Chapter 5
Correlation of biological factors

Diversity of Birds

In total, 160 species of birds were identified in 4 habitat types. This is equivalent to 16.50% of the 970 birds found in Thailand. Of the study plots, dry evergreen forest (DEF) was the most abundantly inhabited with 88 species, and deciduous forest (DF) was the second with 84 species. Seventy-seven and 65 species were found in dry deciduous forest (DDF) and riparian forest along Mae Ngae Gully (GL) plots, respectively. However, no statistical difference was detected between numbers of species present in each habitat type (Chi-square test for homogeneity, $\chi^2_3 = 3.88$, $p>0.05$), suggesting that the 4 habitats maintained similar numbers of bird species.

Additionally, 71 species out of 160 species were found in only one individual habitat (Figure 9). That is, 31 were found in only GL: *Coracius benghalensis, Alcedo meninting, Megceryle lugubris, Centropus sinensis, Psittacula finschii, Hirundapus giganteus, Apus affinis, Phodilus badius, Treron phoenicoptera, Amauronis phoenicurus, Anthus hypoleucos, Vanellus cinereus, Vanellus indicus, Glareola lactea, Avicedae leuphotes, Elanus caeruleus, Milvus migrans, Accipiter virgatus, Polihierax insignis, Egretta garzetta, Casmerodius albus, Ardeola bacchus, Lanius schach, Myiophonus caeruleus, Enicurus immaculatus, Enicurus schistaceus, Acridotheres tristis, Acridotheres cinereus, Gracula religiosa, Phylloscopus fuscatus* and *Motacilla alba*; 12 in DF: *Chrysococcyx xanthorhynchus, Aegithina lafesnayei, Melanochlora sultanae, Pycnonotus atriceps, Pycnonotus finlaysoni, Zosterops erythropleurus, Zosterops japonicus, Seicercus burkii, Abroscopus supercilliaris, Stachyris nigriceps, Dicaeum chrysorrheum* and *Arachnothera longirostra*; 10 in DDF: *Harpactes oreskios, Butastur liventer, Pericrocotus cinnamomeus, Pericrocotus ethologus, Tephrodornis pondicerianus, Monticola solitarius, Muscicapa dauurica,*

Sitta castanea, Phylloscopus coronatus and *Anthus cervinus*; and 18 in DEF : *Picus chlorolophus, Picus canus, Megaliama australis, Upupa epops, Streptopelia tranquebarica, Oriolus chinensis, Oriolus traillii, Dicrurus remifer, Tephrodornis virgatus, Monticola rufiventris, Turdus obscurus, Saxicola ferrea, Hypsipetes mcclellandii, Hypsipetes madagascariensis, Prinia atrogularis, Phylloscopus reguloides, Alcippe morrisonia* and *Yuhina zantholeuca*. These numbers were significantly different (Chi-square test for homogeneity, χ^2_3 = 15.41, p<0.05). Each habitat may contain specific attributes suitable such as prey species, nesting material, cavity in specific trees etc. for the requirements of only some species of birds. Those species that were found in several habitat types could be termed generalists, while those that were found in only a single type of habitat could be called specialists: 71 species were specialists and 89 generalists. Comparison between specialists and generalists from this study showed that no significant difference was detected between the two categories (Chi-square test for homogeneity with Yates' correction factor, χ^2_1 = 1.81, p>0.05). Both groups had a similar number.

Among the generalists, 37 species were found in 2 habitats: *Gallus gallus, Megaliama lineata, Eurystomus orientalis, Surniculus lugubris, Cypsiurus balasiensis, Chalcophaps indica, Treron curvirostra, Spizaetus nipalensis, Microhierax caerulescens, Serilophus lunatus, Garrulus glandarius, Cissa chinensis, Dendrocitta formosae, Corvus macrorhynchos, Oriolus tenuirostris, Coracina macei, Coracina melaschista, Pericrocotus roseus, Pericrocotus divaricatus, Rhipidura albicollis, Dicrurus macrocercus, Dicrurus hottentottus, Terpsiphone paradisi, Copsychus malabaricus, Enicurus leschenaulti, Parus major, Pycnonotus atriceps, Hypsipetes flavala, Orthotomus atrogularis, Garrulax leucolophus, Garrulax pectoralis, Garrulax chinensis, Aethopyga saturata, Arachnothera magna, Dendronanthus indicus, Motacilla cinerea* and *Anthus hodgsoni*; 39 species in 3 habitats: *Picumnus innominatus, Sasia ochracea, Dendrocopos canicapillus, Picus flavinucha, Megaliama virens, Halcyon smyrnensis, Nyctyornis athertoni, Cacomantis merulinus, Chrysococcyx maculatus, Phaenicophaeus tristis, Aerodramus brevirostris, Glaucidium cuculoides, Accipiter badius, Chloropsis cochinchinensis,*

Chloropsis aurifrons, Lanius cristatus, Oriolus xanthornus, Hemipus picatus, Dicrurus aeneus, Hypothymis azurea, Aegithina tiphia, Ficedula parva, Eumyias thalassina, Cyornis banyumas, Hirundo daurica, Pycnonotus flavescens, Iole propinqua, Prinia rufescens, Zosterops palpebrosus, Orthotomus sutorius, Phylloscopus inornatus, Pellorneum tickelli, Pellorneum ruficeps, Pomatorhinus schisticeps, Stachyris rufifrons, Pteruthius flaviscapis, Alcippe poioicephala, Dicaeum concolor, Anthretes singalensis, and 13 species in 4 habitat types: *Megaliama asiatica, Merops leschenaulti, Hemiprocne coronata, Spilornis cheela, Pericrocotus flammeus, Dicrurus leucophaeus, Dicrurus paradiseus, Culicicapa ceylonensis, Sitta frontalis, Pycnonotus melanicterus, Pycnonotus jocosus, Pycnonotus aurigaster* and *Macronous gularis*, which were significantly different (Chi-square test for homogeneity, $\chi^2_2 = 14.11$, $p<0.05$). It may be concluded that most of the generalists inhabited 3 types of forests. Figure 9 interprets numbers of bird species found in specific habitats.

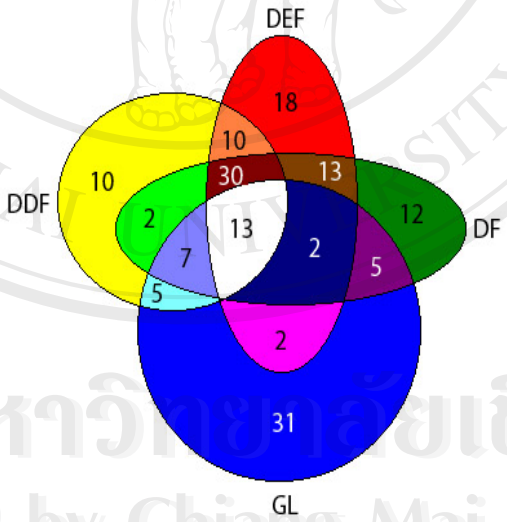

Figure 9 Numbers of bird species found in different habitats

The sightings of the 160 species of birds can be classified into 2 groups. Following Lekagul and Round (1992), 130 species were resident and 30 were migrant species.

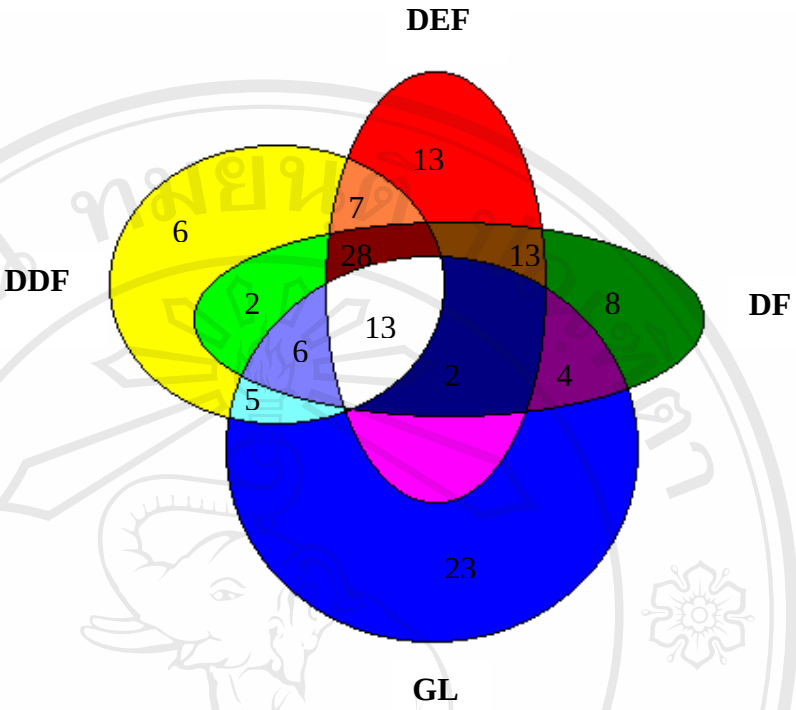

Figure 10 Numbers of resident species found in different habitats.

Of the resident birds that have generalist habit, 13 species were found in 4 habitats: *Megaliama asiatica, Merops leschenaulti, Hemiprocne coronata, Spilornis cheela, Pericrocotus flammeus, Dicrurus leucophaeus, Dicrurus paradiseus, Culicicapa ceylonensis, Sitta frontalis, Pycnonotus melanicterus, Pycnonotus jocosus, Pycnonotus aurigaster* and *Macronous gularis*.

Thirty-six species were found in 3 habitats: *Picumnus innominatus, Sasia ochracea, Dendrocopos canicapillus, Picus flavinucha, Megaliama virens, Halcyon smyrnensis, Nyctyornis athertoni, Cacomantis merulinus, Chrysococcyx maculatus, Phaenicophaeus tristis, Aerodramus brevirostris, Glaucidium cuculoides, Accipiter badius, Chloropsis cochinchinensis, Chloropsis aurifrons, Oriolus xanthornus, Hemipus picatus, Dicrurus aeneus, Hypothymis azurea, Aegithina tiphia, Eumyias thalassina, Cyornis banyumas, Hirundo daurica, Pycnonotus flavescens, Iole propinqua, Prinia rufescens, Zosterops palpebrosus, Orthotomus sutorius, Pellorneum tickelli, Pellorneum ruficeps, Pomatorhinus schisticeps, Stachyris*

rufifrons, Pteruthius flaviscapis, Alcippe poioicephala, Dicaeum concolor, and *Anthretes singalensis.*

Thirty-one species were found in 2 habitats: *Gallus gallus, Megaliama lineata, Eurystomus orientalis, Surniculus lugubris, Cypsiurus balasiensis, Chalcophaps indica, Treron curvirostra, Spizaetus nipalensis, Microhierax caerulescens, Serilophus lunatus, Garrulus glandarius, Cissa chinensis, Dendrocitta formosae, Corvus macrorhynchos, Coracina macei, Coracina melaschista, Rhipidura albicollis, Dicrurus macrocercus, Dicrurus hottentottus, Terpsiphone paradisi, Copsychus malabaricus, Enicurus leschenaulti, Parus major, Pycnonotus atriceps, Hypsipetes flavala, Orthotomus atrogularis, Garrulax leucolophus, Garrulax pectoralis, Garrulax chinensis, Dendronanthus indicus,* and *Motacilla cinerea.*

The resident birds that are habitat specialists found in each type of habitat were the following:

1. GL: There were 23 species, namely*: Coracius benghalensis, Alcedo meninting, Megceryle lugubris, Centropus sinensis, Psittacula finschii, Hirundapus giganteus, Apus affinis, Phodilus badius, Treron phoenicoptera, Amauronis phoenicurus, Vanellus indicus, Glareola lactea, Avicedae leuphotes, Elanus caeruleus, Accipiter virgatus, Polihierax insignis, Lanius schach, Myiophonus caeruleus, Enicurus immaculatus, Enicurus schistaceus, Acridotheres tristis, Acridotheres cinereus,* and *Gracula religios.*

2. DF: 8 species were found in DF, i.e. *Chrysococcyx xanthorhynchus, Melanochlora sultanae, Pycnonotus atriceps, Pycnonotus finlaysoni, Abroscopus supercilliaris, Stachyris nigriceps, Dicaeum chrysorrheum,* and *Arachnothera longirostra.*

3. DDF: 6 species were identified in only DDF. They were *Harpactes oreskios, Butastur liventer, Pericrocotus cinnamomeus, Pericrocotus ethologus, Tephrodornis pondicerianus,* and *Sitta castanea.*

4. DEF: DEF was a special habitat for 13 species, i.e. *Picus chlorolophus, Picus canus, Megaliama australis, Upupa epops, Streptopelia tranquebarica, Oriolus traillii, Dicrurus remifer, Tephrodornis virgatus, Hypsipetes mcclellandii, Hypsipetes madagascariensis, Prinia atrogularis, Alcippe morrisonia,* and *Yuhina zantholeuca.*

Of the migrants, 21 species were found in only a single habitat (specialist habitat) 6 species were found in 2 habitats and 3 species found in 3 habitats (generalist habitat). Not a single migrant inhabited all 4 habitat types. Migratory species were significantly different in selecting habitats (Chi-square test for homogeneity, $\chi^2_2 = 15.50$, $p<0.05$). Figure 11 shows numbers of migrant species in 4 types of habitat.

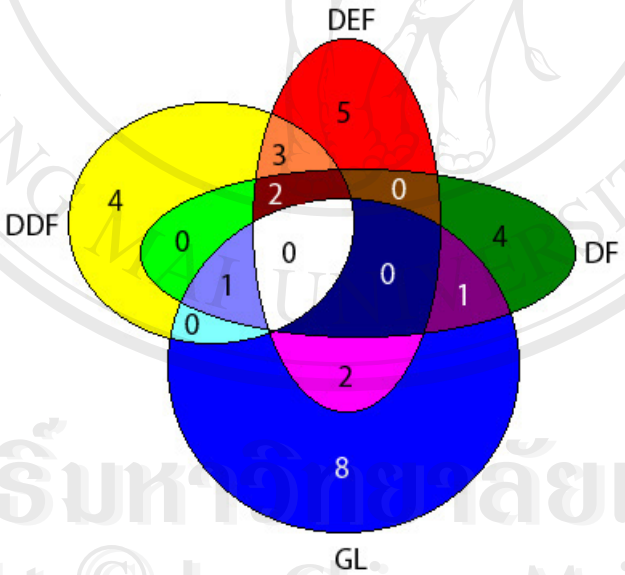

Figure 11 Numbers of migratory species found in different habitats.

Birds that were able to inhabit 3 types of forest, i.e. DEF, DDF, DF, were *Lanius cristatus*, *Ficedula parva* and *Phylloscopus inornatus*. These birds were highly generalist compared to other species. The 2 species living in GL and DEF were

Pericrocotus divaricatus and *Dendronanthus indicus.* Three other species present in DDF and DEF were *Anthus hodgsoni*, *Pericrocotus roseus* and *Oriolus tenuirostris.* The following are species specific to one habitat type.

1. GL: There were 8 species living in only GL. They were *Anthus hypoleucos*, *Vanellus cinereus*, *Milvus migrans*, *Egretta garzetta*, *Casmerodius albus*, *Ardeola bacchus*, *Zosterops erythropleurus,* and *Phylloscopus fuscatus*.

2. DDF: 4 species were only found in DDF. They were *Monticola solitarius*, *Muscicapa dauurica*, *Phylloscopus coronatus,* and *Anthus cervinus.*

3. DF: 4 species, i.e. *Zosterops erythropleurus*, *Seicercus burkii*, *Motacilla cinerea,* and *Carpodacus erythrinus* were present only in DF.

4. DEF: 5 species inhabited only DEF. They were *Oriolus chinensis*, *Monticola rufiventris*, *Turdus obscurus*, *Saxicola ferrea,* and *Phylloscopus reguloides*.

Therefore, migratory species that utilised only a single habitat may be susceptible to habitat change. In other words, if only one habitat disappears from Salween Wildlife Sanctuary, at least 4 migratory birds may disappear accordingly. For example, if GL was converted to agricultural land, it will seriously threaten 8 species of migratory birds and 23 species of resident ones.

Species richness of birds

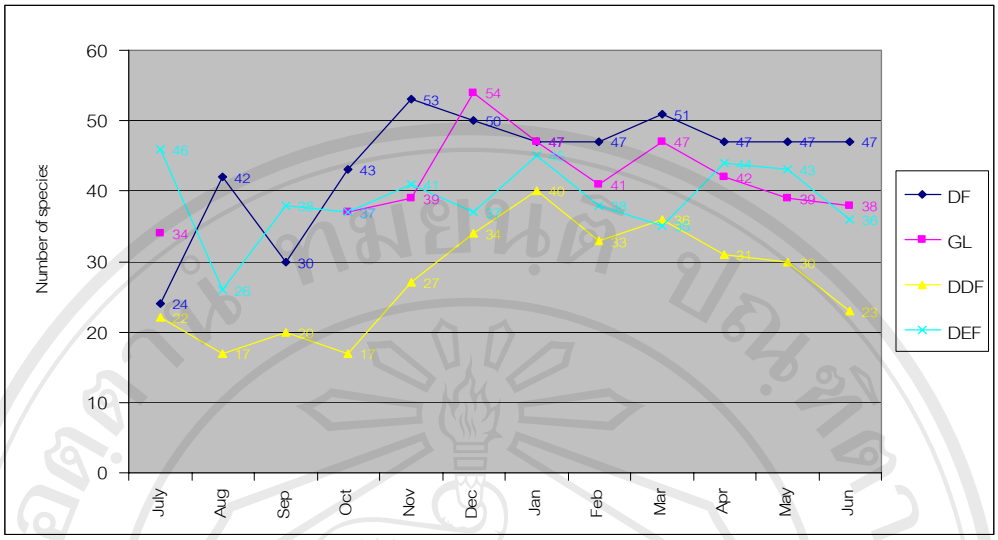

Figure 12 Species richness of birds collected monthly in each forest type.

Among the 4 habitats, fewest species of birds were found in October in DDF and the highest was in GL in December. In all habitats numbers of species peaked in winter, the time that migratory birds arrived. Species of birds in GL were found most in December and least in July 2002 with 54 and 34 species respectively. In DDF, January has the most abundance with 40 species present compared with the least diverse in August and October when 17 species were identified in both months. DF had the highest numbers of bird species in November with 54 species and lowest in July with 24 species recorded. DEF had an unusual pattern of numbers of bird species in that the peak was found in July with 46 species and sharply declined in August with 26 species.

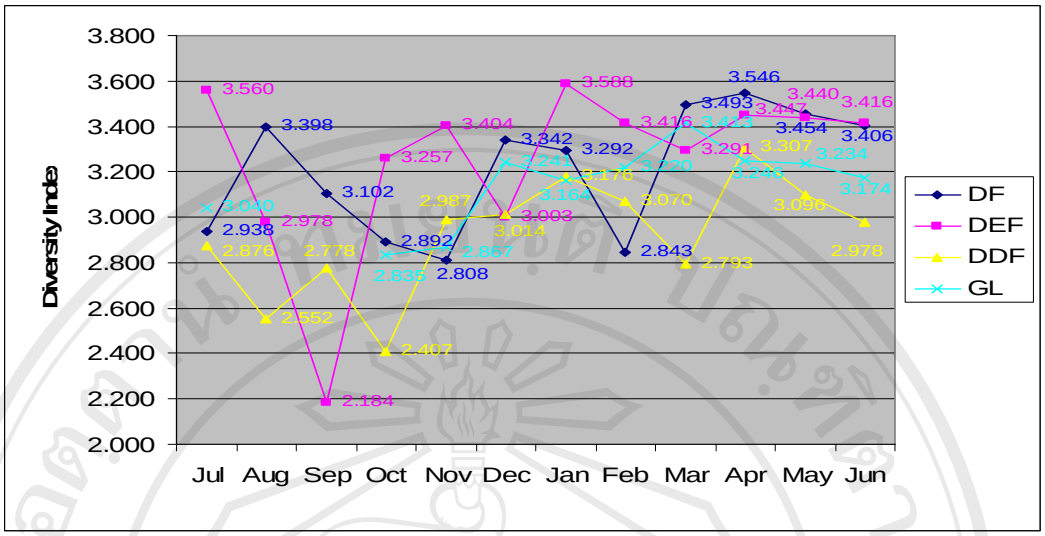

Figure 13 Monthly diversity index of birds in each habitat type.

Unlike the patterns in species composition where most of the species were found in winter, diversity index reached the peak during January-April, following the long stay of the migrants. The highest index among 4 habitats was of DEF in January and the least was also of DEF in September. In GL the peak was in March *H'*= 3.560 and the least was in October *H'*= 2.835. In DDF the peak was in April *H'*= 3.307 and the least was in October *H'*= 2.407. In DEF, the peak was in January *H'*= 3.560 and the least was in September *H'*= 2.808. In DF the peak was in April *H'*= 3.560 and the least was in November *H'*= 2.808. It is apparent that at the period between the end of breeding season and the beginning of migration, birds in SWS had the the lowest in diversity index. This is probably due to some species containing a large number of individuals especially that make scattered distribution of individuals in each species.

1. Shannon Diversity Index

Shannon diversity index (Magurran, 1988) was calculated and statistically compared for different habitats. The DEF was the habitat that maintained the highest diversity index, *H'*= 3.69056, followed by DF, DDF and GL, with 3.67885, 3.62495, and 3.512301, respectively. Statistical testing between the 3 most diversified habitats indicated no-significant difference (Student's t-test, $p>0.05$). However, the least diverse habitat, GL, was significantly different from DEF, DF and

DDF (Student's t-test, $p<0.05$). Statistical value and probability are shown in Table 5.1.

Evenness of resident and migratory birds in the 4 habitats was quite similar ranging from 0.830288-0.841393. The highest evenness was found in GL followed by DDF, DEF and DF, respectively. This indicated that composition in numbers of birds in each species was more uniform in GL than any other habitat type. In other words, though the least diverse habitat, GL was composed of species that contained relatively similar numbers in each species. Uniform distribution in numbers of organisms in a particular habitat helps maintain stability of the habitat. Therefore, in terms of diversity of birds, GL seemed to be more stable than any other habitat.

Table 5.1 Diversity index of birds in each habitat and its comparison.

	[6]DF	[7]DDF	[8]DEF
	H'=3.67885 *E*=0.830288	*H'*=3.62495 *E*=0.834511	*H'*=3.69056 *E*=0.830712
[9]GL *H'*=3.512301 *E*=0.841393	t=5.634 df=5285 p<0.05	t=2.44 df=3411 p<0.05	t=5.230 df=4087 p<0.05
DF *H'*=3.67885 *E*=0.830288	-	t=1.620 df=3434 p>0.05	t=0.3534 df=4553 p>0.05
DDF *H'*=3.623845 *E*=0.834256		-	t=1.758 df=3589 p>0.05

When considering only resident birds, DEF was the most diversified habitat and statistically different from the other 3 habitats, while DF was the second most diverse habitat followed by DDF and GL, respectively. Statistical comparison of diversity index between habitat types is presented in Table 5.2.

Table 5.2 Diversity index of resident birds in different habitats and statistical comparison.

	[10]DF	[11]DDF	[12]DEF
	H'=3.565886 *E*=0.823391	*H'*=3.513551 *E*=0.835626	*H'*=3.728208 *E*=0.863513
[13]GL *H'*=3.313529 *E*=0.83067	t=38.37 df=4898 p<0.05	t=5.77 df=3244 p<0.05	t=13.61 df=4031 p<0.05
[14]DF *H'*=3.565886 *E*=0.823391	-	t=1.54 df=3214 p>0.05	t=5.48 df=4263 p<0.05
DDF *H'*=3.513551 *E*=0.835626		-	t=6.27 df=2998 p<0.05

It is relatively clear from Tables 5.1 and 5.2 that diversity index of resident birds was less than that of resident and migratory birds combined. The value was between 0.03765 and 0.198772. GL was the habitat whose index most fluctuated at 0.198772, because a number of migratory birds were found mostly in GL. Thus GL was the most important habitat and can be regarded as an international conservation area in that it contained high value of diversity index for migratory birds.

While GL is likely to be more stable when considering evenness value for migratory and resident birds combined, evenness of only resident birds in DEF was highest when compared with other habitats followed by DDF, GL and DF, respectively. By definition, resident birds are those that stay and live in habitats longer than migrant ones. Migratory birds, thus, may play a vital role in changing status of habitats in that, to some lesser extent, they escalate stability in a relatively less stable habitat, i.e. GL, to highest rank among the 4 habitats.

However, that mentioned above was based on species and number of birds found in habitats. The weak points were that birds may be double counted. Keeping this in mind, binary data was used to compare the similarity of birds in different habitats.

Simplified Morisita's Index (Krebs, 1989) was employed to secure the similarity between habitats. Table 5.3 indicates index of similarity between each group of habitats, which ranged between 16.04-64.27%.

Table 5.3 Similarity index of birds found in each pair of habitats using Simplified Morisita Index (%)

	[15]Simplified Morista Index (%)		
	DF	DDF	DEF
GL	52.39	33.49	16.04
DF	_	64.27	58.83
DDF	_	_	56.64

The least similar habitats were DEF and GL with index of 16.04%. The most similarity was between DF and DDF (64.27%). The similar index between DDF and GL was 33.49%, between DEF and DF was 58.83%, between DF and GL was 52.39% and between DEF and DDF was 56.64%. Those similarity indices between pairs of habitats were incidentally related to altitude. Habitats next to one another maintain similar birds more than habitats situated far away. This may be explained by the flying ability of birds.

Diversity Index of birds between months

Diversity index declined from rainy season to early winter season. This was probably because winter was the post-breeding season. A great number of birds perish during the breeding season, due to predation, starvation, and natural calamities. The survivors were those that were fit enough for the serious threatening conditions of the previous breeding activities. These birds will be the founders of the next breeding season. This is probably the reason of declining diversity from rainy to winter season, especially prior to the commencement of migration. The migratory birds added diversity index between 0.091019-0.228057. Middle of winter had the highest diversity index.

2. Cluster analysis for bird diversity

To avoid the weak points of re-counted or double-counted birds, binary data (present or absent) was used to group birds found in different months of the year. The following are cluster analyses of birds identified in 4 habitats all year round.

1. DF: The 84 species of birds identified in this type of forest over a year comprised of 8 sp. (9.52%) migrants and 76 sp. (90.48%) resident birds (Appendix I). It can be divided into 5 groups at 50% similarity (Figure 14). The following are groups of months similar in bird species.

1st group March-June

2nd October-December and February

3rd January

4th August-September

5th July

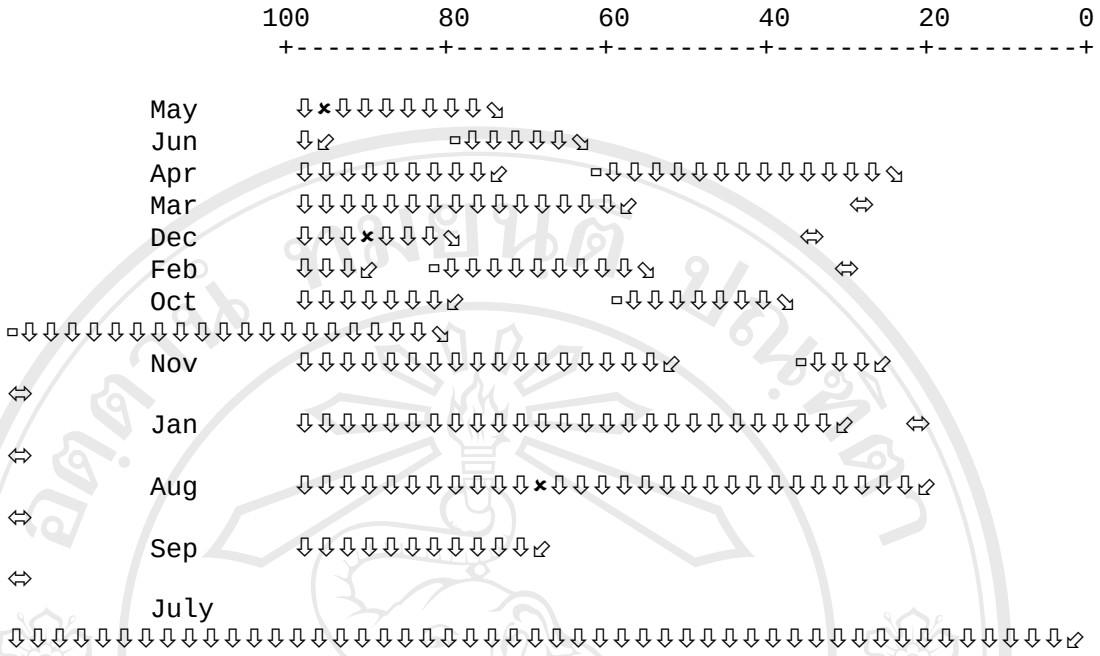

Figure 14 Cluster analysis of birds identified in DF over a year.

The results suggest that instead of spending 12 times in a year surveying birds in DF, only 5 times would be sufficient to cover all the species present. Reliable data could be obtained by conducting surveys in January, March, July, September and December. The cluster also indicated that winter months were in the same group from the influence of migratory birds.

2. DEF: The 88 species present in DEF comprised of 12 sp. (13.63%) migrants and 76 sp. (86.36%) resident birds (Appendix I). It can be grouped into 9 groups at 50% similarity (Figure 15). They are

1st March, September and November

2nd April

3rd May-June

4th July

5th August

6th October

7th December

8th February 9th January

It is apparent that at 50% similarity, more groups were observed compared to DF. Although diversity index was not significantly different between DF and DEF (Table 5.1), together the similarity index of the 2 types was 58.83% (Table 5.3), more times must be spent in DEF in order to cover all species present.

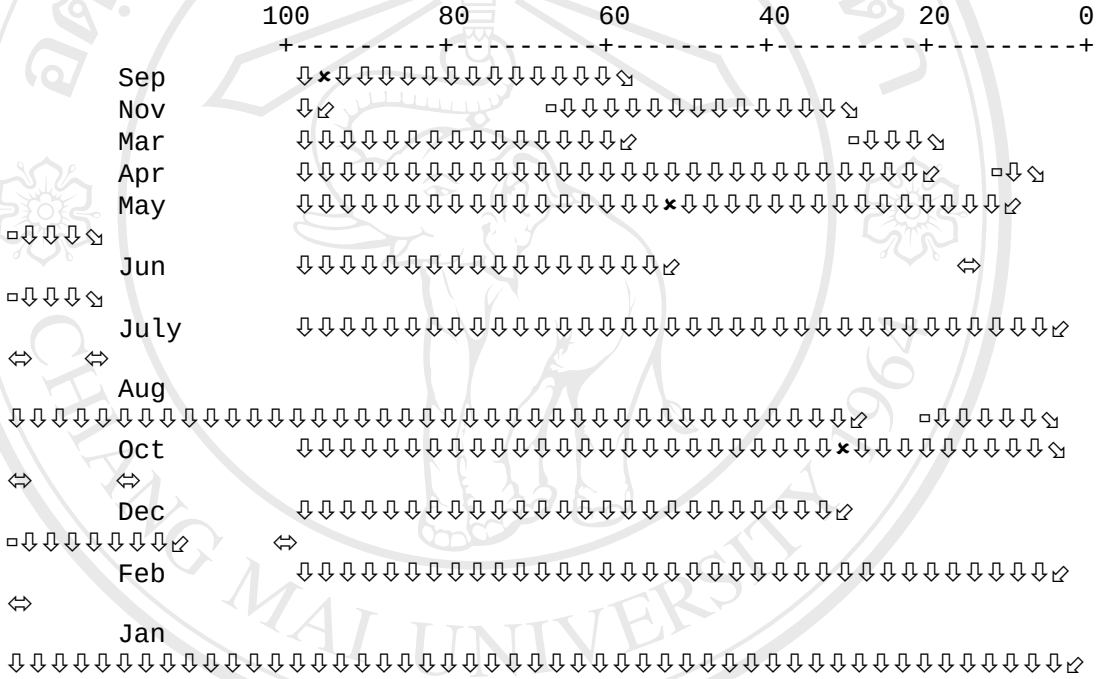

Figure 15 Cluster analysis of birds found in DEF

3. DDF: For the 77 species of birds identified in DDF over 12 months of investigation, they comprised of 10 sp. (12.99%) migrants and 67 sp. (87.01%) resident birds (Appendix I). At 50% similarity, 5 groups can be distinguished (Figure 16). They are

1st December-March

2nd November

3rd April-June

4th August-October

5th July

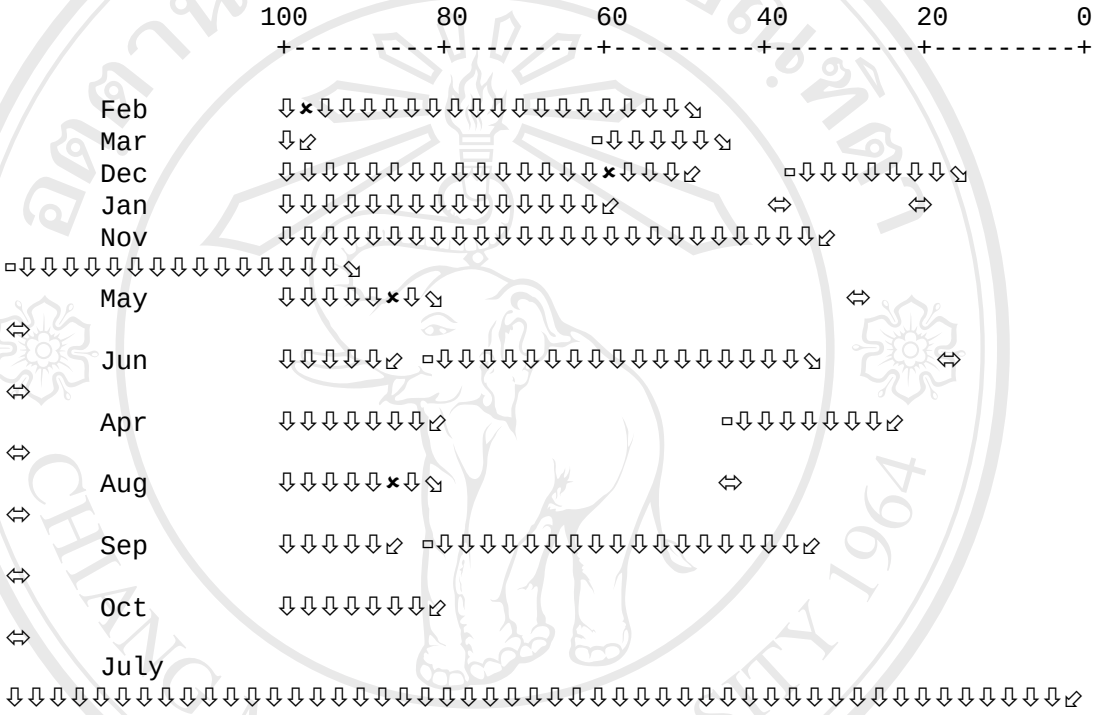

Figure 16 Cluster analysis of birds identified in DDF over a year.

Compared with the previous 2 habitats, DDF was distinct in that all months were in the same cluster at 30% similarity except July which was the only month not similar to the others. Four times could be spent to examine the presence of birds sufficiently in this habitat. Results are likely to be the same with every month surveyed. Cluster analysis suggests that January, May, September, July and November are the months worth examining birds in this type of forest.

4. GL: 65 species of birds were present in GL comprising of 12 sp. (18.46%) migrants and 53 sp. (81.54%) resident birds (Appendix I).. Six groups can be separated at 50% similarity (Figure 17). They are:

1st May-July and October

2nd April

3rd November

4th December-January

5th March

6th February

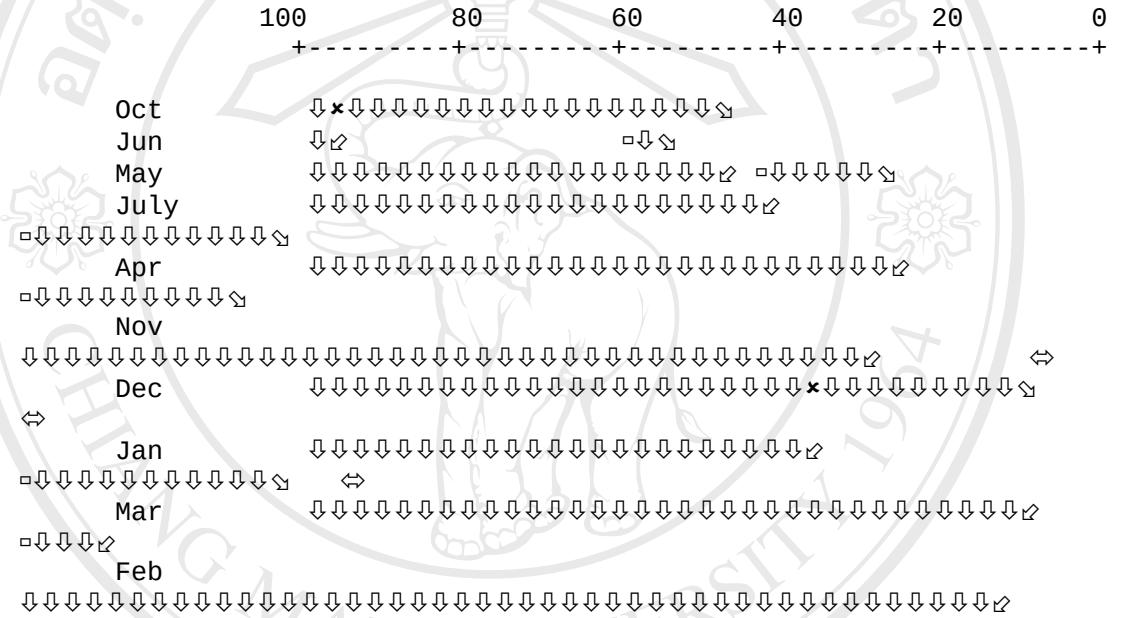

Figure 17 Cluster analysis of birds found in GL over a year.

GL was apparently similar to DEF in that it contained quite a number of groups. Diversity indices of the 2 were significantly different (Table 5.2) and they hadonly 16.04% similarity (Table 5.3). This also suggests that more attention must be paid to investigate in these types of forest as species present over time are more diverse.

It is generally accepted that birds spend more time in habitat less disturbed and more environmentally stable than the less stable and more disturbed. To put it another

way, birds tend not to disperse from habitat that meets their niche requirements for a long time. From the cluster analysis, it was further elucidated that species of birds living in GL and DEF spent less time there than species found in DF and DDF. In GL, local inhabitants usually do fishing. Species of birds found in GL were water-specific species. As water levels fluctuate over time, bird numbers tend to fluctuate accordingly. This is probably the reason of more clusters found in GL. DEF was the most diverse habitat, indicating more species but less numbers were present in this type of forest.

Vegetative communities in Salween Wildlife Sanctuary

1. Tree diversity

Species and numbers of trees identified in plots were used to calculate diversity indices and statistically compared. DF was the most diverse community in terms of species and numbers of trees present. It was followed by GL, DEF and DDF, respectively. Statistical test results are shown in Table 5.4

Table 5.4 Diversity index and statistical value of different forest communities

	DF	DDF	DEF
	H'=3.7307	H'=2.1771	H'=2.7949
	E=0.8312	E=0.5902	E=0.7300
GL	t=7.4638	t=12.4697	t=4.4940
H'=3.143	df=817	df=929	df=824
E=0.8409	p<0.05	p<0.05	p<0.05
DF	-	t=19.7307	t=11.8847
H'=3.7307		df=1270	df=1093
E=0.8312		p<0.05	p<0.05

DDF	-	-	t=7.9758
H'=2.1771			df=1340
E=0.5902			p<0.05

Statistical difference in diversity index was detected among the 4 plant communities. This meant that the 4 plant communities were very different from one another. Evenness was found highest in GL followed by DF, DEF and DDF, respectively. Stability of diversity tends to be in habitats that are composed of similar proportions of individuals in each species. In terms of tree composition, GL was the greatest but DDF was the least.

Cluster analysis separated GL and DF from DEF and DDF (Figure 18). Differences in diversity of plants helps diversify birds in this sanctuary.

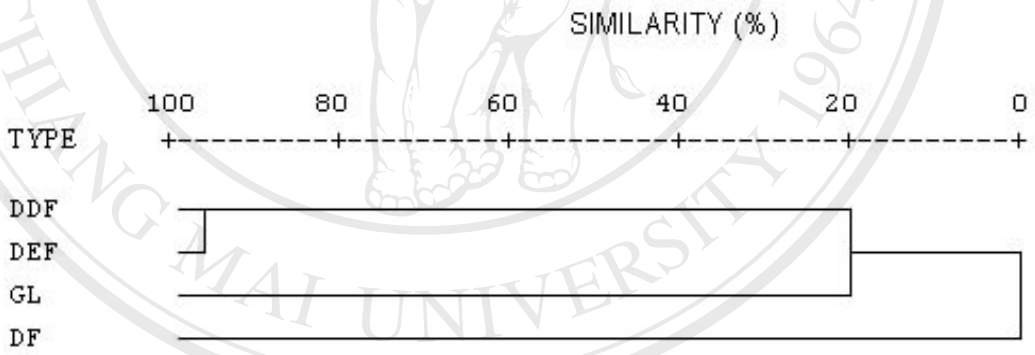

Figure 18 Cluster analysis of plants found in different communities

Similarity index between GL and DEF was the least and between DDF and DEF the most (Table 5.5). Although they were significantly different, there was some degree of similarity among different plant communities. More similarity was found between communities of high altitude than low altitude. For example, DEF located at altitude between 900-1100 had 65% similarity to DF at altitude 500-750, whereas GL located at 250 msl was 3.17% similar to DDF situated at 500 msl.

Table 5.5 Similarity index of plant communities

	Simplified Morisita Index (%)		
	[16]DF	[17]DDF	[18]DEF
[19]GL	32.64	3.17	1.37
DF	_	55.10	65.00
DDF	_	_	61.77

2. Structure of plant communities

The structure of plant community was based on size of trees. Three size classes were developed according Pomded (1997) as follow:

1. Small tree, dbh <40.00 cm.
2. Medium tree, dbh between 40.01-60.00 cm.
3. Large tree, dbh >60.01 cm.

Figure 19 presents size classes of trees recorded from different communities. DDF composed of 24.4% small, 33.9% medium and 41.66% large trees. The proportion was significantly different (Chi-square test for homogeneity, χ^2 =33.94, 2df, p<0.05).

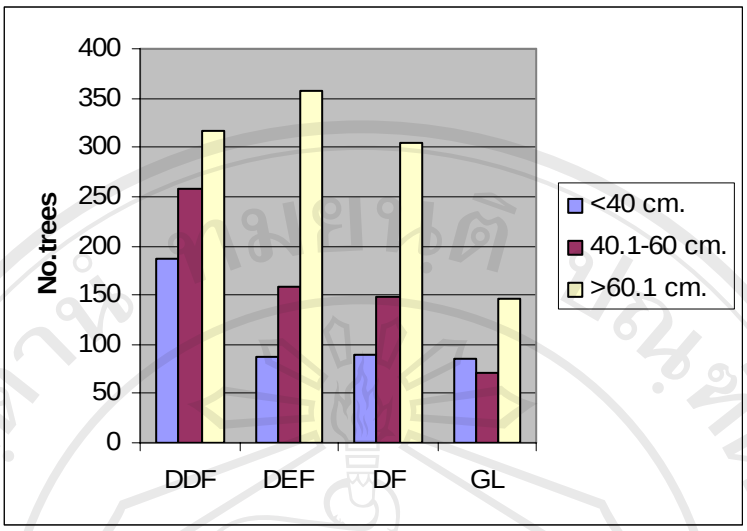

Figure 19 Numbers of trees in different size classes among plant communities.

In GL, 28.38% small, 23.43% medium and 48.18% large trees were found. The proportion was also statistically different (Chi-square test for homogeneity, χ^2 =31.19, 2df, p<0.05).

DF consisted of 16.58% small trees, 27.26% medium and 56.17% large ones. The proportion was also statistically different (Chi-square test for homogeneity, χ^2 =136.72, 2df, p<0.05).

In DDF, 24.44% small, 33.90% medium and 41.66% large trees were found. The proportion was also statistically different (Chi-square test for homogeneity, χ^2 =33.94, 2df, p<0.05).

For DEF, small, medium and large trees were represented by 14.59, 26.23 and 59.20%, respectively. The proportion was also statistically different (Chi-square test for homogeneity, χ^2 =193.80, 2df, p<0.05).

To sum up, every type of plant community consisted of trees which were sized significantly differently. All communities maintained large trees in great proportion. This suggests regeneration and recruitment was very poor in these communities. This is probably the result of previous logging concessions, fires, and timber poaching.

Among community comparisons, there was significant difference in proportion of each size class (Chi-square test for association, χ^2 =65.61, 6df, $p<0.05$). Large trees were mostly found in DEF, medium trees were in great abundance in DDF and small trees were present in GL in great proportion. Structurally, the 4 habitats were intrinsically different in terms of basal area.

Three parameters, i.e. first branch height, tree height and crown height, were investigated as these 3 parameters play vital roles in bird diversity and distribution. Narrow-winged birds tend to use open habitats because they are unable to manoeuvre whereas broad-winged species are able to fly through obstructed habitats because of their high manoeuvrability. Vertical and horizontal structure of habitats may be a determining factor diversifying bird species.

Comparison of the 3 parameters in different communities is presented in Table 5.6. First branch height, tree height and crown height were significantly different among plant communities. Lower space and crown area was found more in GL.

Table 5.6 Statistical comparison of 3 parameters among plant communities.

Type	1st branch height (m)	Tree height (m)	Crown height (m)
DF	8.19± 7.40[a]	12.24± 5.12[a]	4.05± 6.63[a]
GL	9.59± 6.83[b]	18.18 ±10.69[b]	8.58± 6.5[b]
DDF	7.14± 2.90[c]	11.34± 4.14[c]	4.20± 2.58[a]
DEF	7.36± 3.45[c]	12.80 ±6.15[a]	5.15± 3.03[c]

Note, in each column, numbers with the same letter indicate no difference (LSD).

First branch height was significantly different among plant communities (One way ANOVA, $F_{3,2207}$ =19.87, p<0.001). GL had the highest first branch height followed by DF, DDF and DEF, respectively.

Average tree height was significantly different among plant communities (One way ANOVA, $F_{3,2207}$ =107.20, p<0.001). Trees in GL were highest followed by DF-DEF and DDF, respectively.

A significant difference was detected in mean crown height among communities (One way ANOVA, $F_{3,2207}$ 75.95, p<0.001). Crown height in GL was highest followed by DEF-DF and DDF, respectively.