Chapter 7

Discussion

1. Plant communities and diversity of birds in Salween Wildlife Sanctuary

1.1 Diversity of birds and plants

Analysis of data indicated that similarity of plant communities was significantly correlated with similarity of birds in two habitats. This is plausible as diversity index was calculated from numbers of each species present in habitat regardless of the same species being present in both habitats. On the other hand, similarity index was calculated from numbers of individuals of the species present in both habitats. It is the similarity index that can explain the relationships between two habitats in the micro-scale, different habitats in one biome. In macro-scale, diversity index plays an important role in comparison as few species of organisms could inhabit different biomes, so similarity index may reach zero.

The present study found a positive relationship between similarity of birds and plants in different habitats. In other words, the more similar the plant species in habitats, the more similar the birds present in these habitats. It is very clear from this finding that the more similarity in plant communities, the more similarity in birds present in these communities. This may enable birds to have a chance to utilize a vast area nearby in case of disturbance or threats occurring in particular habitats. On the contrary, the less similarity in plants the less similarity in birds species. This means that more diversity of birds happens in these habitats. Wilson (1992) states that diversity of birds is a result of variety of habitat differences. If threats or disturbance occur in habitats that are less similar to one another, birds could not survive, as no suitable alternative habitats are present.

The finding of no significant difference between diversity index of birds and plants may be caused by the presence of insectivorous birds in great proportion in the habitats. It is likely that diversity of birds might be correlated with diversity of insects. A small fraction of frugivorous and nectivorous birds was identified in each habitat. Only 17.10-18.88% of resident birds inhabiting the 4 habitats were frugivorous and nectarivorous. These birds occupy the area all year round and fruits and nectar may be limiting factors. Phrenology of plants in the tropics show 4 patterns (Gentry, 1974) as follows:

1. The “big bang”: production of a large number of flowers over a short period. Examples are *Ficus* spp.,and *Gluta usitata* (Wall.) Ding Hou.

2. The “steady state”: production of a small number of flowers over an extended time period. This type of pattern may be found in *Lithocarpus* sp.

3. The “cornucopia”: a rather large number of flowers over a month’s time period.

4. The “multiple bang”: several widely spaced, large flower crops per year.

In the old world tropics, most plants exhibit the "big bang" pattern. The phenomenon usually takes place in dry season between December and April (WCD, 1991). It has been scientifically concluded that May-November is the critical period for resident birds in the tropics. To put it another way, bottleneck periods for fruit and nectar eating birds in the tropics are in the period of May-November every year.

1.2 Forest structure and diversity of birds

Birds identified in each type of forest were classified according their feeding strategies. Table 7.1 shows percentage of each feeding guild in each habitat.

Table 7.1 Feeding guild of birds (%) in different habitats.

Feeding guild (%)	DF	GL	DDF	DEF
Insectivorous	51.32	37.74	55.22	53.95
Omnivorous	18.42	16.98	14.93	18.42
Carnivorous	7.89	24.53	10.45	5.26
Frugivorous	17.11	18.87	17.91	17.11
Granivorous	1.32	0.00	0.00	2.63
Nectarivorous	3.95	1.89	1.49	2.63
	100	**100**	**100**	**100**

From Table 7.1, it can be seen that insectivorous birds were the biggest group in all 4 habitats. It was followed by frugivorous and omnivorous, respectively. Resident birds, especially insect-eating birds, therefore, are determinant of diversity in these habitats. Comparison of feeding guilds showed no significant differences among groups of birds in 4 habitat types (Chi-square test for association, χ^2_{15} =13.31, p>0.05). Data were then combined and interpreted on a large scale. The following proportions are numbers of feeding guilds of birds in Salween Wildlife Sanctuary.

Species of birds (F.B.) = G1 : N2.52 : C12.18 : O17.41 : F17.97 : I50.18 …… (1)

(F.B.= Feeding Behaviour) G=granivorous, N=nectarivorous, C=carnivorous, O= omnivorous, F= frugivorous and I= insectivorous.

Equation 1 shows that for one species of granivorous bird indentified in Salween Wildlife Sanctuary, there were 2.52 nectarivorous species, 12.12 predatory species, 17.41 omnivorous species, 17.97 frugivorous species and 50.18 insectivorous species. On the other hand, mathematical calculation can predict one from another.

Table 7.2 Feeding guilds (%) of migratory birds.

Feeding guild (%)	DF	GL	DDF	DEF
Insectivorous	50.00	58.33	60.00	58.33
Omnivorous	25.00	0.00	30.00	41.67
Carnivorous	12.50	41.67	10.00	0.00
Frugivorous	0.00	0.00	0.00	0.00
Granivorous	12.50	0.00	0.00	0.00
Nectarivorous	0.00	0.00	0.00	0.00
	100	**100**	**100**	**100**

Like resident birds, insectivorous birds were the largest group among migratory ones. More that 50% of the migrants were insect-eating birds followed by omnivorous and carnivorous, respectively. It is very apparent that insectivorous birds are the biggest group of resident and migratory birds.

Tropical rain forests have 3 dimensions. That is, the structure can be measured by length, width and height. Resource partitioning is a strategy the animals use to survive.

Birds found in all habitat types can be classified stratifically into 4 groups. Those that search for food in open areas (hawking), those that search for food on the ground, those that search for food in the canopy and those that search for food on tree trunks.

For resident birds (Table 7.3), canopy searching birds was the biggest group found in the 4 habitat types. It was followed by trunk-searching and hawking birds, respectively. The proportions were not statistically different (Chi-square test for

association, χ^2_9 =5.83, p>0.05). Data were then combined and averaged to predict proportions for Salween Wildlife Sanctuary as follows:

Species of Birds (F.S) = O1 : T1.2 : G5.09 : C11.34 ……. (2)

(F.S.=Forest structure) O = Open-space birds, T= bark-gleaning birds, G= ground - gleaning birds, and C= canopy-gleaning birds

Equation 2 shows that for 1 species of hawking bird present in the area, 1.2 species of bark-gleaning birds, 5.09 species of ground-gleaning birds and 11.34 species of canopy-gleaning birds will be present. In addition, any single species identified can lead to the conclusion of other species being present.

Table 7.3 Percentage of birds classified stratifically for 4 types of habitats

	GL	**DF**	**DDF**	**DEF**
Canopy	56.60	61.84	62.69	61.84
Ground	33.96	25.00	22.39	27.63
Open space	7.55	3.95	5.97	3.95
Bark	1.89	9.21	8.96	6.58
	100	**100**	**100**	**100**

Migratory birds were classified into 2 groups (Table 7.4): those that search for food in the canopy and those that search food on the ground. The proportion among habitats was not significantly different (Chi-square test for association, χ^2_3 =5.07, p>0.05).

Table 7.4 Proportion of migratory birds classified stratifically for 4 habitats.

	GL	DF	DDF	DEF
Canopy	16.67	62.50	50.00	50.00
Ground	83.33	37.50	50.00	50.00
	100	**100**	**100**	**100**

From Tables 7.3 and 7.4, proportion of migratory and resident birds found in 4 habitats was not significantly different, although a difference was found in species composition. This indicates that forest structure of each habitat was utilised by birds in the same manner. When data were pooled and averaged, it can be concluded that 60.74% of birds in Salween were species of canopy searching, 27.24% species of ground searching, 6.66% species of bark searching and 5.35% species of open area searching. Canopy volume was very important for birds in Salween Wildlife Sanctuary.

2. Diversity of birds and environmental factors.

The present study was consistent with McClure (1990) , Khobkhet (1980) and Khopkhet and Tongaaree (1982) in that diversity of birds negatively correlated with rain. However, it contradicted to Somrang (1985) who found the positive relation of birds and rainfall. This is probably due to Somrang (1985) studying in mangrove forest where most of the birds are water birds. The prey of these birds are triggered by the amount of water. When it rains, water stimulates activity of prey species further inducing abundance of birds.

Inger and Colwell (1977) found that evergreen forest was less variable in environmental conditions than deciduous forest. Animals in predictable environments tend to be more abundant than in unpredictable environments (Inger and Colwell, 1977). Species of birds in DEF were greater than species of birds found in DF. However, the difference was not statistically significant. Species of plants in the 2 habitats was not obviously distinct either. The first 5 most important species of DEF

were *Shorea obtusa* Wall.ex Blume, *Shorea siamensis* Miq, *Quercus* sp., *Gluta usitata* (Wall.) Ding Hou and *Anneslea fragrans* Wall, and the 5 most important species of DF were *Shorea obtusa* Wall.ex Blume, *Tectona grandis* L.f., *Xylia xylocarpa* Tuab. var. *kerrii* Nielsen, *Dipterocarpus obtusifolius* Teijsm. Ex Miq and *Shorea siamensis* Miq. Simplified Morisita Index of both habitats was 65%, which was the highest among habitats. Species of birds in DF and DEF were consequently not different like those of amphibians and reptiles in the study of Inger and Colwell (1977). However, cluster analysis of environmental data i.e. rain, relative humidity, daylength and temperature, in each forest type indicated the closeness between DF and DDF and not far form DEF (Figure 24).

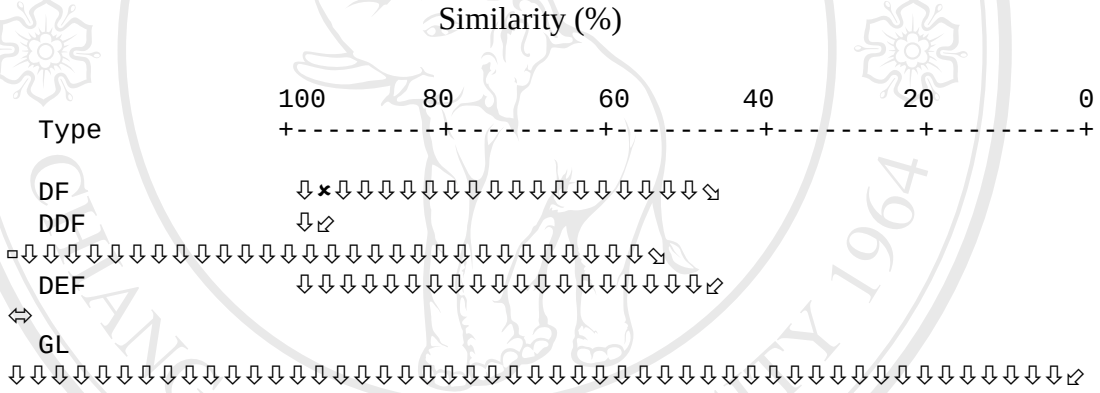

Figure 24 Dendrogram of group of forest types using environmental data

The straight distance between DF and DEF was approximately 6 km. It was likely that some bird species were able to cover such a distance as the 2 habitats were quite similar. Narrow-winged birds characterized by fast flying (Cromer, 1968), such as *Hemiprocne coronata, Aerodramus brevirostris,* etc. could easily move from DF to DEF and vice versa.

A constraint and limitation of habitats situated next to one another like DF and DEF is that negative impacts may reach from one to the other. An example being that fires usually escape from one type of forest to another, and may cover all the sanctuary. Such an impact may set a cascading effect to quality and quantity of forests. This may undoubtedly affect birds and other animals in these areas.

Similarity index between DF and DEF was 58.83% suggesting that species present in one habitat may occur in the other. McClure (1974) stated that presence or absence of related species may be a function of the inability of forest to provide what is needed to the birds even though the situation appears similar to the observer. The difference between DF and DEF is visually distinct for men, not birds. Greater than half of the bird species were found in both habitats.

There were some species found in only a single habitat. That is, 26 species, such as *Halcyon smyrnensis*, *Chrysococcyx xanthorhynchus* etc. were found in only DF and 30 species, such as *Picus canus*, *Megaliama australis*, *Spizaetus nipalensis*, *Garrulus glandarius*, *Dendrocitta formosae* etc. in only DEF.

McClure (1974) investigated diversity of birds in Khao Yai National Park, Thailand and Gombak, Malaysia, and pointed out that migratory birds were not a significant component of bird communities in either area. The findings from this thesis are consistent with McClure's (1974) statement.

The results from this study also support McClure's (1974) work in that diversity of birds was negatively correlated to precipitation. November-February, which was migration season, was not the time that diversity reached the maximum in DDF. On the other hand, the contradiction with McClure (1974) is that diversity of birds in GL was positively correlated to precipitation. The explanation is that GL was a breeding site for a great number of birds. Population may gradually climb up and reach the maximum at the end of breeding season which coincided with the rainy season.

Among the 4 environmental factors, temperature was least correlated to numbers of species, numbers of birds and diversity index. Temperature could be used to predict diversity only 1 time compared with 3 times for precipitation data and 1 time for humidity. Day length was the environmental factor that could be used to predict bird diversity. Temperature is the least fluctuating in the tropics. Temperature does not

strongly fluctuate in the tropics partly because the canopy acts as heat protection and regulation. Bird communities in the tropics are largely dependent upon precipitation, while bird communities in temperate areas depend mainly on temperature (Karr, 1976). It is therefore concluded that temperature was a minor factor affecting diversity of birds in Salween Wildlife Sanctuary. This statement is supported by the finding of statistic testing that temperature was not able to predict diversity of birds in the area. Such a statement strongly supplements Karr's (1976) hypothesis.

Wanghongsa (2000) found that coefficient of variation of temperature under the forest canopy was 1.67%, which was significantly lower than coefficient of variation of temperature in open areas which was 5.45%. In temperate regions, the fluctuation of temperature is so high that some animals may either migrate or hibernate, due to inactivity of insect prey which are very sensitive to temperature (Janzen and Schoener, 1968; Erkert, 1982).

Unlike in temperate zones where insects are susceptible to temperature change, insects in the tropics are more sensitive to precipitation than temperature (Dunning and Kruger, 1996). Insectivorous birds in the 4 habitat types of Salween Wildlife Sanctuary still maintain high numbers and species.

Tropical biomes are more complex than any other biome in the world (ODA, 1991; WCMC, 1992). They are unable to return to their original stage if disturbed (Gomez-Pompa et al, 1972, IUCN 1986; ODA, 1991). Scientists such as May (1972) and Pimm (1982) strongly believed that the more complexity in community, the less stable the community. Tropical ecosystems are thus susceptible to disturbance. Loss of a single species may affect up to 10-30 species of organisms (Raven, 1976). Species- area curve suggests that half of the species may be lost if one-tenth of habitats disappear (Wilson, 1992).

Pristine forests deserve conservation. These forests will be the source area in the future, from which dispersal of organisms start. Optimistically, loss of species may occur when habitats change, but some species may re-colonize the changed ones.

If habitat change happens in Salween Wildlife Sanctuary, a great number of species will be affected especially those that inhabit only a single habitat. Conserving diverse habitats also means conserving bird diversity.

3. Management Recommendations

The results indicted the significant difference between riparian habitats and other ones. Such habitats play a vital role for some species of birds. Similarity index also indicated that riparian forest was less than 35% identical to other habitats, or that the difference was great at the value of 65%. Such a difference makes habitats more diverse for birds to occupy, with 31 out of 160 species of birds inhabiting only GL and not found in other habitats. Of these numbers, 8 species were migrants, so GL can be regarded as an internationally and nationally important site for migratory and resident birds. To help promote diversity of birds, GL should be maintained like it is today. Converting GL to other types of land use may lose 18.75% of bird diversity.

GL was characterized by more space beneath the canopy, high vertical crown cover but poor recruitment of trees compared with other habitats. Human disturbance and natural calamities may be responsible for these characteristics.

The critical period for birds is in the breeding season because birds spent more time in the nest when laying and incubating eggs and because the behavior of flying in and out from the nest may attract predators. In order to minimize threats, the area should be closed to the public. The following are times not serious for disturbing birds in Salween Wildlife Sanctuary but that cover much information about birds in the areas.

GL: the best times are Feb, Oct and Dec.

DF: the best times are Feb, Mar, Oct and Nov.

DEF the best times are Jan, May, Nov and Dec.

DDF the best times are Mar, Oct and Dec.

It is apparent that February, March, October and December are the periods that should be encouraged for bird conservation activity. If this pattern is followed, birds will not be threatened and the public will not lose much chance for detail.

4. Conclusions

The study showed temporal and spatial variations in diversity of birds in Salween Wildlife Sanctuary. Spatially, DEF was the most diverse habitat followed by DF, DDF and GL, respectively. Temporally, winter, in particular in the middle, was the birds' most diverse time of the year. The insectivorous and the canopy-searching birds are huge components of bird community in Salween Wildlife Sanctuary which is of very high importance as a breeding ground of resident birds. However, migratory birds played a significant role in diversity of birds in GL, which can be proposed as an international conservation area. In addition, GL, according to evenness, was a more stable habitat than any other since it maintained uniform distribution of numbers of birds in each species.

Since most of the birds are insectivores, diversity of birds did not directly correlate with the diversity of plants in Salween. In contrast, it strongly depended upon precipitation and temperature, which are determinant factors in shaping insect diversity upon which birds depended.

In conclusion, the diversity of birds, at least, in Salween can be maintained and enhanced by increasing canopy layers as well as promoting diversity of insects.