversity assessment and monitoring, community forestry out of the country. Groups of park staff, extension agents, forestry staff and dzongkhag staff, park risups, and local school teachers were sent on a study tours of protected areas outside the country, to Nepal, Philippines, Australia, but mostly in the South-east Asia region.

Capacity Building for the NBC

Advanced training in taxonomy has been initiated with the University of Missouri in the U.S.A. where an NBC staff is undertaking a Masters course.
NBC staff received short course training in herbarium techniques in the Philippines.

4.2. Strengthening the Biodiversity Information Base

The National Herbarium

A new National Herbarium building complex has now been constructed at the National Biodiversity Center in Serbithang. The new herbarium will also have a library with a good reference collection of botanical literature from Bhutan and outside.

The Flora of Bhutan

All the 9 Volumes of the Flora of Bhutan, documenting the nation's wild flora, have now been completed and are available for use.

Biodiversity Survey and Monitoring

The NCD has undertaken a major effort to establish comprehensive programs for biodiversity survey and monitoring in Bhutan's protected areas and other areas of conservation concern such as biological corridors and conservation areas. Biodiversity surveys have now been completed in all but one of the protected areas, and the results already have been applied to management and in some cases to expanding boundaries.

Bhutan Integrated Biodiversity Information Systems (BIBIS)

This proposed system is based on the recommendation in the original BAP for the development of a scientific knowledge base for biodiversity in the country. BAP I emphasized that the presence of basic knowledge on the country's biodiversity is a prerequisite for the effective conservation and sustainable use of the nation's biodiversity. The BIBIS project will assist in documenting and creating inventories of all the biological resources in Bhutan into one integrated web based system called BIBIS. This inventory and information link will play a key role as the scientific knowledge base for implementing Bioprospecting in Bhutan.

4.3. Ecotourism

National Eco-Tourism Strategy

The Department of Tourism has developed the Bhutan National Ecotourism Strategy with wide participation by the tourism industry, including major stakeholder and industry workshops in April and September 2001. The Strategy addresses the whole of the tourism sector and establishes a set of ecotourism related principles incorporating biodiversity conservation to guide the future development of the tourism sector.

4.4. Bioprospecting

Bioprospecting

A biodiversity prospecting training workshop and program entitled "The Fundamentals of Biodiversity Prospecting: Management Approaches for the Kingdom of Bhutan" was held in May 2001. Bhutan also has now drafted a bioprospecting action plan for the nation.

4.5. Policy and Legislation Affecting Biodiversity Conservation

New Policies and Laws to Strengthen Biodiversity Conservation

A substantial number of policies and laws have been established since BAP I, which have the effect of implementing parts of the action plan. These include:

- Agro-biodiversity Policy and Legal Framework, being undertaken under NBC through the ABC project funded by the Netherlands
- Cooperatives Act
- Environment Assessment Act
- Farm Road Construction Guidelines
- Forest and Nature Conservation Rules
- Land Swapping Policy
- Livestock Act
- National Eco-Tourism Policy and Strategy
- National Environment Protection Act (under preparation)
- National Environmental Education Strategy (under preparation)
- National Environmental Strategy – The Middle Path
- Pasture Policy (Draft)
- Pesticides Act
- Seeds Act

Introduction – Part II

1. Brief Description of Bhutan

The Kingdom of Bhutan is situated on the southern slopes of the Eastern Himalayas. It is land locked between China in the north and India to the east, south and west. It covers an area of 40,076 sq. km (LUPP, 1995) and has a population of 698,950 (CSO, 2001). Its physical features are characterized by high-rising, rugged mountains and an intricate network of deep valleys, ravines and depressions earmarking watercourses, drainage basins, waterfalls, human settlements, glacial lakes and moraine. The components of its biotic feature are as diverse as its geo-physical elements, broadened further by the consequent climatic attributes. Through this natural endowment, the Kingdom has acquired special significance at the global level with regard to biological diversity.

Bhutan is one of the least densely populated countries with 79% of the people living in rural areas (CSO, 2001). The local topography and areas with agriculture and business prospects determine human settlement pattern. The population is growing rapidly at an estimated rate of 2.5% per annum (National Health Survey Report, 2000). Updated estimates of land cover based on the analysis of 1989 satellite imagery, showed that forest accounted for 72.5% (includes 8.1% of scrub forest) of land area. Cultivated area accounted for 7.8% of the land cover and includes cultivated wetland, dryland and horticulture, Tseri/Fallow rotation, mixed cultivated land and others. Table 1 shows percents of classified land cover and the proportion of arable land under different production systems.

Table 1. Figures for Land Cover in Bhutan

Land Use	Area (km^2)	%
Forest	25,787	64.4
Scrub Forest	3,258	8.1
Pasture	1,564	3.9
Agriculture	3,146	7.8
Snow & Glacier	2,989	7.5
Water Spread/ Marshy	339	0.9
Rock Outcrop	2,008	5.0
Other	985	2.5
TOTAL	**40,076**	**100**

Agricultural Land	Area (km^2)	%
Cultivated Wetland	388	12.3
Dryland/Horticulture	977	31.1
Tseri/Fallow-Rotation	883	28.1
Mixed Cult. Land	840	26.7
Other	58	1.8
TOTAL	**3,146**	100

The development in Bhutan is guided by principles which emphasize the need to ensure the preservation of natural and cultural heritage, and that development from subsistence to more modern economy proceeds on a sustainable manner. The Renewable Natural Resources (RNR) sector of the Royal Government of Bhutan (RGOB), represented by the Ministry of Agriculture (MOA), covers agriculture, livestock and forestry. Although the economy has been diversified, the RNR sector remains the single-most important sector accounting for 35.9% of the Gross Domestic Product in 2000 (CSO, 2001) with 79% of the population directly depending on agriculture for their livelihood.

2. Bhutan's Unique Approach to Conservation and Development

His Majesty the King Jigme Singye Wangchuck has stated that:

> ***"Throughout the centuries the Bhutanese have treasured their natural environment and have looked upon it as the source of all life. This traditional reverence for nature has delivered us into the twentieth century with our environment still richly intact. We wish to continue living in harmony with nature and to pass on this rich heritage to our future generations"*** (RGOB, 1996).

The people of Bhutan have managed to achieve this goal primarily due to the enlightened leadership of our Kings, by maintaining the integrity of our culture and by revering and adopting the philosophies of Buddhism in our daily lives which is the state religion of Bhutan.

The RGOB, to further strengthen its role towards sustainable development in Bhutan is adopting the middle path approach by applying a policy that supports the integration of conservation and sustainable economic development. To achieve this goal, the RGOB has set up policies and programs which forego short-term profit at the expense of long-term loss of the biological heritage.

According to Buddhist and pre-Buddhist philosophies, the mountains, rivers, streams, rocks and soils of Bhutan are believed to be the domain of spirits. The Buddhist respect for all living things has led to the development and adoption of ecologically friendly strategies -- a solid foundation for a National Biodiversity Conservation Strategy. This, coupled with the Buddhist tenet that the acts of this life will be rewarded or punished in the next, provides a powerful motivational principle for sustaining Bhutan's natural resource base including its outstanding biodiversity.

In accordance with these principles, RGOB has placed primacy on conservation of Bhutan's natural resources, when formulating development and economic policies. (Paro Resolution 1990, RGOB 1991, NEC, 1993; FSD, 1995). Cognizant of the environmental disasters in neighbouring countries as a result of development policies that largely ignored the inevitable consequences of environmental backlash in favor of quick economic returns, Bhutan has opted to pursue a cautious and environmentally friendly approach to development. This approach has been embodied within the Forest policy of Bhutan 1991. Although the policy recognizes the need for the use of forestry resources, such use will be guided by principles of sustainability. Thus, priority has been placed on conservation, with purely economic benefits relegated to a secondary role.

Conservation is not a new concept to the RGOB and the people of Bhutan. A religious and culture ethos based on a philosophy that values all life forms- Buddhism- has fashioned a life-style that is very much conservation oriented (Bunting and Wangchuk, unpubl, RGOB, 1991, FSD, 1995). Bhutan had established an extensive system of protected areas, including wildlife sanctuaries and nature reserves by 1978. Since then the RGOB has, among other actions:

- Identified and notified nine protected areas representative of Bhutan's diverse ecosystems, comprising over 26 percent of the country's land area.
- Declared an additional 9% of the total area as Biological Corridors connecting all protected areas.
- Pledged to maintain 60% of Bhutan's land under forest cover.
- Included provisions for establishing protected areas and conservation regulations in the Forest and Nature Conservation Act, 1995.
- Passed the Forest and Nature Conservation Rules, 2000, for effective implementation of provisions in the Forest and Nature Conservation Act of 1995.
- Established the Nature Conservation Division with a mandate to oversee and manage the protected areas system and conserve Bhutan's biological diversity into the future
- Established the Bhutan Trust Fund for environmental conservation to provide long term funds for conservation and related activities.

- Established a National Biodiversity Management Board to be the policy and decision making body on biodiversity related activities in the nation.
- Established the National Biodiversity Center under the MOA to oversee the co-ordination and the implementation of all biodiversity related activities in the country.
- Established a Botanical Garden for ex-situ conservation efforts of the flora of Bhutan
- Establishing a National Gene Bank for the ex-situ conservation of agro-biodiversity

In spite of the many challenges that Bhutan faces, and the limited economic opportunities, the RGOB has made it a policy to avoid over-exploitation of its forests and minerals. The RGOB has instead chosen to forego immediate economic gains and has placed a higher priority on the conservation of natural resources. The Royal government has continued to take steps to strengthen its legislation and adopt policies that reflect the significance it places on long-term conservation of Bhutan's biodiversity.

3. A Buddhist Perspective on Environment and Conservation.

Buddhism, the state religion of Bhutan, teaches respect for all life forms. The Buddha taught his followers to cultivate boundless love towards all beings in the manner a mother would protect her only child at the risk of her own life. Such a philosophy is the basis of the Bhutanese cultural fabric. The four great events in the life of the Buddha took place under the trees - his birth, his enlightenment, his first teaching in the Deer Park of Saranath and his passing away. The Buddha taught to love all beings just as a tree that provides shade even to the axe-man that comes to cut it.

The crux of the Buddha's teaching is "Tendrel Gi Choe" or the interdependence among all life forms. In the continuous cycle of birth and death, there is not a single being that has not been, at one point of time or another, our mother. Therefore, the Buddha taught to respect all life forms in a manner that we respect our mother. The physical form, according to Buddhism, consists of four elements - earth, water, fire and air. There are the same corresponding elements in nature, which are directly linked to the elements of the physical forms. Therefore, if the elements within the life form are to be pure, then there must necessarily be an environment where the same elements can be found in their pure state.

Buddhist painting showing harmony between nature and all living beings

Buddhism is all about the growth of the human mind so that it can achieve the highest level of wisdom. The stories of Buddhist saints and sages are replete with examples of how they moved to nature's wilderness once they have acquired adequate levels of academic proficiency in the Dharma. It is this profundity of nature - its richness, its wilderness, its diversity etc. that helps to stimulate the loftiness of their own thoughts.

In the day to day life of the Bhutanese, certain deities such as 'Lha' (deities of the heaven above), 'Tsen' (deities of the mountains), 'Lu' (beings of the underneath world) and 'Sadag' (deities of the land) are worshipped and evoked. The practice comes from our society's deep respect for nature and its environment. There is a fervent belief that if we pollute the heaven above, the mountain in-between and the land below, we are bound to suffer the wrath of their respective deities. So concern for environment is found deeply embedded in our beliefs and day-to-day activities.

4. "Wild" and "Domestic" Biodiversity and Their Integration within the RGOB

Throughout the BAP the material is presented in terms of *Wild Biodiversity* and *Domestic Biodiversity*. This is done to facilitate presentation for several reasons. The Convention on Biological Diversity draws such a distinction, defining *Domestic or cultivated* species as species in which the evolutionary process has been influenced by humans to meet their needs. The RGOB administration, agencies and programs are specific to wild or domestic biodiversity. Also, in many cases the species are different.

However, there is actually often no clear dividing line between the two. Wild relatives of domestic crop plants may have great significance to domestic agriculture. The use of wild species for purposes such as food, medicine, construction and fuel is an integral part of the life of much of Bhutan's population. Both wild and domestic species are dependent upon the ecosystems and habitats of which they, in turn, are integral parts.

Further, this division does not reflect the integration that the RGOB has sought to accomplish through the creation of the RNR sector and the National Biodiversity Center.

Chapter 1

The Status of Bhutan's Biological Diversity

1.1 Overview of Biological Diversity in Bhutan

The Kingdom of Bhutan has a rich and varied biological diversity (both wild and domestic) that has regional and global importance. Bhutan in fact has been identified as one of the more prominent nations for it's rich biological diversity and is in one of the regions considered one of the global biodiversity hotspots. Very few countries in the world match Bhutan's biological diversity and fewer still have taken such strong steps to conserve their biodiversity. Bhutan ranks in the top ten percent of countries with the highest species density (species richness per unit area) in the world, and it has the highest fraction of land in protected areas and the highest proportion of forest cover of any Asian country. Bhutan is one of a very few biologically diverse countries in the world which have the opportunity to maintain its biodiversity largely intact in the coming decades (REID, 1996).

Bhutan's richness in biological diversity is found at the ecosystem, species and genetic levels. Considering Bhutan's terrestrial ecosystems, forests cover about 72.5%. Aquatic ecosystems although largely scattered account for a relatively small portion of the total land cover in Bhutan. 26.23% of Bhutan is under the protected area management system. In addition, 9% has been declared as biological corridors connecting all the protected areas, and there is a series of Conservation Areas, which are intended to protect important conservation sites outside the formal protected area system. As a result, more than 35% of the country's area is under some form of conservation management.

Regarding the diversity at the species level, inventories undergoing completion have indicated that there are more than 5,500 species of vascular plants, more than 770 species of avifauna and more than 165 species of mammals, with many species being endemic to Bhutan. This rich species diversity indicates an equally rich genetic diversity. The domestic biodiversity in Bhutan has species that are either native or ones which have been introduced and which over time have developed unique genetic, morphological, and ecological characteristics. The diverse flora includes many economically important plants such as medicinal herbs, industrial plants, horticultural crops and others yet to be identified.

1.2. Terrestrial Ecosystem Diversity

Bhutan has great diversity of ecosystems partly because of its location at the juncture of the Palearctic realm of the temperate Eurasia and the Indo-Malayan realm of the Indian sub-continent, and partly due to the country's great geological relief and climatic heterogeneity. Valleys in the inner mountains receive less than 800 mm of precipitation, while rainfall in the lowlands is as high as 5,500 mm. The country includes a range of ecosystems from sub-tropical zone in the south at an elevation of 150 meters to mid-elevation temperate zone, and to the northern alpine zone above 7,000 meters.

While there are few areas of the country that have not experienced some human activities, most ecosystems remain substantially intact. According to the 1995 land use survey, conducted by the Land Use Planning Section, MOA, approximately 8% of the country is under cultivation, and the total land area under forests is 29.045 km^2 or 72.5 % of the country. Out of this 8.1% or 3,258 km^2 have been classified as degraded forest or natural scrub forest. Coniferous forests constitute 26.5%, broadleaf forests 34.3%, and plantation 0.2 %. The Interaction of topography, climate and human use has resulted in the development of a complex pattern of vegetation and habitat types all over Bhutan.

1.2.1. Forest Ecosystems – Ecofloristic Zones

The Forests of Bhutan can be divided into three Ecofloristic zones based on altitudes. Each zone contains a distinct set of eco-zones as follows:

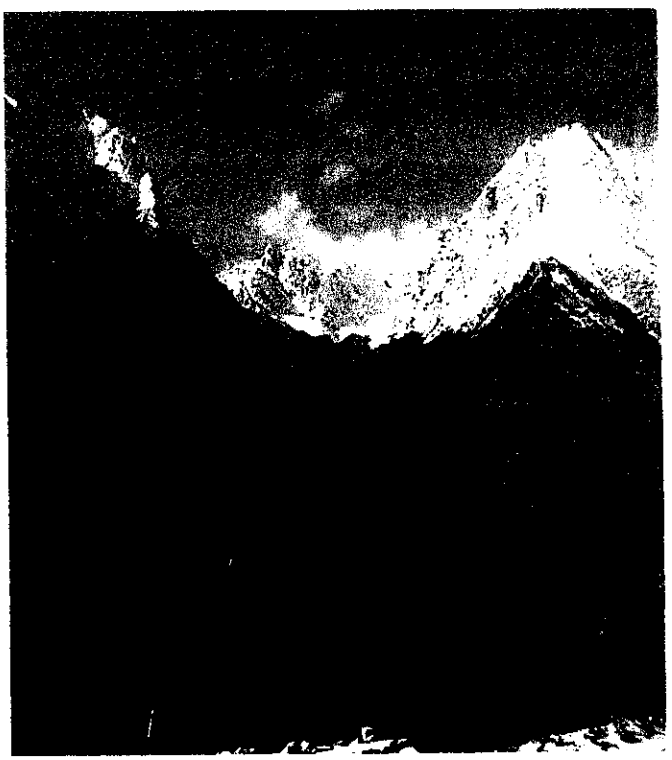
- **Alpine Zone** including areas above 4000m of altitude where there is no forest cover.
- **Temperate Zone**, which lies between 2000m and 4000m of altitude containing the major temperate conifer and broadleaf forests.
- **Sub-tropical Zone**, which lies between 150m to 2000m of altitude containing the tropical and sub-tropical vegetation.

1.2.2. Forest Types

a). **Fir forest**. This forest type is found in the highest forested ridges, between 2700m and 3800m. It requires relatively high precipitation (probably 133+cm), part of which is obtained as condensation. Few Hemlocks and Birches may also be present. Towards the tree line (at 3600-3800m) Fir becomes stunted and grade into Juniper and Rhododendron scrub. The total area under Fir is about 3,45,302 ha.

b). **Mixed Conifer Forest:**
This forest type occupies the largest portion of the sub-alpine region of the country between 2000m and 2700m of altitude. The forests are coniferous and may be dominated by Spruce, Hemlock, Larch or mixtures of these species. Hemlock tends to be found on wetter slopes than Spruce and is generally decorated by beard like lichens and mosses. The total area under mixed conifer is about 4,86,827 ha.

c). **Blue Pine Forest**
This forest type is found in the temperate regions between 1800m and 3000m in Ha, Paro, Thimphu valleys in the West and Bumthang and Gyetsa valleys in central Bhutan. It is sometimes found mixed with Oak and Rhododendron. The total area under Blue Pine is about 128,593 ha.



d). **Chir Pine Forest**
A low altitude (900-1800m) xerophytic forest type occurring in deep, dry valleys of Sunkosh, Kuri chhu and Kulong/Dangmechu river systems, essentially under subtropical conditions. A long dry season is characteristic of these areas, the annual precipitation of 1000-1300 m falling primarily during the summer monsoon. Chir pine forests are much influenced by human activities, including tapping for resin, felling for timber, and frequent ground fires that are deliberately set to produce fresh grazing for livestock and to produce new lemon grass growth, which is harvested for essential oil production. The total area under Chir pine forests is about 1,00,899 ha.

e). Broadleaf Mixed with Conifer

In some parts of Bhutan, the gradation between broadleaf and coniferous forest is very gradual and there are extensive areas of a mixture of these two forest types. These mixed forests are generally Oak mixed with Blue Pine or upper hill forest mixed with Spruce or Hemlock. The total area under this forest type is about 1,35,789 ha.

f). **Upland Hardwood Forest** This forest type dominates the temperate hillsides between 2000 to 2900m of altitude. The total area under this hardwood forest is about 4,50,000 ha. There are two main types:

a. ***Evergreen Oak Forest*** which are more common in the drier areas especially around Trongsa and above Mongar. Maple and Castonopsis dominate at lower altitudes, while Oak predominates higher up. With increasing altitude this type grades towards Blue pine with xerophytic oaks.

b. ***Cool broad-leaved forests*** of wetter hills, which are richer and have many different species.

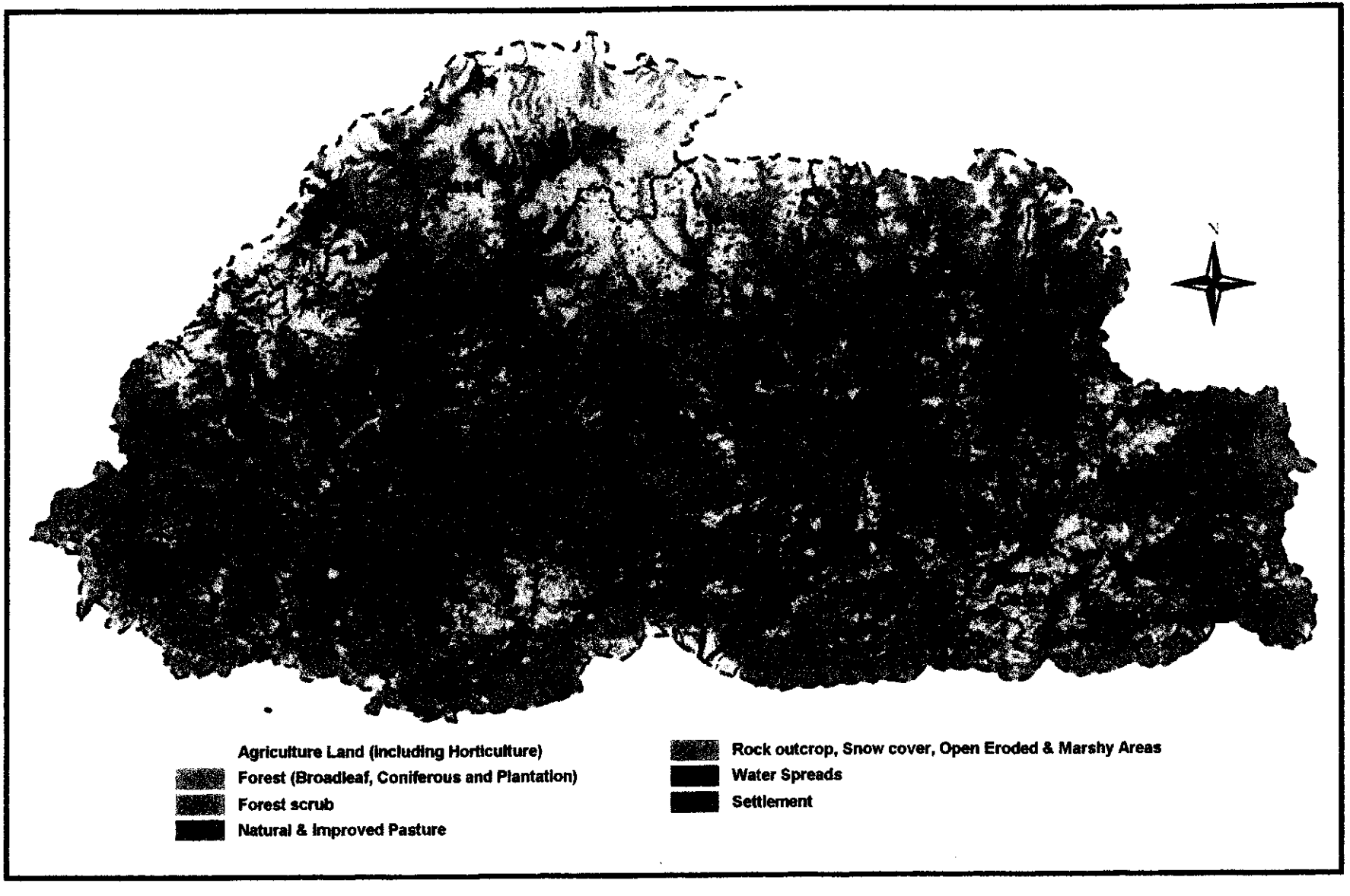
g). Lowland Hardwood Forest

This forest type occupies the sub-tropical hills between 1000-2000m of altitude. These forests are very rich mixed with a wide variety of both sub-tropical and temperate genera.

h). Tropical Lowland Forest

This forest type occupies the low hills below 700m. They are broadly classified as semi-evergreen but vary from almost totally deciduous on exposed dry slopes to almost totally evergreen in the moist valleys. The forests are multi-storeyed and species diversity is very rich. The total area under the lowland hardwood forest and the Tropical lowland forest is about 4,40,000 ha.

Map 1 : Land Use Map of Bhutan



1.2.3. Agricultural Ecosystems

The country can be classified into agro-ecological zones based on the agro-climatic condition determined by altitude, rainfall and topography within three broad geographical zones: the Southern Foothills, the Inner Himalayas, and the High Himalayas.

Livestock and associated farming systems differ from one agro-ecological zone to the other based on altitude, temperature and rainfall distribution. Their combined effects greatly influence agricultural activities.

a) **Temperate Zone:** This zone covers cultivated areas in high altitude (2500-4000m) with low rainfall, so dryland farming is common. Nomadic yak herders operate the livestock system. In this zone, livestock raising forms a predominant feature of the farming system. In particular, a small but distinct population of pastoralists maintain herds of yak and sheep on summer alpine pastures migrating down to about 3000 m before the snowline during winter. Horses, donkeys/mules and dogs also form part of the livestock living in this eco-system.
Wheat, potatoes, buckwheat and mustard are grown in summer; winter wheat and barley are grown in winter. Fertilizers are usually applied to potatoes. Crop cultivation and management follow traditional methods.

b) **Warm Temperate Zone:** This zone falls between 1800-2500 meters above sea level. Temperatures are slightly higher here than the Temperate Zone, although winter frost still occurs. Within this zone are semi-nomadic Siri and Mithun herders, who often have family links with the lower zone. They also keep pigs, poultry, dogs, cats, horses and small ruminants. After the harvest of the crop cattle are allowed to graze on the crop stubble. Rice straw is used as winter fodder for the cattle. For a certain period during winter, feeding of crop-residues is the only alternative. However, due to severity of the climate at this elevation, most of the farmers migrate to lower altitudes in the south. In the wetland, rice is grown in summer followed by wheat, potatoes or vegetables in late winter; rice varieties are mostly traditional red types. The use of improved tools and farm machinery is popular (e.g., power tillers, power threshers, reepers, weeders, etc.).

c) **Dry Subtropical Zone:** In this zone, the temperature is comparatively higher than the other two temperate zones. Cattle are tethered on the paddy land and maize fields after harvest mostly for manure. All other forms of domestic biodiversity are found here. Rice is the main summer crop followed by wheat, mustard and vegetables. Improved crop varieties and use of fertilizers and herbicides are gaining popularity, however FYM is still applied. High crop yields are obtained compared to other agricultural ecological zones.

d) **Humid and Wet tropical zone:** These zones fall within 150-1200 meters above sea level and have excellent areas for crop cultivation. Fodder is scarce here so the cattle are tethered in cropping areas prior to preparation and livestock rearing in these zones is normally stationary. Cattle are kept for milk production and draught power. As these lands are mostly arable, the FYM or cattle manure is the ingredient of compost fertilizer to be used in the field. Due to scarcity of fodder, maize fodder grown prior to rice and crop residues, mostly straw are fed to cattle during winter. All other forms of domestic biodiversity are present here.

In the humid zone the main cropping pattern in the wetlands is rice followed by wheat or mustard as in the dry subtropical areas. However, due to higher rainfall and humidity there are more insect and disease problems in crops. Citrus (mandarin types, locally called "oranges") are grown as cash crops. In the dryland maize is the main crop followed by mustard, millets and buckwheat.

In the wet zone rice is the main summer crop. Maize or wheat are grown in winter depending on irrigation water. Irrigation sources are mostly monsoon-fed and dry up in winter, therefore lack of water precludes large scale winter cropping. In the dryland, maize is the main crop. Other crops include cowpea, mustard, niger, milltes, and sorghum.

Table 2. Description of the six Major Agro-ecological Zones[1].

Agro-ecological Zone	Altitude m.a.s.l.	Temperature °C			Rainfall (mm)
		Monthly Max	Monthly Mean	Mean Annual	
Alpine (AL)	3600-4600 High	12.0	-0.9	5.5	<650
CoolTemperate (CT)	2600-3600 High	22.3	0.1	9.9	650-850
WarmTemperate (WT)	1800-2600 High	26.3	0.1	12.5	650-850
Dry Sub-tropical (DST)	1200-1800 Mid	28.7	3.0	17.2	850-1200
Humid Sub-tropical (HST)	600-1200 Mid	33.0	4.6	19.5	1200-2500
Wet Sub-tropical (WST)	150-600 Low	34.6	11.6	23.6	2500-5500

[1] RNR Research Strategy and Plan Document (May 1992).

1.3. Aquatic Ecosystem Diversity

Bhutan has different forms of aquatic habitats scattered throughout the country. A large number of high altitude lakes and the major river systems originate from the high Himalayas - a renewable water source. The waters from these rivers and lakes traverse from the northern mountainous region to the southern lowlands. The tremendous difference of altitude and the climatic contrast from north to south exhibits a wide variation of ecological conditions ranging from glacial or freezing lakes and streams to torrential cold waters of mountainous and hill region and slow flowing to stagnant eutrophic warm waters of lowlands. The fishes have also adapted to the diversified ecological conditions by establishing different forms, developing different feeding habits and also developing special organs to get attached on rocks or to absorb atmospheric oxygen to respire.

Bhutan's aquatic habitats are found throughout the various ecological zones. They range from glacial origin, perennial torrential rivers to seasonal rivulets or streams, high altitude lakes and springs to lowland lakes, swamps and marshy lands of river flood plains to paddy fields and manmade reservoirs to village ponds. In the near future a greater area of water surface will be added from the implementation of a series of hydropower, irrigation and aquaculture development projects.

a). Rivers

Bhutan has vast inland resources in the form of rivers and lakes. The Manas river system with a total length of 3200 km is the principal drainage followed by Sunkosh river (1810 km), Wang chu (610 km) and Amo chu (310 km). Besides these, Mangde chu, Badanadi and Jomori Chu (Dhansiri) are the other rivers which contribute to the overall drainage of the country. Barring Amo Chu, Badanadi and Jomori Chu the principal tributaries of these river systems are as follows:

Table 3. Major rivers and their principal tributaries

No	River System	Tributaries	No	River System	Tributaries
1	Manas river	1. Kholung Chu 2. Tawang Chu 3. Amri Chu 4. Sheri Chu 5. Kuri Chu	5	Mangde Chu	1. Chumey Chu 2. Chamkhar Chu 3. Tang Chu 4. Mangde Chu 5. Chendebji Chu
2	Sunkosh river	1. Pho Chu 2. Mo Chu	6	Amo chu	---

		3. Dang Chu 4. Daga Chu			
3	Wang Chu	1. Wang Chu 2. Paro Chu 3. Ha Chu	7	Bacanadi	---

b). Lakes

A number of small and medium sized lakes are scattered throughout the country. All the lakes have not yet been surveyed both for its area, location and the flora and fauna. Studies need to be conducted for flora and fauna of the lakes. It is expected to find many endemic species of both flora and fauna of Bhutan.

c). Man-Made Reservoirs

There are only a few reservoirs in the country, the prominent one being the diversion dam for the Chukha Hydropower. Not much work has been done either to assess its flora and fauna or to culture fish in the water body. Many more reservoirs are expected to be made in the near future as quite a number of hydropower and irrigation facilities are either in the process of construction or included in future plans. Government policy requiring mandatory environmental impact assessments with special consideration for biodiversity in the proposed power facilities is needed.

d). Village Ponds

Numerous village ponds are scattered all through the southern belt of the country and many more are expected with development plans to enhance aquaculture production.

e). Irrigated Paddy Fields

The staple food of Bhutan being rice there are a lot of paddy fields scattered all over the country. Most of the paddy fields are filled with water for at least a few months during the monsoon. Traditional as well as modern irrigation system presently covers a considerable area of paddy field under irrigation.

f). Marshy Land

Besides the rivers, lakes and reservoirs it is also estimated that marshy lands in the form of depressions and water logged areas, constitute a considerable area of the country. Such aquatic habitats, along with the sewage tanks in Babesa, are rich in biota and also serve as good habitat for resident as well as migratory birds, reptiles, amphibians and fishes.

1.4. Wild Species Diversity

Bhutan lies within the Eastern Himalayas, which is considered to be one of the ecological wonders of the world. The country straddles two biogeographical realms: the Palearctic realm of the temperate Eurasia, and the Indo-Malayan realm of the Indian Sub-continent.
The nation is extraordinarily rich in species biodiversity, including a large percentage of endemics. Moreover, the ecological and biodiversity integrity of the country is still largely intact. The natural forest covers over 72 percent of the country, agriculture remains largely the traditional, highly

integrated farming systems, and the country has a very comprehensive protected area system. The system stretches from the sub-tropics in the south, temperate areas in the central interior, to the alpine zone in the north. This protected area system, including the linking biological corridors, serves as a globally unique system for in-situ conservation of biodiversity.

It is noteworthy that the wild fauna and flora of Bhutan are very rich but in general the fauna remains poorly known. In terms of mammals, for example, the National Conservation Plan for Bhutan (Mackinnon 1991) provides a provisional list of 178 species based on predicted occurrence. This includes 24 internationally threatened species and 64 species that may be nationally endangered; however it needs to be emphasized that this is a provisional list and not a list of known species. A subsequent list of 145 species produced by Yonzon (1992) included 74 species (mostly shrews, bats and rodents) that are suspected but not yet confirmed to occur in Bhutan. Within Bhutan's borders, one can find over 60% of the endemic species of the eastern Himalayan region.

1.4.1. Mammals

Within the altitudinal range of the Bhutan Himalayas, one can distinguish three different ecological units with their typical mammalian fauna.

- High altitude fauna include snow leopard, blue sheep, red panda, marmots, Tibetan wolf and Tibetan antelope, takin and Himalayan musk deer.

Takin: Bhutan's national animal

- In the temperate zone, grey langurs, macaques, tiger, common leopard, goral and serow are found. The old growth in the temperate broadleaf forests, with a variety of fruit-bearing trees and bamboo brakes provide habitat for Himalayan black bear, red panda, squirrels, sambar, wild pig and barking deer.

- The sub-tropical lowland fauna includes animals such as the tiger, one-horned rhinoceros, Asiatic water buffalo, pygmy hog, golden langur gaur, clouded leopard, swamp deer, pygmy hog, hispid hare, capped langur and sloth bear exist in the lush tropical forests of the south. The Riverine vegetation serves as habitat for lynx and takin, and the lower riparian acts as dispersal corridors for tigers.

Red Panda

Several species of mammals are globally or regionally threatened and some are listed in Schedule I of the Forest and Nature Conservation Act, 1995. These include several that can be considered as 'flagship' species such as takin, blue sheep, snow leopard, tiger and red panda. Other species of conservation importance for reasons of threat and /or their ecological roles as significant predators or prey are the great Indian rhino, Asian elephant, Himalayan black bear, leopard, wild dog, musk deer, sambar, barking deer, goral, serow, marmot, and pika.

Several species of mammals are habitat specialists and thus have restricted range distributions. For instance, blue sheep use alpine meadows for grazing and venture into alpine scree in the ridge tops above the meadows. During winter blue sheep migrate down into the alpine scrub habitat. Takin follow the blue sheep migratory pattern but remain in one habitat category below, by migrating into alpine scrub in summer and down to the sub-alpine and cool temperate broadleaf forests in the winter. During winter, takin populations can be found around Gasa, Tashithang and Bayla, and in summer around Lingshi, Lunana and Tsharijathang.The distribution of snow leopard is restricted to the higher elevations, such as alpine scree and meadows. Musk deer usually found

in moist sub-alpine forests, overlaps with the red panda, which inhabit old growth mixed conifer and temperate forests with heavy moss cover on trees and bamboo undergrowth.

Other mammals restricted to higher elevations include the marmot, which is found in localized colonies in the alpine meadows, and pika, which is distributed from the sub-alpine forests to alpine meadow. Both these species are likely to form an important base for many carnivores, such as foxes, martens, weasels, snow leopards and predatory birds (NCS, 1996).

1.4.2. Avifauna

Although Bhutan's avifauna is still poorly known, around 770 species to date have been recorded (MacKinnon 1991, RGOB, 1996). The avifauna includes both Indomalayan (tropical) and Palearctic (temperate) elements. Approximately 73% of the known species are resident. Most of the resident species are altitudinal migrants (Inskipp and Inskipp n.d) that move between higher altitude breeding areas and lower altitude wintering areas. The remainders are summer visitors that breed in Bhutan but winter elsewhere; winter visitors that breed further north; passage migrants or vagrants (Inskipp 1995).

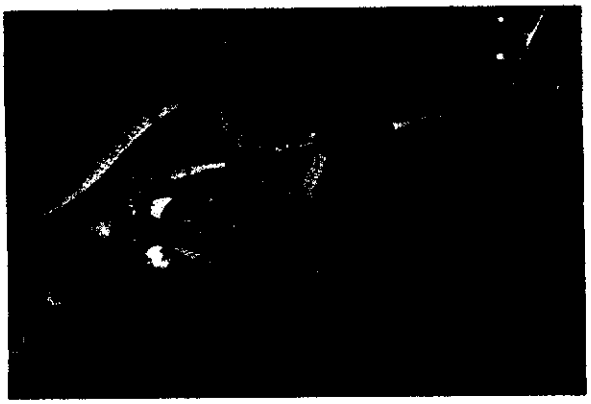
Birds typical of the alpine area include the snow pigeon, yellow billed chough, red billed chough, upland pipit, robin accentor, rufous breasted accentor, grandala, and Tibetan snow finch. Other birds in the alpine scrub include fire tailed sunbird, black red start, rose finches, red headed bullfinch, white winged grosbeak, and Juniper finch, although most of them are summer visitors. Some of the rarer bird species characteristic to sub-alpine birch rhododendron forests include golden bush robin, gold crowned black finch and fire-tailed myzomis. Some birds in the Temperate Zone are the pheasants, partridges and martins.

Bhutan may support significant populations of at least 119 species of birds whose breeding ranges are restricted to the area encompassing the Himalayas, North-eastern India, Northern Southeast Asia and South-western China (Inskipp et.al, 1993). Several birds that are globally and/or regionally threatened occur throughout the country. Some are listed in schedule I of the Bhutan Forest and Nature Conservation Act, 1995. At least 12 of Bhutan's bird species are considered to be globally threatened (WCMC/IUCN 1994) and 11 have world-wide breeding ranges of less than 50,000 km^2 (ICBP 1992), putting them at risk from any significant loss. Bhutan's temperate and subtropical broad-leaved forests are particularly important for bird conservation, as a high proportion of the area of these forest types remaining on the South subcontinent lies in Bhutan. The low altitude broad-leaved forests in the extreme south of the country support a particularly high diversity of bird species (Inskipp et.al, 1993).

Table 4. The number of bird species that may have internationally significant breeding populations in Bhutan arranged according to ecosystem type.

HABITAT TYPE	Nos.
Warm broad-leaved forests	**19**
Cool broad-leaved forests	**35**
Mixed coniferous/broadleaved forests	**31**
Blue pine forests	**6**
Subalpine forests	
a. Fir	**45**
b. Spruce	**10**
c. Juniper	**10**
Alpine scrub	**9**
Alpine meadows	**4**
Wetland (river, marsh, pool)	**0**
Cultivation around villages	**1**

1.4.3. Herpetofauna



Snake

The herpetofauna of Bhutan is poorly documented but is considered to be rich, probably including a tropical/subtropical element in the south (MacKinnon 1991). MacKinnon et al (1994) provides a list of 15 reptiles and three amphibians for Manas National Park, a small part of which extends into the east in the subtropical zone. There are many reptiles including the crocodile, several river turtles, pythons, and other snakes and lizards. Tadpoles were even found in alpine lakes to the south of Tse thso La at 4300m (Wikramanayake 1995, NCS, 1996). Threatened species of herpetofauna include the Gharial *Gavialis gangeticus*, the Indian python *Python molurus* and the yellow monitor lizard *Varanus flavescens* (MacKinnon et al, 1994; WCMC/IUCN 1994)

1.4.4. Invertebrates

1.4.4.1 Butterflies

The invertebrate fauna is poorly known, although a start has been made in cataloguing the butterflies. Bhutan is considered to have rich butterfly fauna, including some rare species MacKinnon 1991); Yonzon (1992) lists 50 species as occurring in Bhutan, based on literature review and field studies, of which 28 are endemic to the Eastern Himalayas and others are rare or uncommon. At least four species are considered to be internationally threatened (WCMC/IUCN 1994). Butterflies are extremely varied and include some rare swallowtails and other precious species like the *Bhutanitis lidderdali*, *Troides* spp., *Atrophaneura* spp. alpine *Parnassus* spp. and the spectacular *Teinopalpus imperials.*

Butterflies have been used as an indicator species (including as indicators of habitat condition) in rapid biological inventories elsewhere (e.g. Davenport et al 1994; Howard and Viskanic 1994) and it would be useful to develop additional data on butterfly distribution, abundance and habitat associations in Bhutan (Salter, 1995).

1.4.4.2 Bees

Bhutan's diverse agro-ecosystems have provided sanctuary for at least four different species of honeybees, namely, *Apis cerena, Apis dorsata, Apis laboriosa* and *Apis florea.* These wild bees are the most efficient pollinators of agricultural and horticultural crops. Without their pollination services, both yield and quality of the mountain crops may be compromised. These bees are also an important indicator of ecology and can be used as efficient conservation tools to monitor the health of the ecosystem. Besides producing valuable natural wax, these bees produce as high as 50 kg to 80 kg of honey per colony.

In the neighbouring Himalayan countries and elsewhere in the world, honey hunting and exploitation for wax are leading to shrinkage of wild bee populations. In Bhutan, however, harvesting honey from a bee colony (especially of the wild species) is still considered a taboo in the Bhutanese society. Bhutanese believe that bees put in a lot of work to produce a little honey and so it is an act of sin to rob them of their hard earned produce. This philosophy, which is still valid and practiced in Bhutan, has probably contributed to the existence of a diverse and rich local bee types. Studies have indicated that Bhutan could be the largest home to the Giant Rock bee *A. laboriosa,* which is endemic to the Himalayas.