SECTION 4: BIRDS

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4.1. Introduction:

This report presents preliminary analyses and conclusions of the bird survey component of the Jambi base-line study. The analysis is largely descriptive and aims to provide an overview of the data to facilitate comparisons with findings from other disciplines and generate ideas for more detailed and multidisciplinary analysis. The conclusions section flags some areas which may merit further investigation. A brief discussion on the sampling protocol suggests that for birds, an approach drawing on a landscape ecological framework may be more suitable for Rapid Biodiversity Assessment that aims to assess the impact of land use change.

4.2. Aims and objectives:

- To provide baseline data for above-ground biodiversity assessment based on bird species richness and functional (guild) type.
- To investigate the changes in bird diversity across a disturbance gradient from natural forest to agricultural habitats.
- To provide a sample reference point for other multi-disciplinary input.

4.3. Personnel:

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4.4. Methods:

4.4.1 *Review of existing methods:*

For the purpose of measuring and comparing bird diversity there are two broad groups of methods: those which generate a species list, perhaps with an approximation of abundance, and those which generate a species list with a quantifiable measure of abundance.

For birds, abundance is enormously difficult to measure with any precision. A key problem is the difference between observed and real abundance. This can be a factor of a species' habits and the openness of a habitat (distance at which birds can be seen and/or heard). The latter variable differs between habitat types and must be accounted for if the aim (such as in this study) is to compare diversity between habitats. A group of methods called Distance Sampling [Reynolds, 1980] which are supported by a sophisticated analytical statistics package (DISTANCE2) are available for comparing abundance in different habitats. One of these methods (Variable-circular Plot) has been employed by the BirdLife International-Indonesian Programme in Nusa Tenggara and Maluku to compare biodiversity values of different habitat types with proposed reserves. Although distance sampling is highly compatible with a plot-based protocol, it was not considered appropriate for the survey because BirdLife's experienced has revealed that:

- while a density can be calculated with five contacts for a species, twenty contacts are usually required to generate densities within 5% confidence limits; this requires planning for at least 8 days sampling for each habitat type;
- data analysis is complicated and time consuming;
- it is questionable if the assumptions of Distance Sampling methodology are justified in tropical rainforest.

"Rapid" as defined by the time horizon of this study, constrained the choice to *presence-absence* methodologies and those which could yield useable data in one day's sampling per division. Species accumulation curves were selected. This method is well known in Indonesia because it was described by John MacKinnon in his popular field guides. Counts of species are made during successive sampling units, and the cumulative number of species plotted. The rate at which the curve flattens gives an indication of total number of species and whether all species in the habitat have been observed.

MacKinnon defined the sampling unit as the first 20 species and envisaged an observer walking. This introduces a rough measure of relative abundance and increases the likelihood of meeting rare species. The need to link bird observations to a plot, as well as time constraints, required a variation of this methodology - observers stayed with the immediate vicinity of the plot and the sampling unit was a five minute time period. With this protocol an abundance measure is not possible, and rare species are likely to go unrecorded.

4.4.2 *Field Methods used on this survey:*

Twelve plots were sampled using a species accumulation methodology. A species list of contacts was compiled for each five minute period between 16.30hrs and 18.00hrs and between 06.30 hrs. and 08.00 hrs. Audio-visual species contacts were made by the two observers named above in 'wooded' land use types and by a single observer in 'open' land use types. The observers roved within 30m of the plot centre.

Bird species contacts were scored: "H" = heard, "L" = seen, "T" = fly-over. In open habitats a list was made of species actually recorded in the land use.

Data were entered into a spread-sheet after each morning count. Entering data while a count is within immediate memory is an integral part of the overall methodology, because it:

a) assisted with learning\confirming identity of calls;
b) ensured both observers gave the same name to the same contact.

In additional to the above, bird species lists were complied for three landscape elements of the logged forest land-use not sampled in the plots, namely : access road edge; camp; and log pond.

4.4.3 *Analysis:*

4.4.3.1 Data storage and access:

The following two data sets are annexed to this report and contained in the Excel file name 'Jambird.xls':

1. A matrix of species recorded in each 5-min count.
2. A total species list by plot and also by additional "landscape elements". (Annex III, Table 4)

Data set 1 is a combined and agreed record taken from the field notebooks of the two observers. The second data set is compiled from the first. Additional values attributed to each species in order to facilitate investigation of the data sets are as follows:

- Species number code according to [Andrew, 1992 p.147];
- Species number code specific to this study. i.e. the number of the species in the total species list for the study ordered according to [Andrew, 1992 p.147];
- Status i.e. resident (R), migrant (M);
- Diet guild *sensu* [Thiollay, 1995 p.199]
- Feeding site guild *sensu* [Thiollay, 1995 p.199]
- Body size category *sensu* [Thiollay, 1995 p.199]

4.4.3.2 Data analysis:

The methods used resulted in a *presence-absence* data set. Although species were recorded by five minute count, it is not possible to analyse for relative abundance because counts are not independent, i.e. a bird recorded in one count may or may not be the same bird recorded in subsequent counts.

Three species flying over the plot and unlikely to utilise the LUT in which the plot is embedded, were omitted from the analysis (see Appendix 4.1 for list).

To explore the question of the impact of disturbance on forest bird diversity the following analyses were made:

a) **Species richness**. Species accumulation curves were plotted to compare species richness between plots. The intention is to re-analyse this data using the British Museum program "Curves" which optimise the curve. This analysis will be submitted as an update to this report.

b) **Functional diversity**. Species were assigned to diet guilds, foraging site guilds and body size classes *sensu* [Thiollay, 1995 p.199]. Counts of number of species per class are graphed. Unidentified species were omitted from the analysis. A table of number of species according to taxonomic family is also presented.

c) **Resident\migrant status**. A simple count of migrant species by plot was made to ascertain whether numbers differed between plots.

d) **Differentiation in β diversity between sites**. Sørenson's similarity indices were calculated using the Multivariate Statistical Package (MVSP), 1987. This is a simple measure suitable for presence and absence data; it treats all species as equal irrespective of whether they are abundant or rare. [Magurran, 1988 p. 200]

e) **Clustering of sites**. A nearest neighbour cluster analysis was performed on the Sørenson's similarity indices with randomised data input.

4.5. Preliminary results:

4.5.1. *Descriptive analysis:*

4.5.1.1 Species richness:

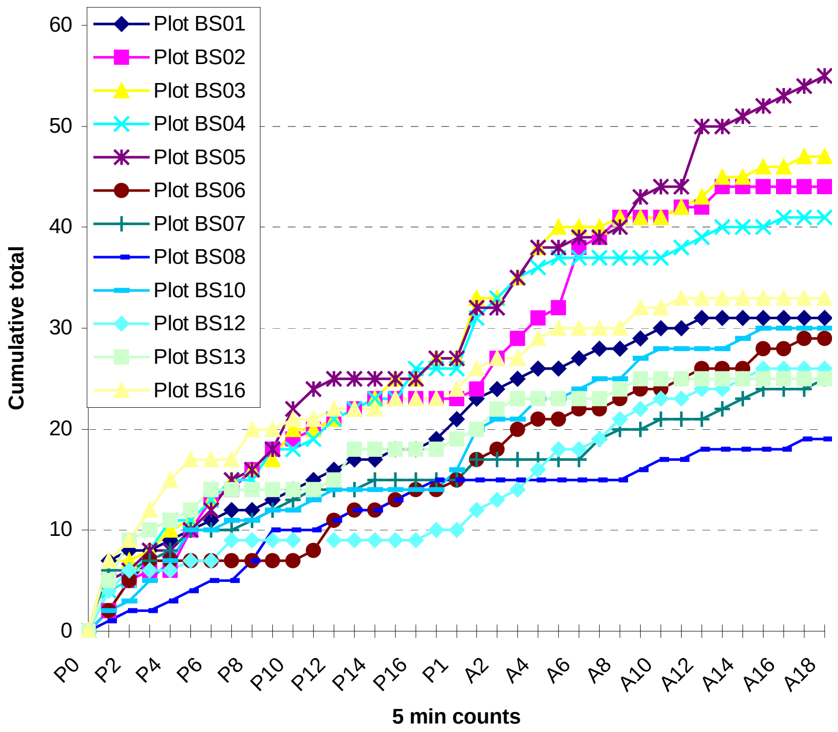


Figure 4.1 Species accumulation curves

Figure 4.1 shows species accumulation curves for each plot. The rate at which the curve flattens is crucial to comparing such curves, and it is regretted that it is not possible as yet to present smoothest-fit curves.

The richest plots were the natural forest plots (BS2 & BS5) and the heavily disturbed logged forest plot (BS3). The two industrial plantation plots (BS7 & BS8) were the most depauperate. The 'wooded' plots appear to show increasingly depauperate sub-sets with increased intensity of management. The 'non-wooded' plots have a largely open-country species assemblage distinct from the 'forest' plots. The *Chromolaena* plot (BS16) has some forest species and represents the change-over point.

4.5.2.1 Trophic diversity:

4.5.2.1.a Proportion of diet guilds:

Figure 4.5.2.1i. Percentage of species diet guilds

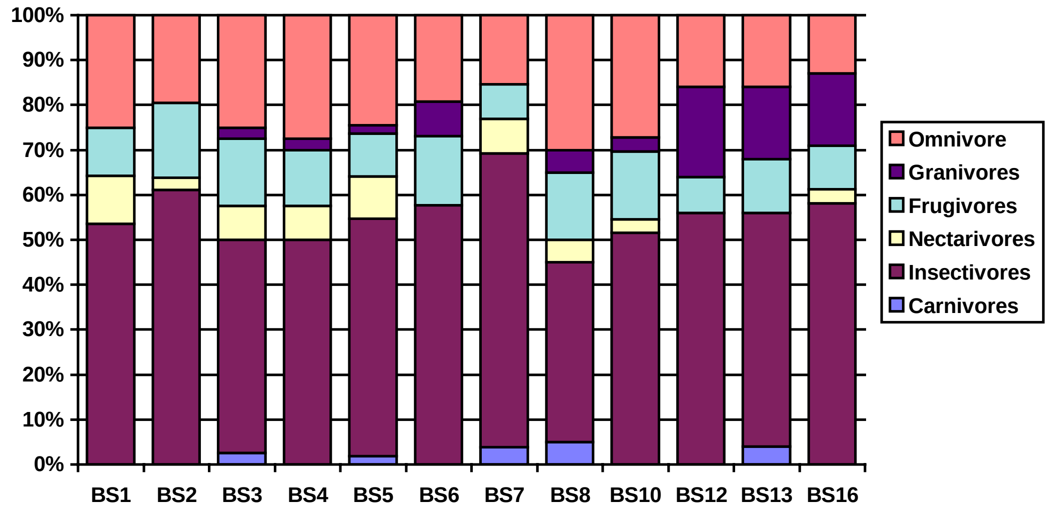
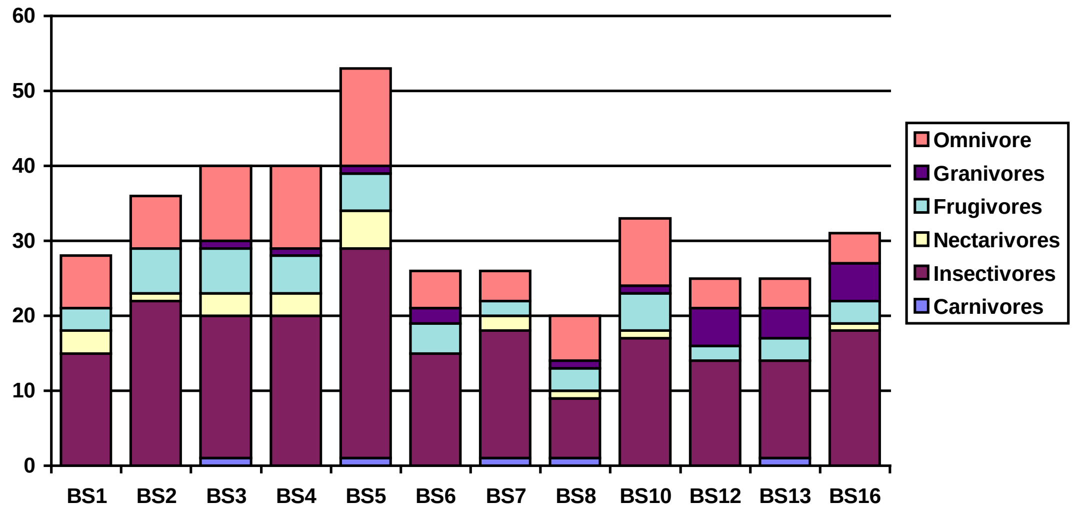


Figure 4.5.2.1b. Number of species diet guilds



The gramnivore guild is represented in disturbed forest habitats and constitutes the largest percentage of species richness in the most highly modified habitats: *Imperata*; *Cassava* and *Chromolaena* (plots BS12, BS13 and BS16). Plantation rubber (BS8) and jungle rubber (BS10) have similar proportions of each guild, as do the three logged forests. The two *Paraserianthes* plots are dissimilar - BS6 has gramnivores and no nectarivores, whereas for BS7 it is the reverse (species numbers are low).

4.5.1.2b Proportion of feeding site guilds:

Figure 4.5.1.2i. Percentage of species in each feedings site diet guilds

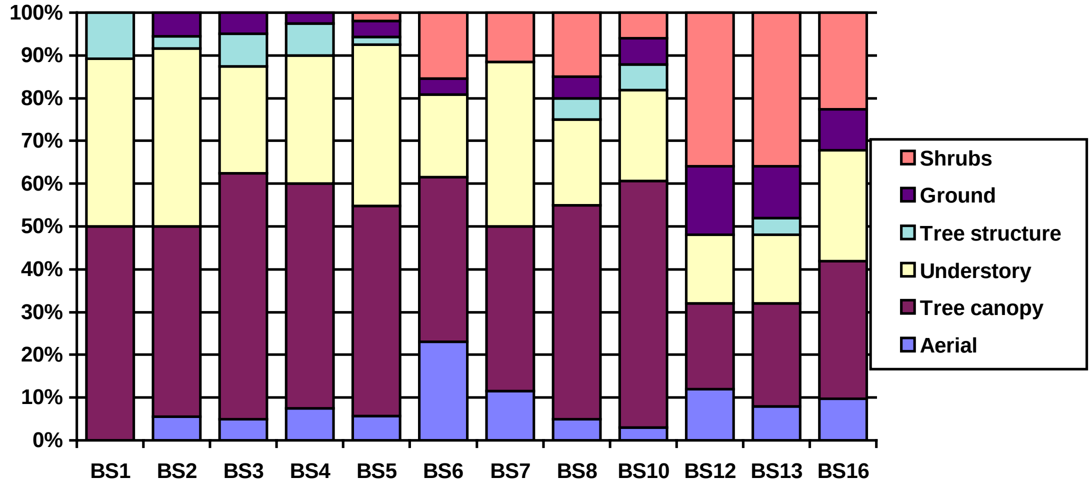
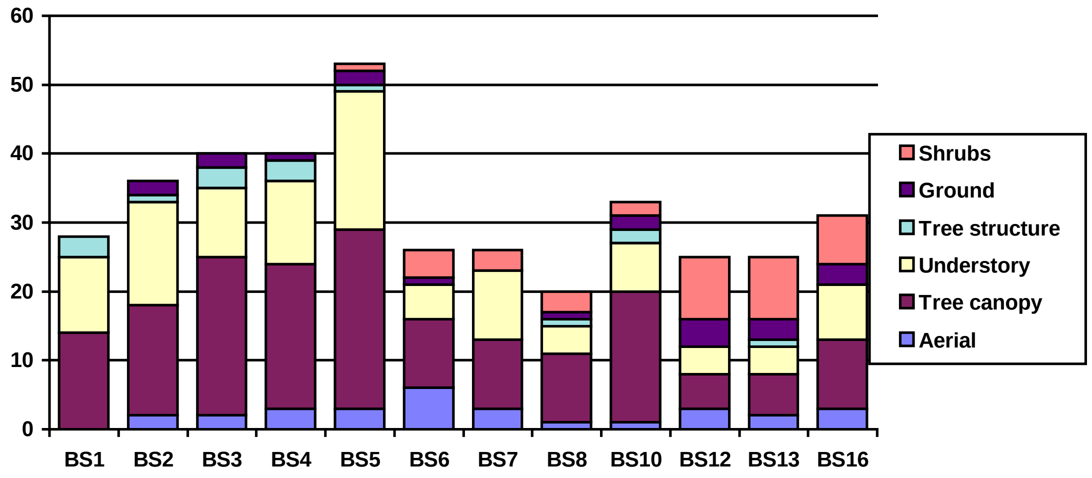


Figure 4.5.2.2a. Number of species in each feedings site diet guilds



The tree canopy feeding guild constitutes over 45% of species in natural forest plots (BS1-BS5) and in the jungle rubber (BS10) and plantation rubber (BS8). The proportion of this guild is less than 35% of species total in all other plots. Species adapted to feeding from grasses and shrubs are present in all non-natural forest plots, but not in natural forest plots (with the exception of one species in Plot BS5).

4.5.2.3 Proportion of body size classes:

Figure 4.5.2.3 a. Percentage of species by size class

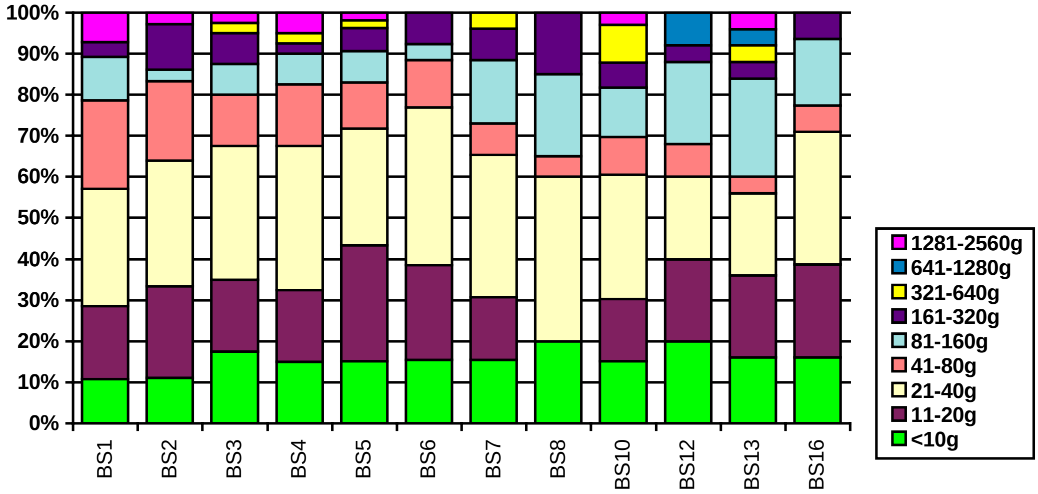
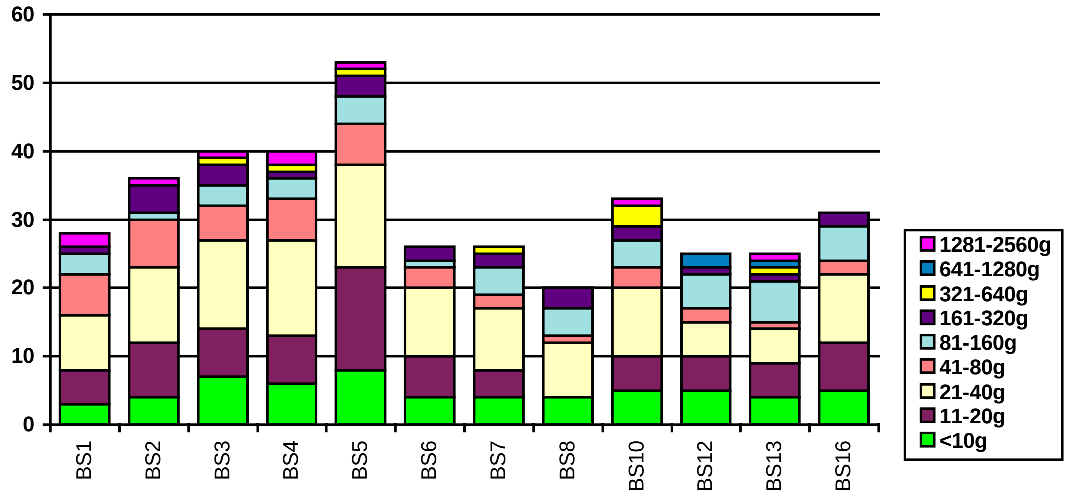


Figure 4.5.2.3 b. No of species by size class



No clear patterns differentiate the plots. Both the unlogged natural forest site (BS1) and *Imperata* (BS12) have the largest percentage of species in the heaviest weight class.

4.5.1.4 Species diversity by taxonomic family:

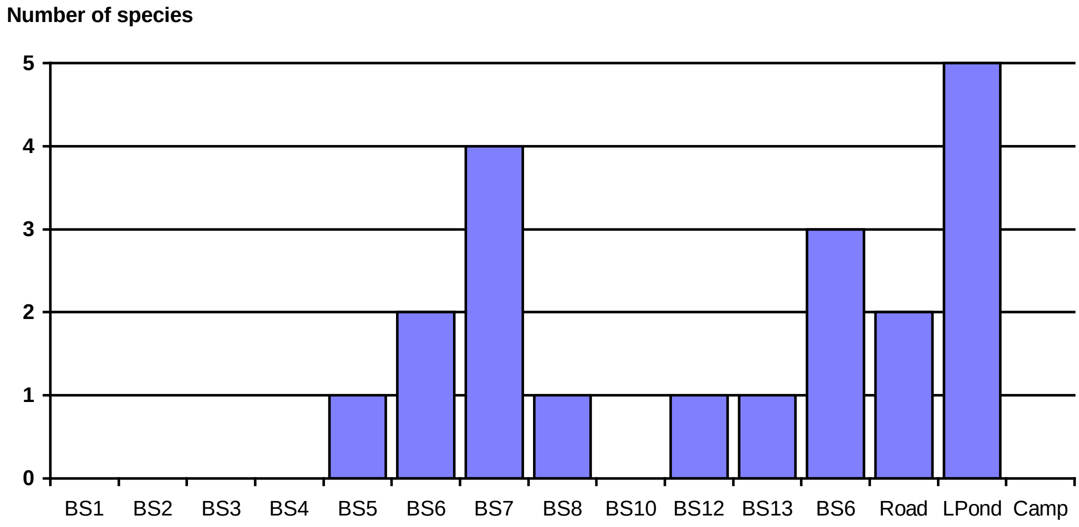
Natural forest plots are characterised by higher numbers of bird families and passerine bird families, compared with non-natural forest families (with the exception of BS1), see Table 4.1. Five families are only present at natural forest plots, namely: Hemiprocnidae; Trogonidae; Muscicapidae; Monarchidae; Zosteropidae.

Table 4.1
Summary of species in each taxonomic family by plot

	Natural Forest Plots											
	BS1	BS2	BS3	BS4	BS5	BS6	BS7	BS8	BS10	BS12	BS13	BS16
Ardeidae											1	
Accipitridae			1		1		1	1				
Falconidae						1	1					
Anatidae										1		
Phasianidae										1	1	
Turnicidae						1				1	1	1
Rallidae											1	
Charadriidae												
Scolopacidae												
Glareolidae												
Columbidae		1	1	1	1			1	2	3	2	3
Psittacidae	2	2	2	2	2	2		2		1	1	
Cuculidae	1			2	3	2	3	1	4	2	2	4
Strigidae												
Caprimulgidae												
Apodidae			1	1		3						
Hemiprocnidae												
Hemiprocnidae		1	1	1	1							
Trogonidae	1	1		1	1							
Alcedinidae	1	1			1		1	1		1	1	
Meropidae		1		1	2	1	1	1	1	1	1	1
Capitonidae	1	1	2	2	1				2			1
Picidae	3	1	3	3	1			1	2		1	
Eurylaimidae			2	1	1		1	1	1			
Hirundinidae					1	1	1			1	1	1
Campephagidae	1	2	2		1							
Pycnonotidae	2	2	3	4	3	3	2	3	4	2	2	2
Irenidae	1	2	2	1	2	1						1
Laniidae												1
Orthonychidae		1										
Timaliidae	4	6	3	3	6	1	2	1	3	1	1	3
Sylviidae	1	3	3	3	3	5	4	2	3	6	5	5
Muscicapidae	2	1	1	1	2							
Monarchidae		2	1	1	4							
Dicaeidae	1	1	2	2	2			1	2			1
Nectariniidae	3	1	3	3	6		2	1	1			1
Zosteropidae			1		1							
Estrildidae						1				2	2	2
Ploceidae												
Sturnidae	1	2	2	1	2	1	1	1			1	1
Oriolidae				1	1				1			
Dicruridae	1	1	2	1	2		1		1			1
Corvidae		1				1	1	2	1			
non-passeriformes	6	8	7	9	10	6	5	7	5	8	10	5
passeriformes	10	13	13	12	15	8	9	8	9	5	6	11
Total Families	16	21	20	21	25	14	14	15	14	13	16	16

4.5.1.5 Migrant species:

Figure 4.5.1.4i Number of migrant bird species by plot and landscape element



Migrant species are more frequent in non-natural forest plots and in disturbed landscape elements within the natural forest.

4.5.2 *Exploratory (pattern) analysis*

4.5.2.1 Differentiation in β diversity (Sørenson similarity indices=Dice's Coefficient)

Table 4.2. Similarity indices

	BS1	BS2	BS3	BS4	BS5	BS6	BS7	BS8	BS10	BS12	BS13	BS16
BS1	1	0.535	0.389	0.423	0.381	0.107	0.143	0.080	0.159	0.036	0.036	0.164
BS2	0.535	1	0.482	0.390	0.442	0.269	0.239	0.197	0.162	0.091	0.121	0.167
BS3	0.389	0.482	1	0.578	0.563	0.235	0.206	0.258	0.320	0.060	0.090	0.219
BS4	0.423	0.390	0.578	1	0.568	0.299	0.299	0.295	0.486	0.121	0.121	0.306
BS5	0.381	0.442	0.563	0.568	1	0.225	0.275	0.270	0.299	0.101	0.127	0.235
BS6	0.107	0.269	0.235	0.299	0.225	1	0.615	0.391	0.271	0.510	0.549	0.491
BS7	0.143	0.239	0.206	0.299	0.275	0.615	1	0.435	0.407	0.431	0.471	0.561
BS8	0.080	0.197	0.258	0.295	0.270	0.391	0.435	1	0.453	0.222	0.267	0.275
BS10	0.159	0.162	0.320	0.486	0.299	0.271	0.407	0.453	1	0.172	0.172	0.375
BS12	0.036	0.091	0.060	0.121	0.101	0.510	0.431	0.222	0.172	1	0.840	0.571
BS13	0.036	0.121	0.090	0.121	0.127	0.549	0.471	0.267	0.172	0.840	1	0.536
BS16	0.164	0.167	0.219	0.306	0.235	0.491	0.561	0.275	0.375	0.571	0.536	1

Undisturbed forest plots (BS1 & BS2) are highlighted in grey and all natural forest plots enclosed within the dotted line (Table 4.2). These constitute a group with similarity indices greater than 39%. Outside this group dissimilarity increases markedly. A second group: *Chromolaena* (BS16), Jungle rubber (BS10) and *Paraserianthes* (BS7) exhibit between 14% and 16.5% similarity. Then there is a gradient of increasing disimilarity (10.7% to 3.6%) from *Paraserianthes* 1(BS6), plantation rubber (BS8) to *Cassava* and *Imperata* (BS12 & BS16). The *Cassava* and *Imperata* plots are the most similar, and the more mature *Paraserianthes* plot shows greater similarity with natural forest than the younger *Paraserianthes* plot.

4.5.3 Cluster analysis:

The analysis resulted in two main groupings: natural forest plots and mono-dominant plots. The natural forest plots are all quite dissimilar. The logged and unlogged plots are included in separate sub-groups. Plantation rubber is grouped with natural forest plots although it is the most dissimilar. *Paraserianthes* is grouped in the mono-dominated 'agricultural plots'. Of all the plots, *Cassava* and *Imperata* are the most similar.

4.6 Discussion:

4.6.1 *Review of methods: costs in time and effort per plot (?per taxon):*

4.6.1.1 Cost effectiveness:

The protocol employed in this study lends itself to a range of simple descriptive analysis as well as similarity indices. It is not suited to more detailed statistical analysis. As such, the method produces an initial indication of changes to bird diversity caused by increasing degrees of forest modification.

It is highly cost-effective. For each forest plot, two observers could collect data and enter it in to a spreadsheet ready for analysis in one day. In open habitats one observer was sufficient. It is an excellent technique for producing quick results. But it depends closely on the identification skills of the observer; for example in the natural forest plots (BS1-BS5) more than 85% of bird contacts were by call. This generates the need for experienced field ornithologists (who are often quite expensive). Furthermore, if the observers are unfamiliar with the avifauna, they should spend 3-4 days practising identification before starting counts.

4.6.1.2 Limitations and recommendation for modifications to the sampling protocol:

In the case of birds, the protocol had two important limitations: a) variation in sampling area and b) selection of the landscape element to be sampled. The question under investigation concerned the effects of different levels of disturbance on avian diversity. The distance at which birds could be detected varied significantly between plots and species. For example, in primary and secondary forest and jungle rubber plots, sight records were all within 30m but some vocal species could be heard up to 500m or more. In the *Cassava* and *Imperata* plots, species could be seen and heard for 1 km or more. Obviously, among the latter there is a greater chance of detecting thinly dispersed species.

Other disciplines sampling at the plot can assume that habitat is homogenous for their sample. This assumption is difficult to meet for birds. Sampling within a fixed area (e.g. 30 m from the plot) would produce very few contacts and as a result increase the required sampling time. Sampling (as we did) all contacts made from the plot overcomes the time consideration, but introduces bias because habitat heterogeneity increases with size of sampling area. Increased habitat heterogeneity correlates strongly with increased species diversity.

The argument that this does not matter because we are sampling the land use is also problematic. It assumes that the plot vegetation type is crucial to defining bird diversity in the land use concerned. This may be true for mature forest, but is not the case for birds in the highly modified sites. For example, in the *Cassava* plot only 7 of the 25 species were actually recorded in the *Cassava*. At resolutions below 500m^2, scrub and trees associated with access tracks and field edges were important elements, adding species such as *Prinia familiaris; Cocomantis merulus; Copsycus solaris and Macronus gularis*. At a wider resolution, woodland patches around homesteads and rivers probably accounted for the presence of *Psiticinus* and *Gracula religiousus*.

A way round these problems could be to base sampling design on landscape ecological principles [see Forman, 1986 p. 201]. This would involve identifying first landscape units(LUTs) and then landscape elements within each landscape unit. A possible protocol could be to establish plots in the principal vegetation type of each landscape unit (as we did). The time-consuming sampling disciplines (plants, termites, insects, etc.) could confine themselves to these, but those disciplines sampling groups with larger home ranges and greater dispersive abilities would combine standardised sampling of plots with non-standardised sampling of other landscape elements (e.g. searching).

Some benefits of this approach are:

- it maintains the benefit of data comparability across groups provided by the plot reference point;
- through knowing what occurs in all landscape elements it enables discussion of the influences of these elements on the plot-based species set, i.e. it accommodates source-sink theory which is expected to become more important with increasing habitat modification and ;
- it enables the identification of landscape elements that are critical to maintaining biodiversity values in the overall landscape or land use;
- policy interventions arising from studies such as these will have impact at the land use or landscape level.

If we consider the Jambi surveys in this framework, we sampled four landscape types: managed natural forest (primary and logged forest plots); commercial plantation forestry (rubber and *Paraserianthes* plots); traditional agro-forestry systems (jungle rubber and *Chromolaena*); and 'frontier' agriculture (*Cassava* and *Imperata*). These constitute a gradient of landscape change. Taking the two ends of this gradient as an example, I have summarised in Table 4.3 the variety of landscapes elements represented. It is constructive to think of the functional contribution of each of these elements to the overall biodiversity value of the landscape.

Table 4.3
Landscape elements in Natural forest and Frontier agriculture landscapes

Natural Forest		**Frontier agriculture**	
Element	**Sampled?**	**Element**	**Sampled?**
Pristine forest (various types)	Plot	*Cassava*	Plot
Logged forest (various age classes)	Plot	*Imperata*	Plot
River	-	Track with scrub	from plot
Access road;	Bird count	Stream with vegetation	
Extraction tracks	-	Woodlot/Fruit tree grove	birds in flight
Log pond	Bird count	Marshy pond	Ducks in flight

Camp	Bird count	Scrub	

In the natural forest LUT, we sampled three landscape elements according to the protocol suggested above. These were the logging road and forest edge the log camp, and the log pond. Each of these landscape elements characterises a managed forest estate.

Table 4.4
Species record in key habitats outside the sampled landuse types

	Species	
Landscape element	**Total**	**Cum. total**
Logged Forest	74	74
Unlogged Forest	45	88
Road	35	101
Log pond	12	112
Camp	21	119

Sampling the logging road added 13 species not recorded in the forest interior, and the two highly modified landscape elements accounted for 15% of species in the overall landuse. These added mainly non-forest species, migratory shorebirds in the case of the log pond and garden and night birds in the case of the logging camp (Table 4.4).

4.6.2 *Relevance of study at regional and global levels:*

The lowland, evergreen, mixed dipterocarp forests of the Sunda-shelf are among the most bird diverse habitats on earth; 291 species of which 164 are Sunda endemics, breed mainly or exclusively in this biome [Wells, 1985 p. 202]. They are also among the most threatened; large areas are being converted to agriculture with the remaining areas being modified by commercial timber extraction. Understanding the effects of this process on the distribution and status of bird species is crucial for planning and prioritising conservation action. This study is an important contribution in this field of investigation.

4.6.3 *Relevance to Rapid Biodiversity Assessment:*

A World Bank review of Integrated Conservation and Development Project (ICDPs) in Indonesia, identified a lack of clear linkages between the conservation importance of a reserve and rural development activities as a key factor in the under performance of these projects. This is a growing recognition of the need for spatially-referenced biodiversity information during the preparation phase. The protocol employed in this study would appear ideal for providing an understanding of relative biodiversity values of habitats represented in an ICDP area.

4.7 Preliminary conclusions and discussion of results:

Although natural forest habitats form a group distinct from the 'frontier' agricultural sites, there are quite high levels of dissimilarity between plots. This may be a factor of sampling time. The total number of species recorded in the five natural forest plots and forest edge (see Table 4.3) was 112, and the maximum number of species at any one plot was 56. The dissimilarity is believed to be as much a function of short sampling times and small sampling areas, as a real difference between plots. If the number of replicates was increased we would expect more shared species between plots. This conclusion is supported by the species accumulation curves which flatten out slowly. In the open frontier agriculture and plantation habitats, sample effort created less bias, and the similarity indices are more robust.

The bird communities of natural forest plots differ significantly from the commercial plantation and frontier agriculture plots. The latter support non-forest bird communities. Typical forest bird families such as hornbills, trogons and tree-swifts are replaced by typical open-country families such as Ardeidae, Turnicidae and Estrillidae. Within families there are also clear differences. There is little overlap in the species composition of, for example, Pycnonotidae, Timalliidae, Sylviidae between natural and non-natural forest habitats. The Jungle rubber has many species in common with natural forest, but species typical of scrub habitats are also represented.

A point of interest in the *Imperata* plots was the co-occurrence of two closely related warbler species occupying the same niche. On Sumatra, *Cisticola juncidis* is typically a species of wet-rice agriculture and is well established. *Cisticola exilis* is a grassland species, typical of *Imperata* grasslands. A possible explanation of this co-occurrence is that *Cisiticola juncidis,* already well established on Sumatra, rapidly colonised these new *Imperata* grasslands, and *Cisticola exilis* subsequently moved into the area. Selective logging appears to result in an increase in overall species richness of the forest. This is to be expected because it increases habitat heterogeneity and contrast within the landscape. This is illustrated most clearly by the log pond, which adds migratory shorebirds to the species total. As indicated earlier, the invasive species are widespread and common species of little conservation concern, and the important question is what species drop out rather than how many are added. To properly investigate this question for birds requires more detailed studies. This is because greater mobility (and in some species, longevity) may mask subtle changes in habitat quality.

4.8 References:

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Magurran, A.E. *Ecological Diversity and its Measurment* (Croom Helm, London, Sydney, 1988).

Forman, R.T.T. & Godron, M. *Landscape Ecology* (John Wiley & Sons, New York, 1986).

Wells, D.R. in *Conservation of Tropical Forest Birds* (eds. Diamond, A.W. & T.E.Lovejoy) 213-233 (International Council for Bird Preservation, Cambridge, 1985).

Appendix 4.1 Species excluded from analysis

Number	Species Name English	*Scientific*	Plot BS6	BS12
626	Silver-rumped Swift	*Rhaphidura leucopygialis*	X	
633	Whiskered Tree-swift	*Hemiprocne comata*	X	
701	Wreathed Hornbill	*Rhyticeros undulatus*		X