Chapter 2
Literature Review

Concept of Biodiversity

Nalgel (1995) has noted that there is no question that many species are necessary prerequisites for the functioning of ecosystems, from the local to the regional and global levels up to the biosphere. These species are required for the existence of other elements integrated into these systems. The role of most species in maintaining functioning biological systems is unknown. The hypothesis that higher species richness or species evenness causes greater stability of the system does not apply, although many examples seem to document this. For instance, it is known that tropical ecosystems, particularly tropical rain forest ecosystems with the greatest species richness, are most sensitive to external influences, while ecosystems of the temperate zones, with fewer species, show greater elasticity against disturbances from outside. Sah e*t al.* (1999) reported that biodiversity refers to the number, variety, and variability of all life on the earth or in one area. It deals with different ecosystems including the variety of habitats and communities, diversity of species, and variation of genes within species, i.e. biodiversity is the sum of genetic, specific, and ecosystem richness on the planet.

Samitinand (1995) stated that biodiversity is a term that has recently been widely used. It is the variety and variability among living organisms and the ecological complexes in which they occur. It can be defined as the number of

different or ganisms and their relative frequencies. For biological diversity, these items are organized at many levels, ranging from DNA sequences that are the molecular basis of heredity to complete ecosystems. The term encompasses genes, species, ecosystems, and their relative abundance.

Odum (1995) divided biodiversity into three hierarchical categories:

1. Genetic diversity refers to the variation of genes within species covering distinct populations of the same species or genetic variation within a population.
2. Species diversity refers to the variety of living organisms on Earth.
3. Ecosystem diversity refers to the variability of habitats and biotic Communities including the variety of ecological processes within ecosystems.

Biologists call diversity comparisons within communities alpha diversity, comparisons between similar communities beta diversity, and comparisons between large heterogeneous areas with several communities, gamma diversity (Pielou, 1975).

Measures of Diversity

There are two principal drawbacks to using species counts as a measure of diversity. First, they fail to take account of species abundance patterns. A community with two species might be divided in two extreme ways:

	Community 1	Community 2
Species A	99	50
Species B	1	50

The second community would seem intuitively to be more diverse than the first. Secondly, species counts depend on sample size. Adequate sampling can usually get around this difficulty, particularly with vertebrate species (Krebs,1972).

The simplest measure of biodiversity is the number of species in the community or ecosystem concerned. This is termed “species richness”. It is arrived at merely by counting. Admittedly, statistical problems arise when the community of interest is too large to census in its entirety, then it must be estimated by extrapolation (Pielou, 1975).

Numerous diversity indices based on measures (or estimates) of the quantities of the different species in each sample plot have been devised. The two best known are Shannon's index and various inverse functions of Simpson's Index of Concentration (the converse of diversity). They are wholly unsuitable for measuring biodiversity. This becomes clear from consideration of the following points after Pielou (1975):

1. Biodiversity studies need rapidly gathered data from as many plots as possible, over large areas. This requires presence/absence (binary) data, not detailed, time-consuming measures of quantity.

2. Biodiversity deals with organisms ranging in size from trees to bacteria, making comparable quantitative measurements on such different scales impracticable.

3. Use of binary data overcomes difficulties with quantitative data, such as the size of herbaceous plants changing rapidly with seasons.

4. In many animals (e.g. insects), population sizes fluctuate enormously from year to year. Binary data are much less affected than quantitative data by such quantitative variability.

Species Diversity Indices

Species diversity may be thought of as being composed of two components. The first is the number of species in the community, which ecologists often refer to as species richness. The second component is species evenness or equitability. Evenness refers to how the species abundance (e.g. the number of individuals, biomass, cover) are distributed among the species. For example, in a community composed of ten species, if 90% of the individuals belong to a single species and the remaining 10% are distributed among the nine other species, evenness would be considered low. If each of the ten species accounted for 10% of the total number of individuals evenness would be considered maximum.

Over the years, a number of indices have been proposed for characterizing species richness and evenness. Such indices are termed richness indices and evenness indices. Indices that attempt to combine both species richness and evenness into a single value are what is referred to as diversity indices. The major criticism of all diversity indices is that they attempt to combine and hence, confound, a number of variables that characterize community structure: (1) the number of species, (2) relative species abundances (evenness), and (3) the homogeneity and size of the area sampled (James and Rathbun, 1981).

Diversity indices incorporate both species richness and evenness into a single value. Because of this, Peet (1974) termed these heterogeneity indices. Probably the biggest obstacle to overcome using diversity indices is interpreting what this single statistic actually means.

Northern Region of Thailand

National Park, Wildlife and Plants Conservation Department (2004) reported characteristics of the northern region of Thailand as in Table 2.1:

Table 2.1 Northern forest areas in 2003.

Land area (km^2)	Forest area (km^2)	Area of nature reserves (km^2)
113,425	61,374	11,369
54.1 % of land area	10.0 % of land area	18.5 % of forest area

Geography

Round (1998) stated that the northern region is bounded by the Salween and Moei rivers to the west, the Mekong River to the north and east and by the Central Plains to the south. It comprises of the largest area of uplands in the country and includes six peaks of over 2,000 m elevation. The plain areas lie mostly above 200 m and are highest in the north and west of the region. The major valleys and mountain ranges are mostly north-south oriented. The climate is highly seasonal with a pronounced cool season and average annual rainfall is 1,200-1,300 m in the lowlands.

Habitats

Table 2.2 The remaining areas of forest type in northern Thailand**.**

Forest type	Evergreen (all categories)	Mixed deciduous	Dry dipterocarp	Coniferous
Area (km²)	25,568	25,006	34,318	2,018
Percentage of total	29.4 %	28.8 %	39.5 %	2.3 %

Although forest cover is apparently higher than for any other region, the present estimate does not give a reliable indication of areas occupied by primary forest. Most of the lowlands are covered with degraded, scrub formations with relatively few large trees. The most extensive and least disturbed lowland forests are found in the west of the region. Most of the evergreen forest cover is of hill evergreen formations, above 1,000 m. Huge tracts of hill evergreen forest have been cleared by shifting cultivators (hill tribes) so that most of the uplands are covered by a patchwork of succession habitats in which relict forest stands on the highest mountains, above 1,800 m elevation. Such areas are usually above the upper margin of cultivation. Forest cover in Northern Thailand declined by 22.75 percent during the years 1973-1982 (Klankamsorn and Charuppat, 1984).

Avian Ecology

Welty (1963) reported concurrently that "Ecology is education of relationships between fauna and flora with environments". Berger (1961) further explained that "The environment is influential to biotic survivals which depend on both biological and physical factors and education of relationship among biotic and environment is the most necessary". Pettingill (1950) stated that "Education between relationships of birds and environment is the education of bird ecology". The elements of bird ecology are strongly dependent on physical factors such as temperature, humidity, light, rainfall and wind velocity, and biological factors such as food, plants and animals.

Bird Fauna in Thailand

Lowlands. The lowland bird fauna is almost entirely shared with that of the other regions of continental Thailand. Only five resident lowland species, *Gecinulus grantia, Riparia paludicola, Enicurus immaculatus, Saxicola jerdoni,* and *Passer domesticus* are restricted to northern Thailand. The Khun Tan mountain range is regarded as an important zoogeographical boundary and many subspecies of lowland bird which occur in the drier forests to the west are of Indo-Burmese affinity (Deignan, 1945). Many of these species and subspecies extend also into south-western Thailand. The lowlands to the east of the Khun Tan range have more Indo-Chinese affinities and evergreen forests in this region support species such as *Lophura diardi*

and *Carpococcyx renauldi*, which are widespread in north-east and south-east Thailand.

Among the lowland birds, those species which inhabit the larger forested streams and rivers are most at risk, both from habitat destruction and from hunting. These include *Cairina scutulata, Sarkidiornis melanotos, Icthyophaga humilis* and *I. ichthyaetus, Aegypius calvus, Pavo muticus, Heliopais personata,* and *Megaceryle lugubris*. Most lowland valley bottoms have been cleared and settled while previously remote forested stretches of the Ping and Nan rivers have been inundated by hydro-electric dams.

Upland (>1000m). Northern Thailand is of primary importance for the large number of Sino-Himalayan species which occur in association with hill evergreen forests or successional habitats since 58 species of breeding bird species are apparently restricted to this region. Some species, such as *Saxicola torquata,* appear to be recent colonists which have moved into deforested areas. Other upland species are shared with the uplands of the south-west or the north-east while a few also extend into the mountains of the south-east or the peninsula.

While the majority of upland birds species are widespread on many mountains in Northern Thailand between 1,000-1,800 m, there are a small number of ‘upper montane’ birds which may only occur on those few mountains of over 2,000 m elevation. These are *Columba pulchricollis, Sylviparus modestus, Minla strigula,*

Brachypteryx montana, *Rhipidura hapoxantha*, and *Dicaeum melanoxanthum*. Two more 'upper montane' species, *Phylloscopus maculipennis* and *Aethopyga nipalensis* are only found around the summit of Thailand's highest mountain, Doi (mountain) Inthanon (2,565 m).

The mountains of the extreme north of Chiang Mai Province, and those further south in the northern part of the Khun Tan Range and in Chiang Rai and Nan Provinces support a few species of upland bird species which are absent from Doi Inthanon and other mountains to the south and west. These include *Picoides cathpharius* and *Tesia cyaniventer*. In addition, these areas support more Yunnanese or Laotian species of birds than do the areas to the west, where the bird fauna is closely similar to that found on Mount Muleyit in south-east Burma (Deignan, 1945). Based on differences in both the lowland and upland bird communities, northern Thailand can be further subdivided:

1. The Salween and Ping Drainage. This includes Doi Inthanon, Doi Suthep-Pui, and Doi Chiang Dao, together with the areas to the west.

2. The drainage of the Mekong, Wang, Yom and Nan rivers. This includes the mountains of Doi Pha Hom Pok, Doi Mae Tho and other peaks of the northern Khun Tan Range and the mountains of Nan Province, close to the Laotian border, including Doi Phu Kha.

The environmental pressures on upland birds are much greater in this region than in any other region, owing to the presence of large numbers of hill tribes who live in close proximity to the forest. Many birds of prey, partridges *Arborophila* spp., pheasants, the larger pigeons and hornbills have been greatly reduced or extirpated. The most critically endangered upland species is *Syrmaticus humiae* which is listed as vulnerable in the IUCN/ICBP Red Data Book (IUCN, 2003). This species has certainly disappeared from areas where it was previously known on Doi Suthep, though it may still be present on Doi Chiang Dao and has also been reported from Doi Langka (Young, 1967), which has not been recently surveyed. The larger hornbills are thought to be close to being extirpated in northern Thailand (Round, 1988). The situation is especially severe for *Aceros nipalensis* which has a relatively restricted range in Thailand, being shared only with the south-west.

The impact of deforestation upon smaller upland birds is more difficult to judge. Selective cutting, combined with repeated burning continues to degrade most remaining areas of primary evergreen forest. Although many recently deforested mountains still support populations of smaller understorey birds in relict forest patches along stream sides and on steeper mountain slopes, it is not clear whether such populations will be self-supporting in the long term. While a great many babblers and bulbuls are relatively ecologically tolerant and inhabit forest edges and secondary growth, other species which depend upon large, mature trees or lush, moist understorey may be more vulnerable. Four species of small, upland birds (*Sitta magna*, *Certhis discolor*, *Garrulax erytrocephalus* and *Niltava grandis*) could not be

relocated in Doi Suthep-Pui National Park during intensive surveys in 1978-1984 even though these species were apparently fairly common there 50 years previously (Round, 1988).

The studies on bird diversity in Thailand

Thailand has established laws and a large network of protected areas for the conservation of terrestrial ecosystems which are administered by the National Park, Wildlife and Plants Conservation Department. The laws offer two basic approaches: protection of forest habitats and direct species protection through controls on hunting or trade. Laws relating to national parks are enforced by the National Park Division while other conservation legislation is enforced by the Wildlife Conservation Division. Both of these bodies are divisions of the National Park, Wildlife and Plants Conservation Department. Wildlife sanctuaries have been established under the jurisdiction of the Wild Animal Reservation and Protection Act. Wildlife sanctuaries are equivalent to national parks in both their size and their completely protected status. As in national parks, modification of the environment is forbidden but, the collection of animals and plants is permitted for scientific purposes, subject to the issuing of permits. In contrast to national parks, recreational use of wildlife sanctuaries, though permissible, is not actively encouraged (Round, 1988).

At present there are many associations, clubs and other groups of people who engage in bird watching. In particular, to observe, identify, and categorize the birds in

the wild are very significant parts of wildlife management, either in wildlife conservation areas, non-hunting areas, or in national parks. With knowledge about the kind, varieties, and numbers of birds it will be possible to plan and manage these natural resources appropriately (Khobkhet, 1999).

The scientific survey and study of birds in Thailand was started in 1859 by Sir Robert H. Schomburg, the English Consult in Bangkok at the time. He collected samples of birds in northern Thailand and later wrote up a report and described examples of bird species from all regions of Thailand. There are 962 species of birds recorded in Thailand. Among these, the resident species which actually breed or are supposed to breed in the country consist of 549 species and include the little grebe (*Tachybaptus ruficollis*), yellow bittern (*Lxobrychus sinensis*), black-shouldered kite (*Elanus caeruleus*), and siamese fireback (*Lophula diardi*). In addition there are around 284 species of migratory birds which move into the country during the short cool period. These include the northern pintail (*Anus acuta*), eastern marsh – harrier (*Circus spilonotus*), eurasian coot (*Fulica atra*), brown-headed gull (*Larus brunnicephalus*), and white wagtail (*Motacilla alba*). Some spend the whole winter breeding in Thailand. A study and survey report showing figures and bird species found in various preservation areas in Thailand has been produced (Biodiversity Conservation in Thailand, 2000).

In northern Thailand, Sitasuwan *et al.* (1998) carried out a survey of bird diversity in the areas around four rural communities in Mae Hong Son Province: Ban Huay He, Ban Huay Pha and Ban Huay Sue Thau in Muang District, and Ban Tham

Lod in Pang Ma Pha District, from January to December 1998. At least 264 bird species in 49 families were recorded: Ban Huay He, 202; Ban Huay Pha, 70; Ban Hauy Sue Thau, 142; and Ban Tham Lod, 153 species. There were 39 common bird species from 23 families in the observed areas. The dominant species in all areas were black-crested bulbul (*Pycnonotus melanicterus*) and red-whiskered bulbul (*Pycnonotus jocosus).* In addition, Groom (1998) carried out a survey in the Mae Ping National Park in Chiang Mai Province and published a handbook of bird sightings. He found at least 208 bird species with 151 resident species and 57 migratory birds. Most of them could be found in mixed deciduous forest because this ecosystem has resources which are more suitable for birds than the dipterocarp forest. There was a bird survey in Doi Inthanon National Park, Chiang Mai, in 1991 (RFD, 1992) that found more than 364 species including 104 species which migrate in some seasons. It was found that around the lower terrain of Doi Inthanon is seasonal dipterocarp forest which is inhabited by the blue magpie (*Urocissa chinensis*), rufous treepie (*Dendrocitta vagabunda*), and eurasian jay (*Garrulous glandarius*). These species live in flocks. Lineated barbet (*Megalaima lineate*), and collared falconet (*Microhierax caerulescens*), which always roost on tree tops, were also found. Pattanavibool (1999) studied the birds in Om Koi Wildlife Sanctuary, Chiang Mai Province, and Mae Tuen Wildlife Sanctuary, Tak Province. There was a total of 2,433 observations of 89 species in Mae Tuen and 1,192 detections of 119 species in Om Koi. For each forest patch the number of species found was 50 (289 counts), 54 (304 counts), 51 (340 counts) and 61 (305 counts) in Mae Tuen Wlidlife Sanctuary and 68(310), 64(356), 54(241) and 67(285) in Om Koi Wildlife Sanctuary. In the survey to establish a master plan for the management of Salween Wildlife

Sanctuary, a total of 122 species in 89 genera and 36 families were found (Forest Research Center, 1991). They were 108 resident species, 14 of which migrate in the winter season. Some rare species in Thailand were found in this wildlife sanctuary such as the green peafowl (*Pavo muticus*), grey peacock – pheasant (*Plyplectron bicalcaratum*), kalij pheasant (*Lophura leucomelana*), and mountain hawk-eagle (*Spizaetus nipalensis*). Many water birds were also found such as the little heron (*Butorides striatus*), the black bittern (*Dupetor flavicollis*) and the oriental darter (*Ahinga melanogaster*). Vacharaloka and Pamajitsouyngam (2000) carried out a study in Salawin Wildlife Sanctuary and found only 87 bird species, a great decrease compared with the earlier survey.

There were other surveys carried out in the middle and eastern regions of Thailand for the purpose of creating a management plan for Khao Aang Rue-nai Wildlife Sanctuary, which is located on the borders of five eastern provinces (Forest Research Center, 1995). They found 246 species from 160 genera in 64 families. Pitayakajonvut *et al*. (1998) carried out a study in the same area and found 98 species from 78 genera in 35 families. This represents only 39.83% of the numbers found in the original survey. Most of the birds there inhabit the forest and other natural environments such as seasonal evergreen, deciduous, dipterocarp forest or limestone outcrops. Other species including the great hornbill (*Buceros bicornis*), siamese fireback (*Lophura diardi*) and bluewing pitta (*Pitta moluccensis*) live near water resources while the spotted dove (*Streptopelia chinensis*), common myna (*Acricotheres tristis*), streak–eared bulbul (*Acridotheres tristis*) and scaly-breasted munia (*Lonchura punctulata*) inhabit grassland and farming areas and villages near

the border of the wildlife sanctuary. Khobkhet (1998) studied the birds in Bueng Boraphet Non-hunting Area, Nakornsawan Province. He found more than 187 species in 11 orders of 43 families and 114 genera. The white-eye river martin (*Pseudochelidon sirintarae*) was found here which is the newest resident endemic species which has never been reported anywhere else in the world. Treesucon (2000) carried out a bird survey in Kaeng Krajan National Park, Petchburi Province, which has been regarded as the preservation area where the highest number of bird species are found in Thailand. Not less than 413 species were confirmed, with 305 resident species and 72 migratory birds in the cool season, only 16 of which made a stopover on their migratory route. Some 8 species are residents that also migrate past. Another 8 species are resident birds that migrate in the cool season. Four species are migratory birds which build nests and lay eggs. There are 49 species which have been found scattered only in southern Thailand.

In southern Thailand, Round and Treesucon (1996) carried out a survey in the Kao Nojujee forest, which is now Khao Pra-bang Kram Wildlife Sanctuary, Krabi Province. They found no fewer than 318 species, including 247 resident species, 2 migratory species which built nests and laid eggs and 69 species which migrated for the cool season or passed by. Many species were found here because there is a lowland plain connected to the surrounding area.

The presence of birds is related to two main environmental factors: physical and biological (Pettingill, 1950). The physical factors are temperature, moisture, sunlight, rainfall, wind and elevation. The biological factors are food, plants and

animal species, which affect bird distribution, migration, singing, nesting, and mating. Feeding behaviour of birds is related to food abundance, which is seasonal (Moller, 1983). Temperature, sunlight, rainfall, wind and terrain are the main factors affecting bird activity. Allee *et al.* (1950) reported that an increase of sunlight intensity will decrease bird activity. In any habitat the physical environment is occupied by vegetation. In this process the environment is modified; both substrate and microclimate are changed by the presence of plants. Only after the plants have arrived and provide food then animals move in. During evolution, animals have adjusted to various combinations of physical factors and vegetation, with species evolving to occupy the various niches provided (Dangsee, 1996). The evolution of each species suits it to a particular habitat and rules out the use of other areas (Lauhachinda, 1983).

The diversity of birds varies throughout the year by the effect of seasons. Bird diversity is highest in the cool season (Ingkapatanakul, 1995). Ingkapatanakul (1995) reported that the highest total number of species of birds in Chalerm Ratanakosin National Park occurred in January, which was the same month of the highest total number of bird species in Bung Borapet Non-hunting Area (Khobkhet, 1998). Aumgate (1999) also reported that the total number of species of birds in Bung Borapet in January 1996, January 1997, and January 1998 were the highest for each year.

The diversity of birds in mangrove forest is positively related to rainfall. Somrang (1985) reported that the total number of bird species in mangrove forest is

high when the rainfall is high. Birds in other kinds of forest differ from birds in mangrove forest. McClure (1996) reported that the diversity of birds is low when the rainfall is high. This is consistent with Khobkhet (1980) who showed that most birds are found when the sky is clear and only a few are found on rainy days. Khobkhet and Thongaaree (1982) reported that the presence of bird species in Bung Borapet is low when rainfall is high. Khobkhet (1980) also reported that the highest number of bird species was found in the morning (7-9 a.m.) and in the afternoon (4-6 p.m.).

Wildlife Sanctuaries and Conservation in Thailand

A total of 59 wildlife sanctuaries had been established by 1 November 2003. These range in size from 95 km² to 3,200 km² and cover an area of 22,995,326 rai (36,793 km²) (Wildlife Conservation Bureau, 2003). Many of the most important wildlife conservation sites in the country have wildlife sanctuary status.

Study Area in this Research

The study site is situated at the Salween Wildlife Sanctuary, an important site with abundant habitats, with much of it consisting of mountainous terrain known as the Tenasserim Range. It was the 20th sanctuary in Thailand to be declared as a wildlife conservation area on August 24th, 1978. It is situated in Mae Sariang District of Mae Hong Son Province in northern Thailand, between latitudes 18º 15´ - 18º 35´ N and longitudes 97º 21´ - 97º 49´ E. This area is the watershed of Salween basin covering 546,875 rai (875 km^2). The topography is mountainous with the elevations ranging from 200 to 1300 m. The highest peak is Doi Kun Gong Mai (1,300 m). The

climate is tropical and the average rainfall is 1,230.2 mm/year with the highest average rainfall (243.2 mm) in August and lowest in February (5.3 mm). The average highest temperature is 32.7º C and average lowest is 19.8º C, with the highest in April of 38.0º C, and lowest in February of 12.9º C. The highest relative humidity average is 85.5% in August and the lowest of 56.1% in March (Salween Wildlife Sanctuary Report, 2000).

Vegetation Cover

Vegetation types in Salween Wildlife Sanctuary have been characterized by the Thailand Forest Research Center (1991,1992) and are influenced by elevation, soil type, and human activities. There are 7 types.

1. Deciduous forest – This forest type is present from 200-650 m. It can be classified into two subtypes, deciduous with teak and deciduous without teak. Deciduous with teak is characterized by teak, upper height 25-30 m dominated by *Tectona grandis, Xylia xylocarpa* mixed with *Gmelina arborea, Terminalia* spp., *Spondias pinnata,* and *Quercus herrii.* Deciduous without teak is dominated by *Xylia xylocapa,* and *Pterocarpus macrocapus.* A variety of bamboo is also characteristic of this forest type.

2. Dipterocarp forest – This is distributed from 200-800 m. The morphology is similar to deciduous forest dominated by the family Dipterocarpaceae. Forest fires often occur every dry season. Other characteristics include an open canopy and lack

of bamboos with tree species such as *Dipterocarpus tuberculatus, Shorea obtuse, Shorea siamensis,* and *Terminalia alata.*

3. Dipterocarp – Pine forest - This forest type is similar to dipterocarp forest but pine is mixed with it at 600 m. *Pinus merkusil* is the emergent layer, with the majority over 25 m tall, and maybe found are *Dipterocarpus tuberoclatus, Shorea obtuse, Shorea siamensis, Dipterocarpus obtusifolius, Dipterocarpus tuberoculatus, Melanorrhoea glaba, Wendlandia tinctoria, Lithocarpus polystachyus,* and *Spondias pinnata.*

4. Hill evergreen forest - This forest type covers the top of the hills at 1,000 1,300 m, and occurs along the boundary betweem Salween and Mae Youm Fung Kwa Wildlife Sanctuary. It is dominated by family Fagaceae including three main genera, *Lithocarpus, Castanopsis,* and *Quercus,* with *Lithocarpus garrettianus, Lithocarpus sootepensis, Lithocarpus fenestratus, Quercus kingiana,* and *Betula alnoides*. In the open areas shrubs in the genera *Melastoma, Osbeckia* and *Rhamnus* can be found.

5. Evergreen forest- This forest type is found less, occurring in humid creeks in rather high areas. Although it is mainly closed canopy, there are fewer species in the family Fagaceae and more spacing between trees than hill evergreen forest. Canopy trees comprise of *Hopea* spp., *Toona ciliate, Alstonia scholaris, Magifera caloneura, Protium serratum,* and *Paranephejium* and also some of Family

Zingiberceae and *Calamus* spp, *Dryopteris amboinensis*, and *Lasia spinosa* can be found.

6. Old clearings and shifting cultivation areas- This kind of habitat is caused mainly by the hill tribes and local people. The area is mostly covered with *Imperata cylindrica* if the soil is very degraded. In the areas with higher moisture, *Eupatorium odoratum, Thysanolaena maxima* and *Tithonia deversfolia*, are dominant.

7. Limestone forest- This forest type has little shrubs in Family Ficuseae and some plants in the Family Gramineae.

Round (1998) reported that the forest of Salween Wildlife Sanctuary has not been surveyed in detail, but consists of rolling hills of low to moderate elevation, covered by mixed-deciduous and dry dipterocarp woodlands. The lowland riverbed areas are mostly occupied by Karen hill tribe villages. It is situated in a loop of the Salween River, which forms the western boundary of the sanctuary and also the Thai-Burmese border. Most of the terrain slopes down from north to south and west. The western border common with Myanmar (Burma) is approximately 120 km long consisting of 65 km of the Salween River (Salween Wildlife Sanctuary Report, 2000).