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Cover photo: The golden crowned babbler, a Luzon endemic understory insectivore (M. van Weerd)

THE USE OF AVIAN GUILDS FOR THE MONITORING OF TROPICAL FOREST DISTURBANCE BY LOGGING

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ABSTRACT

This paper covers a literature review on the impact of logging on avian guilds in tropical forests, and in addition an analysis of avian guild structure in the Sierra Madre Natural Park, North Luzon, with sites of tropical lowland forest in Cameroon, Indonesia and Colombia.

The paper concludes, that the present system of using species richness of flora and fauna in most Criteria and Indicator systems for Sustainable Forest Management should be improved. In order to improve monitoring systems a protocol should be developed, that includes monitoring of vegetation characteristics, and some selected fauna indicators. The use of avian guilds is proposed for consideration in future monitoring, since these:

1) represent energy and nutrient flows in the forest ecosystems
2) can be calculated from existing species lists with relatively little effort and
3) are therefore relatively cost effective

Although understory insectivores seem to form the most sensitive group when it comes to logging disturbance, other guilds should also be considered. The analysis of species composition per forest dependent bird guild in Northern Sierra Madre Natural Park (NSMP) and in three other field-sites showed significant differences between the sites. It is suggested that these data may form a base-line for a future experimental monitoring programme in these different sites. For the future use of avian guilds for monitoring in the selected sites, trends in diversity and abundance of the guilds in space and time should be included. Point counts, implemented preferably by experienced bird watchers, seem to be the best census technique to quickly asses the effects of habitat disturbance on birds, although transect counts may be practicable too when investigating trends over time. Mist netting could be of additional value for some specific understory groups. When assessing habitat alteration, it is important to include vegetation in the analysis. As a rule, in addition to the proposed survey methods, consultations with local communities, if present, should always be an integrated part of any standard protocol.

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1 INTRODUCTION

The main aim of our study is to discuss the feasibility to use avian guilds in monitoring programmes for sustainable forest management as an improved and additional measure to bird species richness alone. Suggestions are made to implement a protocol for the use of avian guilds in monitoring.

The present study covers one research site of Leiden University in the Philippines (Northern Sierra Madre Natural Park-NSMNP) and three research sites included in the programme of Tropenbos International located in Cameroon, Colombia and Indonesia.

The increasing rate of habitat loss in the tropics forms a serious threat to the world's biodiversity. This threat is particularly pronounced in tropical forests which contain a large portion of the planet's species, and which are being converted faster than any other biome (FAO 1997). Tropical forests are used in various ways, but timber harvesting is probably the most lucrative and widespread. Logging can have large environmental impacts. It affects structure, composition and function of the forest (Fimbel *et al.* 2001). The most common logging practice, called selective logging, in the tropics today is a variation of the diameter-limit or selective cut, where most merchantable stems of a species above a specified diameter are harvested in a specific area (Fimbel *et al.* 2001).

In many tropical countries, the large area of timber production forests represent an opportunity to complement existing protected areas which provide critical habitat for wildlife and native plant species. Production forests are not a substitute for nature preserves but they can provide a complementary role when sustainably managed for timber and non-timber resources (Ros-Tonen *et al.* 1995; Fimbel *et al.* 2001; Azevedo-Ramos *et al.* 2002). Sustainable forest management can be defined as 'the stewardship and use of forests and forest lands in a way and at a rate that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, a role of ecological, economic and social functions, at local, national and global levels, and that does not cause (long term) damage to the ecosystem.' (the Ministerial Conference on the Protection of Forests in Europe 1993, as quoted in Myers 1996).

2 ASSESSING DISTURBANCE IN TROPICAL FOREST ECOSYSTEMS

2.1 SELECTION CRITERIA FOR BIOLOGICAL INDICATORS

The assessment and monitoring of biological diversity is an essential part of most certification schemes for sustainable forest management. Monitoring the whole array of systems, species and processes in the species-rich lowland forests of the tropics, is a complex task and involves enormous amounts of work, if no proper system of indicators/verifiers is selected. An ***indicator*** is any variable or component of the forest ecosystem or relevant management system that is used to infer attributes of sustainability of utilization of the resource. ***Verifiers*** are the data or information that needs to be collected for the assessment of any particular indicator (Ghazoul and Hellier 2000). Generally indicators and verifiers provide trends in space and time away from conservation (degradation) or towards conservation (recovery).

Generally, two categories of indicators are in use which are defined by Stork (1997), World Bank (1998) and CIFOR (1999) as follows:

1) Pressure indicators measure the frequency and intensity of human interventions in the forest (e.g. logging, fire, mining)
2) Performance indicators reveal trends toward, or away from, biodiversity conservation. These performance indicators show whether the management needs to be modified so as to enhance or mitigate the effects of the projects interventions and are therefore the most interesting to this study.

In this study we will mainly focus on the use of *performance indicators.*

In the scientific literature some protocols have been developed for a procedure to select suitable biological indicators. Hilty and Merenlender (2000) compiled criteria from different studies and put them into a clear decision-making framework, which is given below.

Step 0 Decide what ecosystem attribute(s) indicator taxa should reflect.

Step 1 Make a list of all species in the area that best satisfy the baseline information criteria: the indicator has to have a clear taxonomy, the biology and life history has to be reasonably well studied, the tolerance levels have to be known and a correlation to ecosystem changes has to be established.

Step 2 From this initial list, retain species that best meet the suggested niche and life history criteria: trends are detectable (species are in a low or medium trophic level), the indicator is a specialist (food/habitat) and is easy to find and measure and as indicator, the early warning detection is maximized while minimizing unpredictable fluctuations.

Step 3 Remove species that may respond to changes occurring outside the system of interest.

Step 4 Use only those species that can be easily detected and monitored with available funds.

Step 5 Select a set of complementary indicator taxa from different taxonomic groups so that all selection criteria are met by more than one taxon. Use multiple indicators.

CIFOR (Prabhu *et al*. 1998) and Worldbank (1998) formulate their criteria in a similar way, but Worldbank adds to this list that

1) indicators should be amenable to sampling by non-specialists
2) indicators should be meaningful to local people.
3) indicators should reveal meaningful trends (see step 1)
4) indicators should be cost effective (see step 4)

2.2 AN OVERVIEW OF BIOLOGICAL INDICATORS IN FOREST CERTIFICATION SCHEMES

Several organisations (like CIFOR) have applied general approaches (generic templates) for the selection of indicators. This is mostly done because they are supposed to cover different areas, like countries and ecosystems. It is difficult to apply one single set of indicators to all different situations so each set should be further adapted to the specific situation by local stakeholders. Van der Hoeven *et al.* (2000) state, however, that this does not mean that they can be kept deliberately vague, by not defining goals or by refraining from validating the references.

Table 1 summarizes the biological indicators/verifiers used in a number of certification systems for sustainable forest management. This table shows, that most certification systems use species richness as an indicator/verifier species, some use genetic diversity, keystone species or rare and endangered species as additional indicator/verifier.

Table 1 Aspects of biological indicators mentioned in sets Criteria and Indicators of several organisations and NGO's. Acronyms: CIFOR: ***Center for International Forestry Research,*** **ACT:** ***Amazon Cooperation Treaty,*** **ATO:** ***African Timber Organisation*****, ITTO:** ***International Tropical Timber Organisation,*** **TFS:** ***Tropical Forestry Services,*** **FAO:** ***Food and Agriculture Organisation,*** **FSC:** ***Forest Stewardship Council,*** **UNEP:** ***United Nations Environment Program,*** **Malaysia:** ***Malaysian criteria and indicators for forest management,*** **PEFC:** ***Promoting Sustainable Forest Management*****, Neth. Min Req.:** ***Netherlands criteria and indicators for forest management 'BRL'*** *(concept)***.**

	CIFOR	ACT	ATO	ITTO	TFS	FSC	PEFC	FAO/UNEP	Smartwood	World Bank	Malaysia	Neth. Min Req.
Species richness*	X			X	X	X	X	X			X	X
Species abundance	X					X				X	X	
Genetic diversity	X				X	X		X			X	
Keystone species				X	X					X	X	
Rare and endangered species	X	X	X	X	X	X	X	X	X		X	
Guild diversity/ abundance	X	X		X								
Population dynamics	X							X				
Hunting	X									X		
Invasive species										X		

* Often described as the number of forest depended species or species lists.

Data derived from: Van der Hoeven et al. 2000, Ozinga 2001 and The Netherlands Criteria and Indicators for Forest management (concept).

Ghazoul and Hellier (2000) suggested that species richness alone may not be a good indicator of the recovery of forest biodiversity, given that there are no consistent patterns among the studies they reviewed. Ghazoul and Hellier also suggested that although diversity indices (such as the Shannon Weaver index) are better predictors of disturbance than species richness alone, these indices remain ambiguous and highly dependent on the nature and intensity of the disturbance event.

An important question is, whether there is evidence that applying these (imperfect) methods has led to inappropriate forest management decisions? Are there alternative feasible, cost effective, systems available that would lead to better results? While recognising that a return of forest biodiversity to the exact original state is impossible, ecological sustainability infers the conservation of certain key functions and parameters of the ecological system. This implies that under sustainable forest management trends should be detected towards “conservation” and not away from “conservation”.

Standards of performance (s.o.p.’s) are an important element of some of the certification systems of timer companies. These s.o.p.’s represent threshold-values (e.g. the percentage of forest under protection), which must be met in order to obtain a certificate. Thresholds must be developed based on locally available expertise, on a case-by-case basis, if they are to be applied to timber companies included in certification schemes. In practice however, standards of performance for biodiversity monitoring are not used in existing certification schemes (Ghazoul and Hellier, 2000; Fimbel et al.2001).

This means that a timber company may not be bound by a standard of performance, but it is still accepted because it takes into account ‘bio diversity’ in their management plan by providing lists of forest dependent species.

In this case monitoring of changes is not required. On the other hand, if a standard of performance is given, monitoring becomes necessary and verifiers are needed to test against the standard of performance. It is then up to timber company to provide the data for control of the compliance of this standard. Mentioning that a standard of performance is required is enough to bind the timber company to the criteria, indicators and verifiers. Control of the progress made in compliance becomes then more manageable (Van der Hoeven *et al*. 2000).

Only CIFOR and ITTO have extensive sets of indicators for monitoring purpose, including avian guild abundance (CIFOR 1999, ITTO 1999). Other organisations mention only a few. The Amazon Cooperation Treaty (ACT), mentions under Criteria 10, that the conservation of a forest ecosystem should include: ‘measures to protect, recuperate and sustainably use wild populations of species in danger of extinction’ (http://www.tratadoamazonico.org This is a sound approach, but without standards of performance and measurable indicators it does not result in effective monitoring.

CIFOR (1999) divides each category or indicator into sub-indicators, for example guilds into species diversity and abundance. This is elaborated; for example, the abundance of the species should stay at the level prior to the start of the commercial logging operation. These are generic templates with specific standards of performance, which make these criteria and indicators practicable.

The CIFOR generic template provides for so called “Critical time thresholds” for indicators/verifiers. In this system two values are needed for each verifier; a) the baseline (or target) which implies the average value of the verifier in the desired state. (Associated with the baseline should be a measure of variability to reflect temporal and spatial variation (s.d.)); b) the pattern of recovery, which implies the rate and direction of change in verifier values through a time series.

Most other certification systems do not offer such extensive explanations. CIFOR proves, with extensive studies on the usability of these indicators, that a generic set up is possible without losing the general applicability (Ghazoul and Hellier, 2000).

2.3 EXPERIENCE SO FAR WITH THE USE OF BIOLOGICAL INDICATORS IN CERTIFICATION SCHEMES

The experiences with the actual use of biological indicators in current certification schemes have rarely been published. Within the framework of this study through a web search, information was compiled on the performance of biological monitoring protocols of a number of timber concessions in tropical forest areas. The information obtained from this web search is summarised in the table below (due to confidentiality rules, the names of the companies are not revealed).

Table 2 An overview of biological indicators used for monitoring certified timber concessions

Company	Forest type/ country	Type of certificate	Type of biological indicator used	Type of verifier or standard of performance (s.o.p.)
Company A	Tropical lowland forest Congo	Keurhout	Permanent vegetation plots; tree diversity; growth/yield Statistics of wildlife catches per village Fauna surveys by WCS through transect counts Monitoring of illegal bush meat trade	-Verifier is the actual presence of the monitoring system, not the outcome -No s.o.p are proposed
Company B	Tropical lowland forest Gabon	Keurhout	Permanent vegetation plots/tree species diversity/growth & yield Monitoring of illegal bushmeat trade	-Verifier is the actual presence of the monitoring system, not the outcome -No s.o.p are proposed
Company C	Plantation forests Peninsular Malaysia	Keurhout	Permanent vegetation plots/tree species diversity/growth & yield	-Verifier is the actual presence of the monitoring system, not the outcome -No s.o.p are proposed
Company D	Tropical lowland forest Cameroon	FSC	Permanent vegetation plots/tree species diversity/growth & yield Fauna surveys by WCS through transect counts Bird inventories by Birdlife international	-Verifier is the actual presence of the monitoring system, not the outcome -No s.o.p are proposed

s.o.p. – standard of performance

The overview table shows that the timber concessions make use of permanent plots for monitoring tree species diversity, growth and yield. In some African concessions, in the Congo, Gabon and Cameroon, monitoring also covers wildlife species caught in village hunting schemes or illegal bushmeat trade activities, the latter with the aim to control this type of illegal trade. Only a few companies operating in Central Africa and SE Asia are known to have allowed a survey of birds on their concessions, mostly implemented by Birdlife International. To date, in these surveys, no use is made of standards of performance. The verifier used is the fact that a system for monitoring biodiversity is in place.

2.4 CAN BIOLOGICAL INDICATORS BE USEFUL IN MAKING DISTURBANCE ASSESSMENTS?

In 1995 a FAO/ITTO expert consultation concluded that no satisfactory biological indicators have been fully developed in the sense of being clear, flexible, feasible and applicable (FAO, 1995).

Several authors have expressed doubt, however, about the validity of the use of biological indicators for ecosystem health and especially the existing practice in certification schemes (e.g.

Landres *et al.* 1988; Lawton *et al.* 1998; Hilty and Merenlender 2000; Sheil 2001, Azevedo-Ramos *et al.* 2002, Sheil et al. 2004). Most of the authors doubt criteria used when selecting indicators in the existing certification system (see Sheil 2001, Azevedo-Ramos *et al.* 2002, Sheil et al. 2004). Others doubt whether a single taxon can predict responses of other taxa to a disturbance factor (i.e. Lawton *et al.* 1998). Although examples for the predictive capacity of disturbance of single plant taxa have been reported (Kessler, 1999; Slik, 2001), there is much less scientific evidence for single fauna taxa having this predictive capacity. Without confirmatory research, using fauna indicators to assess population trends and habitat suitability for other species is inappropriate (Landres *et al.* 1988). A further constraint is the possible high costs and manpower that are required in monitoring animal populations (Azevedo-Ramos *et al.* 2002).

It is our belief that the doubts expressed by the authors above are partly covered by the proposed protocol of Ghazoul and Hellier (2000), who suggested a monitoring framework on a) forest structure b) bird community structure c) butterfly species richness and d) forest disturbance through dead wood and decomposition. Their monitoring protocol included suggestions for the use of insectivore avian guilds, but lacked further detail on the approach.

2.5 THE USE OF AVIAN GUILDS

When studying birds in tropical forests visibility is a major issue. In this paper a large proportion of the observations will be based on audio recordings. We will not further discuss the methodological part of avian surveys and for further reference is made to Bibby et al. (1992).

Guilds can be defined as “a group of species that exploit the same class of environmental resources in the same way” (Root, 1967). Guilds thus represent a functional relationship between a (group of) species and an ecosystem. The advantage of using guilds above single species indicators or multiple lists of species is, that guilds reflect (changes in) ecosystem parameters.

Several authors have recommended the use of bird guilds for monitoring purpose, but in practice no or little experience has been gained with its implementation (Ghazoul and Hellier, 2000; Mannan et al., 1984).

Birds have been presented as potentially valuable disturbance indicators (i.e. Furness and Greenwood 1993). There is a large international knowledge of birds and many people can identify individual species. Various studies have examined the response of bird groups to disturbance levels and restoration processes in tropical forests, which have been disturbed by logging practices, plantations and bush fires. Few of these studies have, however, attempted to extrapolate their outcomes in terms of the use of avian feeding guilds for monitoring (i.e. Wiens 1989; Danielsen 1997).

Categories of red list species, endemic species and keystone species, in addition to guilds, have been proposed for monitoring purpose (see Table 1). Butchart et al. (2004), for instance, developed biodiversity red list indices for birds based on their global Red List status. The use of these indices on a regional scale remains to be developed.

The use of avian guilds has the added advantage of the direct functional relationship with forest structure and changes in nutrient and energy flows in the ecosystem. This relationship is less evident with in other diversity indices; the number of red list species, keystone species and endemic species. The relationship between avian guild and energy/nutrient flows is established through the specific feeding niches of the guilds; e.g. terrestrial frugivores take care of a completely different energy/nutrient flow in the forest ecosystem compared with arboreal insectivores.

Table 3 Studies that assess the impact of logging on birds together with some information on the used method.

Source	Country	Census type	Treatment and effort	Impact on understory birds	Vegetation parameters
Neotropics					
Aleixo 1999	Brazil	PC	U: 73, L: 24	neutral on species richness/ positive on edge species	Dbh, dsp, h
Canaday 1997	Ecuador	M	10x10m	negative on mixed flock species and larger insectivores	none
Guilherme and Cintra 2001	Brazil	M	120m	positive on nectarivores/ neutral on species richness	none
Johns 1991	Brazil	TC	?	negative understory insectivores	?
Jullien and Thiollay 1996	French Guiana	SR, M	4-10	positive on raptors	Cf
Mason 1996	Venezuela	M	20x12m	negative on terrestrial insectivores	Cf, h, d
Schemske and Brokaw 1981	Panama	M	G: 8, F: 8	negative on understory insectivores	H, d
Thiollay 1992	French Guiana	PC	U: 440, L: 497	positive on raptors/ overall decrease in abundance in mixed species flocks /negative on terrestrial insectivores	Cf, ld
Thiollay 1997	French Guiana	PC, M	?	neutral to positive on nectarivores	Cf
Thiollay 1999	French Guiana	TC	U: 12, L: 11	neutral to positive on nectarivores	?
Thiollay 1999	French Guiana	PC	?	neutral to positive on nectarivores	?
Whitman et al. 1998	Belize	PC, M	U: 2x12 G: 2x6, L: 2x6	negative on species richness	Dbh, d
Africa					
Dale et al. 2000	Uganda	M	10x18m	positive on species richness	Cf, d
Dranzoa 1998	Uganda	M	120m	positive on species richness	none
Fanshawe 1995	Kenya	M, SR	?	positive on species richness/ negative on terrestrial insectivores	none
Allport et al. 1989	Sierra Leone	M, PC	24-32	negative on understory insectivores	several
Gartshore et al 1995	Ivory Coast	M	U/G: 1-4x15 nets	negative on species richness	
Owiunji 2000, 2001	Uganda	PC, M	U: 40, L: 20 p.t.	positive on species richness/neutral on frugivores	Ft
Owiunji and Plumptre 1998	Uganda	PC	?	negative on terrestrial insectivores	Ft, dbh, cf, d
Sekercioglu 2002	Uganda	SR	10	positive on species richness	Dbh, d, dsp, cf

Source	Country	Census type	Treatment and effort	Impact on understory birds	Vegetation parameters
Oriental					
Wong 1985	malaysia	M,PC	1	negative on understory insectivores	?
Bennett and Zainudin 1995	Malaysia	TC	2km	negative on terrestrial granivores and insectivores	?
Johns 1987	Malaysia	TC, SR			?
Johns 1988	Malaysia	SP	1	negative on understory insectivores	none
Johns 1989	Malaysia	TC	1	negative on species richness/ positive on nectarivores/ positive on frugivores	?
Johns 1992	Malaysia	M, TC	3-5km	positive on raptors/negative on understory insectivores	?
Johns 1996	Malaysia	M, TC	M: 100m TC: 1x5km	neutral on species richness/negative on terrestrial insectivores	Dbh, d
Jones et al. 2003	Indonesia	PC	T: 210	negative on understory insectivores	H, cf, bta, sp. richness
Lambert 1992	Malaysia	M, TC	M: 1, TC: 2	positive on frugivores	?
Marsden 1998	Indonesia	PC	?	negative on understory insectivores	Cf, h, d
Marsden and Pilgrim 2003	Papua New Guinea	PC, SP	?	negative on understory insectivores	Ft, fp, pns
Shankar Raman and Sukumar 2002	India	PC	25	neutral on species richness	D, bta, dbh, cf, h
Styring and Ickes 2001	Malaysia	TC	4	negative on species richness	?
Zakaria et al. 2002	Malaysia	M	?	negative on species richness/positive on nectarivores	?

Explanation of the abbreviations: Census types: M= Mist netting, PC= point counts, SR= spot recordings (auditive or visual), TC= transect counts. Treatments and effort: F= forest, G= gaps, L= logged forest, U= unlogged forest, T= total effort of all plots. Vegetation parameters: bta= basal tree area, cf= cover of foliage in one or more strata, d= density of vegetation, dbh= diameter at breast height, dsp= distance from sampling point, fl= flower production, fr= fruit production, ft= forest type, h= height, ld= logging damage, pns= probable nest sites.

3 THE EFFECTS OF LOGGING ON FOREST BIRDS

3.1 INTRODUCTION

A literature review on the impact of disturbance, by selective logging of tropical forests, on birds in the tropical regions of South and Central America, Africa and Southeast Asia is made in this paper. Indirect effects of logging, like fragmentation, increased harvesting of non-timber forest products and hunting are not included. The review builds on a total of 35 papers (Table 2), and on some major reviews like MacKinnon *et al.* (1996), Johns (1997), Danielsen (1997), Putz et al. (1998), CIFOR (1999), Fimbel *et al.* (2001), MacKinnon *et al.* (1996), Azevedo-Ramos et al. (2002) and Van der Hoeven *et al.* (2000) and Azevedo-Ramos et al. (2002), resulting in a total number of 43 studies.

In this review firstly the effects of logging on the total community of forest-dependent bird species are summarised, then the effects on specific bird-guilds are given.

The distribution of species into guilds can be done in various ways. Here guilds are separated based on differences in diet, resulting in *carnivores* (raptors), *nectarivores* (nectar feeders), *frugivores* (fruit-eaters) and *insectivores* (insect eaters).

3.2 NEOTROPICS

Communities

Several studies, in Brazil and French Guiana, reveal similar species richness and abundance between logged and primary forest communities (Aleixo 1999; Thiollay 1999; Guilherme and Cintra 2001). Others find that logging operations disrupt forest and bird community structures, with resulting decreases in lower species richness and abundance (Johns 1991a; Thiollay 1992; Mason 1996). For example in French Guiana, overall bird species diversity and abundance were, respectively, 27 to 34 percent lower in areas where an average of 3 trees per hectare were logged, as compared to primary forest. Only 15 percent of the species increased significantly in abundance following logging despite a decrease in overall abundance (Thiollay 1992). Thiollay finds similar species richness between logged and unlogged forest in 1999. He also detects a general trend towards more dominant species and a lower proportion of rare species in forests with increased logging activity.

The immediate impacts of logging on birds are often minor, but increasing divergence of forest structure during the following first decade after logging has a great impact on birds (Mason and Thiollay 2001). In Belize, French Guiana and Venezuela, one year after logging, the understory forest structure and its avifauna were similar to those of primary forest. In sites logged five to six or ten to twelve years earlier, however, the understory vegetation had become twice as dense as that of primary forest, and the composition of the bird assemblages was significantly different (Whitman et al. 1998; Thiollay 1992; Mason 1996). It is known that in the long term, forest structure will converge towards primary forest, which may lead to complete restoration of the original avifauna (Mason and Thiollay 2001). No long term studies on avian communities are available to date.

Canopy birds descend into edges or gaps where they find conditions similar to those of the upper canopy. Compared to understory birds, they are less susceptible to the effects of forest fragmentation because they are more likely to cross non-forest gaps to forage opportunistically over large areas. In French Guiana, the overall richness of canopy species decreased slightly in logged forest; some species increased in abundance while others decreased. The apparent increase of some species may partly be an artefact of increased visibility. Others (especially large frugivores) may have decreased because of increased hunting intensity (Thiollay 1992).

Understory birds need relatively dark, humid undergrowth and usually avoid canopy openings. They are sensitive to timber extraction and the resulting gaps and changes in humidity. In French Guiana, 92 out of 108 species of undisturbed forest understory decreased in abundance.

Terrestrial foragers were the group most affected by logging: they decreased 91 to 98 percent in abundance, while at least 11 of 17 species disappeared (Thiollay 1992).

Carnivores

In French Guiana, species diversity of raptors tends to increase with selective logging, as secondary forests were colonized by species associated with forest gaps and edges, while primary forest species persisted (Thiollay 1992). This increase may originate in that prey becomes more visible and more easily captured in the open conditions created by logging roads and gaps (Johns 1991). Nevertheless, 56 percent of the raptor species had their optimum density in primary forest (Jullien and Thiollay 1996). A third of raptor community consisted of interior forest species highly sensitive to forest disturbance and opening. The other two-third were upper canopy, gap or edge species more tolerant to forest disturbance and opening (Thiollay 1992, 1997; Jullien and Thiollay 1996).

Overall, raptor abundance decreased in Guianan logged forest. No studies from other regions could be found.

Nectarivores

Studies in three countries showed that the effect of selective logging is generally neutral to positive, with mixed effects in French Guiana (Thiollay 1992, 1999) and an increase in abundance and activity in Venezuela (Mason 1996), Brazil (Guilherme and Cintra 2001) and Bolivia (Fredericksen *et al.* 1999a). The most likely explanation for the success of hummingbirds is the abundance of flowers that result when light floods the forest understory (Mason and Thiollay 1996).

Frugivores

In Brazil, French Guianan and Venezuela, frugivorous birds tend to be more resilient than insectivores to the effects of logging (Johns 1985, 1988; Thiollay 1992; Mason 1996; Guilherme 1995). This may be explained because frugivores tend to be more generalist feeders, taking a variety of fruit species. They are also adapted to foraging on a resource that is patchy and widely available, requiring foraging over large areas. This may enable them to exploit forest mosaics created by logging, provided that fruit is still available. Many understory species may also survive because second growth forest is often rich in small fruits (Wong 1985). A reduction in large fruit-trees may affect some specialist canopy frugivores (Mason and Thiollay 2001).

Insectivores

In studies in Brazil, French Guiana and Venezuela, insectivores are the group that is most negatively affected by logging (Johns 1991a; Thiollay 1992; Mason 1996). This finding is important, as insectivorous birds make up the majority of understory species in Neotropical forests (Hilty and Brown, 1985) (). The most affected groups include members of mixed species flocks, terrestrial insectivores and solitary sallying insectivores (Thiollay 1992; Mason 1996).

This is illustrated in a study conducted in French Guiana, where overall species richness declined by 31 to 42% and abundance by 37 to 63%. The most affected guilds were small solitary species, terrestrial insectivores and solitary sallying insectivores. These guilds decreased with 33 to 75% in species richness and 72 to 93% in abundance. Other strongly affected groups were mixed flock species members and larger solitary insectivores (a decrease in species diversity of 48 to 57% and a decrease in abundance of 69 to 88%) (Aleixo 1999; Thiollay 1999; Canaday 1995). Groups that were also negatively affected, albeit less severe, include small bark gleaners, sallying insectivores, slow moving foliage gleaners and some terrestrial insectivores (Thiollay 1992).

The decline of understory insectivores may be caused by the disruption of their travelling or foraging by the frequent gaps or patches with dense re-growth. Alternatively, they may experience a drop in insect prey abundance as the understory becomes hotter and drier (Mason and Thiollay 2001). Not all groups of insectivores respond negatively to logging. Aleixo (1999) finds increases for bamboo-specialist and edge generalists in the Brazilian Atlantic rainforest.

3.3 AFRICA

Communities

In Uganda, extensive studies in two forest sites showed a slight trend towards a higher alpha diversity in the logged forests (Dranzoa 1998; Dale *et al*. 2000; Owiunji 2000, 2001; Plumptre *et al.* 2001; Sekercioglu 2002). Patches of logged forest appear to support many of the species found in disturbed forest. Climber tangles support a very different community in disturbed forest. At one site, overlap in species composition was high (72 to 82%) between logged and unlogged compartments, indicating that many birds do not respond directly to forest type or successional state of the forest (Plumptre *et al.* 2001).

Species diversity in some forest types in Kenya increased in when logged. In others there was a decrease (Fanshawe 1995). Studies in Madagascar, Ivory Coast, Liberia and Sierra Leone all show that the majority of the species is present in both logged and unlogged forest, with some species present only in logged and others only in primary forest (Kofron and Chapman 1995; Hawkins and Wilme 1996; Gartshore *et al.* 1995; Allport *et al.* 1989). Differences in abundance of species or integrity of the communities are not given in any of the studies.

Although most species persist, logging generally alters the structure of the bird community, with a few abundant species occupying a higher proportion of the total sample (Dranzoa 1998). This alteration remains visible long after logging takes place: Sekercioglu (2002) for example found 31% of the forest dependent species still missing 30 years after logging.

Owiunji (2001) found increases in abundance in all guilds, with only frugivore-insectivores and frugivore-granivores not showing significant differences. On the other hand, in 2000, Owiunji found significant negative effects for insectivores in the same reserve. Difference in the outcome of these two studies might come because the 2001 study was done only one year after logging, and the vegetation did not have the time yet to fully respond to the disturbance. The 2000 study was performed in a plot with varying, up to 70 year old, logging activity.

Dranzoa (1995) is one of the few authors that investigated nesting success. She found relatively similar values in logged and unlogged forest (21 and 23%, respectively). However, fewer forest specialist species bred in logged forest, despite a higher number being caught in mist nests in logged forest compared to unlogged forest. Crevice and hole nesters especially failed to breed in logged forests.

Carnivores

No studies could be found that specifically included carnivores in their analysis.

Nectarivores

No studies could be found that specifically included nectarivores in their analysis.

Frugivores

Species that eat fruit or seeds generally exhibit an increase in density and/or biomass following logging in Uganda, Kenya and Sierra Leone (Plumptre *et al.* 2001; Fanshawe 1995; Allport *et al.* 1989). If there is a loss of large fruit trees, however, large frugivores show a decrease in biomass (Kalina 1988; Dranzoa 1995). Granivores increased in Uganda, which was perhaps a consequence of the greater degree of canopy opening that occurred in the logged compartment – a change that allowed grasses to penetrate the forest.

Insectivores

Understory foliage gleaners show higher densities in logged forest in one site in Uganda, while there’s no significant effect in another (Owiunji and Plumptre 1998). Strangely, Plumptre *et al.* (2001) give as an explanation that higher densities of this group might be explained by the dense undergrowth that appears after logging, providing habitat for insects the birds prey upon.

This is contrary to findings in South America, where the dense undergrowth in gaps thought to cause the fall back of many undergrowth insectivores (Mason and Thiollay 2001).

Studies in Kenya and Sierra Leone show a decrease in gleaning insectivores after logging (Fanshawe 1995; Allport *et al.* 1989). Sallying insectivores show negative responses to logging in all but one study (Plumptre *et al*. 2001). The increase in this Kenyan project (Fanshawe 1995) can probably be completely explained by the increase of Drongo *Dicrurus adsimilis*, a species of savannah woodlands. Finally, ground-foraging insectivores were found to decrease after logging in most studies (Plumptre *et al*. 2001).

3.4 ORIENTAL

Communities

In the Western Ghats of India, few species have disappeared over the past century, despite considerable human disturbance. This may come because most species have become opportunistic in habitat selection in response to over 1000 years of disturbance in the region. Because little or no undisturbed forests remain here, intolerant species may already have disappeared from the region (Beehler *et al.* 1987; Daniels 1996). Shankar Raman and Sukumar (2002), find similar results, but most species tend to occur at lower densities in the altered habitats (forest edge, abandoned plantations and selectively logged forests).In Malaysia and Indonesia, where a relatively large number of studies have been conducted, species composition in general showed much overlap between primary and logged forests (Van der Hoeven et al. 2000; Lambert and Collar 2001; Styring and Ickes 2001; Zakaria *et al.* 2002). Logged sites, however, contain slightly lower abundance and species diversity index levels (Wong 1985; Johns 1986c, 1989a, 1992b; Zakaria 1994; Lambert 1992; Grieser Johns 1996; Nordin and Zakaria 1997). Species that increased as a result of logging were mostly common edge and second-growth species, while rarer forest-dependent species declined (Johns 1986, Styring and Ickes 2001).

Lambert and Collar (2002) found in their review of the Sundaic region (which comprises southern Peninsular Thailand, the Malay Peninsula, Borneo, Sumatra, Java and Palawan) that of 274 resident forest species up to 76 species (or 28%) respond negatively to the effects of logging in at least part of their range. Furthermore, almost all species that typically excavate tunnels in rotting tree stumps or termite mounds appear to be strongly affected. Birds typical of the canopy were found to be more resilient to logging. Lambert and Collar suspect the higher number of species in logged forests found in studies in the region to be at least partly biased by the failure to detect all true forest species, since these are highly unobtrusive, and are occurring at much lower densities than those typical of more open, heavily logged forest.

Carnivores

Because raptor-surveys require specialized census-techniques, little data on selective logging effects on this guild is available (Zakaria 1994; Thiollay 1998). In one study covering sites in five different countries in Southeast Asia (Thiollay 1998), raptors were found to have higher densities and higher species diversity in primary or little disturbed forests compared to logged forests and tree plantations. Unfortunately, the effects of the latter two were not differentiated, making it difficult to be sure of the effects of logging alone.

Nectarivores

Most species of nectarivorous birds appear to be more abundant after logging in Malaysia (Johns 1989a; Lambert 1992; Zakaria 1994). Increases might be expected from enhanced growth of vines and flowering herbaceous plants. This growth could also lead to increased numbers of insects, which most nectarivorous birds use as supplementary food source (Lambert 1990). Trends are probably biased, however, because of increased conspicuousness of canopy species in logged forests (Zakaria Bin Hussin and Francis 2001).

Frugivores

Arboreal frugivores, on both Peninsular Malaysia and Borneo, appear to be adversely affected by logging in some areas, though not in others (Johns 1989a; Lambert 1992; Zakaria 1994; Nordin and Zakaria 1997). Some of the effects may be biased because of enhanced visibility of canopy species in logged forests. Studies that avoid this bias found fewer arboreal frugivores in logged forests than in primary ones (Zakaria Bin Hussin and Francis 2001; Zakaria and Nordin 1998). Species that use both canopy and understory are markedly reduced in logged forests. This is probably because the large fruit trees they depend on are much reduced, while they do not feed on the small fruits of many pioneer plants that are abundant in secondary forests (Lambert 1991; Zakaria 1994). More generalist species that eat insects also feed on smaller berries. This factor, together with a possible reduced competition with primary forest frugivores and their ability to switch to another food source may cause the increase that many frugivore insectivores show after logging (Johns 1989a; Lambert 1992; Zakaria 1994; Grieser Johns 1996).

Hornbills, which are both frugivorous and carnivorous, showed decreased densities in some studies, but little changes in others (Zakaria Bin Hussin and Francis 2001; Datta 1998; Johns 1987). The effects of logging on this group are perhaps biased by the effects of hunting pressure. Hornbills forage over large areas and, hence, may be detected flying over degraded forest, even while they spend little time there. As a result, the adverse effect of logging on this family may be underestimated by short-term studies (Johns 1987; Zakaria 1994).

Terrestrial frugivore-insectivores like pheasants and other phasianids, tend to decrease after logging (Johns 1989a; Lambert 1992; Bennett and Zainuddin 1995; Griesser Johns 1996). Although this might be correlated with increased hunting pressure, decreases were also observed in areas that were almost devoid of hunting.

Insectivores

Many sallying insectivores were found to decrease under logging pressure in Malaysia (Zakaria Bin Hussin and Francis 2001), although there are species, like a monarch flycatcher, that may increase (Zakaria 1994). Among foliage-gleaning insectivores, largely consisting of babblers, some species have been reported to increase as a result of logging, while many others decrease. Most species, however, seem to persist in logged forest (Johns 1989a; Zakaria 1994; Lambert 1992; Nordin and Zakaria 1997).

Terrestrial insectivores, especially wren-babblers and pittas, show declines after logging in several reports (e.g. Johns 1989a; Lambert 1992; Lambert and Collar 2002). One cause of these declines may be loss of sheltered understory, which could affect the food supply for these birds. In one study, while some recovery was found in one area 6 years after logging, density and diversity still remained lower than in primary forest 25 years after logging in another (Johns 1992b). This occurred even though few differences were found in arthropod abundance between logged and unlogged sites (Wong 1986).

Bark-gleaning insectivores decreased in all logged forest studies in Malaysia. Presumably, these species are affected by the loss of large trees, although a short term benefit might be expected due to an increase in standing dead trees shortly after logging (Zakaria Bin Hussin and Francis 2001).

4 MONITORING BIRDS IN DISTURBED FOREST ECOSYSTEMS

4.1 INTRODUCTION

In this chapter an attempt is made to develop recommendations for a standard protocol for monitoring the impact of logging on bird guilds, with a special focus on understory insectivores.

As described in the previous chapter, a number of studies investigating logging effects on birds have been conducted. Unfortunately, there are numerous differences in the methodology used between the various studies. Earlier reviews addressed this problem. Danielsen (1997) stated that 'comparison is constrained by lack of suitable controls, incomparable census methods, inadequate description of the disturbance regimes, and differences in the intensity of disturbance'. He suggests that 'well coordinated studies in many different areas, with good and standardized documentation of many habitat variables, may have considerable importance' in revealing comparable trends in responses to habitat degradation. In order to come to such a usable monitoring method, 35 studies on logging effects on birds are reviewed. Table 3 shows these studies together with some of the parameters that were compared. Also, different handbooks on monitoring birds are consulted, such as Ralph and Scott (1981), Bibby *et al.* (1992) and Furness and Greenwood (1993).

4.2 AREA REQUIREMENTS

If the results of a study have to be representative for a large area of forest, then the abiotics (altitude, soil, temperature, rainfall) and the vegetation of the study area have to be representative too.

Good control plots are essential. They should describe the baseline situation appropriately (ie before logging), even if this is not a primary condition! Observation plots in disturbed forests have to be at a large enough distance from nearby undisturbed ones to prevent the undisturbed forest to function as source area, thereby causing underestimations of disturbance effects. How large this distance has to be, will depend on the range of the forest-dependent species present. Although the problem is recognized by various authors (i.e. Aleixo 1999, Dranzoa 1998) most of the studies reviewed included logged plots that were located adjacent to unlogged forests.

The size of the areas to be studied is important, and needs to be large enough to contain a sufficient amount of observation plots. In small areas, sample size is often too small to analyse statistically afterwards (Bibby et al 1992).

The logging history is preferably equal in the different sites. Not only the number of years since logging occurred, but also the intensity is important as both factors can have a considerable effect in the response of different bird species (see chapter 3). Ideally (but probably too elaborate in most cases), a study includes a series of different values of both these factors.

4.3 CENSUS TYPE

In Ralph and Scott (1981), Bibby et al. (1992) and Furness and Greenwood (1993), four types of widely accepted types of censuring bird populations are discussed: territory mapping, transect counts, point counts and mist-netting. Different studies (Jullien and Thiollay 1996; Kofron and Chapman 1995; Sekerciogly 2002; Johns 1987, 1988; Marsden and Pilgrim 1998) also use spot-observations to census bird populations. Every bird seen or heard is recorded opportunistically. This method can be useful for making species lists more complete, but results are difficult to compare statistically. This method, therefore, will not be considered further.

Territory mapping is used widely in temperate zone countries. In tropical forests, however, there are a number of constraints (Bibby *et al.* 1992 and Ralph and Scott 1981):

1) too little is known about the biology of most species to accurately assess territories;
2) birds do not necessarily live in pairs in fixed, discrete and non-overlapping ranges;

3) unlike in most temperate areas, in several species both male and female sing;
4) mapping is very time consuming, and therefore poorly suited to low budget studies.

Mapping is not very suitable in the tropics for these reasons. Consequently none of the reviewed studies made use of this method.

Transect counts; point counts and mist-netting are all used frequently in logging-effect studies (respectively 13, 13 and 17 times out of 39 studies, see appendix 1). All methods have their pros and cons which are discussed here.

Transect counts are more accurate than point counts. This is because the most likely violations of assumptions concern distances between bird and observer. The standard error of estimates rises linearly for transects and by square for point counts (Bibby et al. 1992). Large birds may be flushed easily and be included in the census if they cross the transect in front of the observer. Line transects are best suited to areas that are relatively uniform within sections of hundreds of metres or more (Ralph and Scott 1981; Bibby *et al.* 1992). Although this seems superficially true for forest plots, tropical forests contain a very high spatial diversity, with individuals of, for example, tree species occurring only once every hectare. Transects are considered to be particularly useful in open, species poor habitats (Bibby *et al.* 1992), none of which is true for rainforests. These two aspects are especially important when doing a one-time assessment. When monitoring changes in the bird community over time, they may be less important.

In a point count census it is easier to locate plots randomly or systematically than it is to lay out transect routes. This is because routes require a better access which may bias the habitats sampled. A well-spaced sample series of points in an area will provide more representative data than a few transects. Point counts are therefore often preferred to transects in more fine-grained habitats if identification of habitat determinants of bird communities is an objective of the study (Bibby *et al.* 1992).Compared to transect counts, the observer will have slightly more time to identify individual birds in a flock and will observe less obvious signs of a bird's presence. This is because the observer doesn't need to cope with a moving environment and doesn't need to worry about where he or she is walking. To make an even quicker assessment, or make it more complete, additional sound-recording surveys can be an option. Estimating numbers may be difficult in this method, and evidently it is biased towards the more conspicuous and vocal species.

In one comparative study, point counts gave underestimations of true densities, but most results were within about 30% of the actual density (other techniques showed error percentages that were not very different). Densities were likely to be overestimated where the species was scarcer and underestimated where it was more common. This is probably because in regions where birds are scarcer, they have larger ranges and make larger movements, making double counts more likely (Ralph and Scott 1981).

Mist-netting is the only method that excludes observer bias. It is particularly useful for estimating densities of species that are difficult observe and count in the field (Bibby *et al.* 1992). Karr (1981) states that 'mist nets, in my opinion, are the best procedure for 'censusing' bird populations in tropical forests. They avoid the bias of inadequate knowledge of the resident avifauna and provide a random, unbiased sample of birds moving in the space sampled by the nets. They do not, however, randomly sample the entire avifauna. Mostly understory species are sampled. Of the understory birds, species that walk on the ground, large and very small species, and species active at levels above net operation are under-sampled. Very mobile species are captured out of proportion to their local density'. Except for the groups mentioned by Karr, mistnetting is also biased for hummingbirds (Johns 1991), which seem to avoid the nets and for sunlit places, when nets become more visible.

Point counts are therefore the best way to census effects of habitat alteration on birds in tropical forests. The ability to census a large number of plots in a short time is statistically important in the heterogeneous habitats of tropical forests. Another advantage is the fact that the vegetation structure can be kept relatively uniform and can be recorded for the same area as the bird censuses (Ralph and Scott 1980). When differences over time are more important, transect lines are statistically accurate and convenient, as old transects can easily be relocated and re-opened. For understory birds, which showed to be the most vulnerable group to logging (see chapter 3), mist-netting is in our opinion an alternative. The disadvantage of mist-netting is that it is very labour and time intensive, making it less suitable for a rapid assessment. When using mist-netting, it is advisable to use many, relatively short-length nets, to be able to census many plots and record vegetation parameters in a similar way as in point counts.

Two forest guilds will be underestimated in any of the census methods mentioned above and demand therefore special effort. For nocturnal birds, nocturnal point counts are equally useful as diurnal point counts for other groups. The playback of the bird's sound can be an effective method. Only a few species do not respond well to this method (Bas van Balen pers. comm.). The effects of logging on raptors have unfortunately been studied little. In three different studies by (partially) the same author in French Guiana and Southeast Asia, visual point counts from gaps or logging roads were used (Thiollay 1992, 1998; Jullien and Thiollay 1996). In French Guiana, additional auditive point counts were performed at dusk and dawn for non-soaring forest falcons *Micrastur sp.*

4.4 EXPERIMENTAL SET-UP

Due to the complexity of the ecosystem and the number of possible biases involved, it is important to census many plots in order to draw conclusions that are as accurate as possible. The majority of the species are rare in tropical forest systems, requiring a considerable census effort to include them in an analysis (Ralph and Scott 1980).

Ideally, plots should be no closer than about 200m apart in forest habitats. If they were any closer, some individual birds would be counted at more than one plot (Furness and Greenwood 1993). The number of plots used per treatment in the reviewed studies ranges from as few 12 (Whitman et al. 1998) to as many as 497 (Thiollay 1992).

The duration of individual point counts ranges from 5 to 20 minutes (see appendix 1). The longer the census lasts, the higher the chance that a bird is double counted. Longer intervals may be needed, however, in places with a richer bird fauna or with a high proportion of species that are very hard to detect, such as tropical forests (Bibby *et al*. 1992).

Bibby *et al.* (1992) recommend allocating recorded birds to one or two distance bands from the observer, with a dividing point of about 25-30 meters. In this way, it is possible to make an estimation of population densities in the habitat.

Finally, training of personnel in the identification of bird sounds is required, as most recordings will be done by sound. Training in distance-estimation is useful, especially if using different distance bands.

4.5 VEGETATION PARAMETERS

A good description of the vegetation is important, especially if the goal of the study is to assess bird responses to habitat alteration (Furness and Greenwood 1993, Bibby *et al.* 1992). Considering this, it is surprising that quite a number of the studies reviewed do not specify their habitat parameters or do not include them in their analysis at all (see appendix 1).

Besides logging intensity, Bibby *et al*. (1992) give a number of habitat variables that might be useful in assessing habitat alteration in forest habitats:

1) tree species and diameter at breast height
2) quantity of dead wood
3) ground cover
4) canopy cover

5) canopy height
6) vertical vegetation density: density of canopy, shrub and ground layers

Ghazoul and Hellier (2000), suggested a monitoring framework on a) forest structure b) bird community structure c) butterfly species richness and d) forest disturbance through dead wood and decomposition.

Other studies also include basal tree area (Jones et al. 2003, Shankar Raman and Sukumar 2002), fruit and flower production (Marsden and Pilgrim 2003), direct logging damage (in number of trees and saplings dead) (Thiollay 1992), probable nest sites (Marsden and Pilgrim 2003) and the densities of other plant groups like bamboo, bole-climbers, lianas, ferns, mosses, grasses (Bas van Balen pers. comm.) Habitat variables can be recorded in standard circular sample plots that are used for the point count bird census. Bibby *et al*. (1992) recommend sampling or estimating within a circle of 0.05 ha (12.62 m radius).

If it is not feasible to include all observation plots used in the point count censuses, it is strongly recommended to include at least some permanent plots where the different vegetation parameters are measured throughout the monitoring period.

5 GUILD COMPOSITION COMPARED BETWEEN TROPICAL RAINFOREST SITES

5.1 INTRODUCTION

The analysis of chapter 3 revealed that the bird guild of understory insectivores seems more sensitive to disturbance to logging than other bird guilds. Chapter 4 covered different aspects of a standard protocol for monitoring, including the pros and cons of census methodology.

It is suggested that a pilot study is implemented to test the validity of the use of avian guilds to monitor the responses of avian forest dependent communities to logging and other human disturbances.

The aim of the present chapter is to present an analysis of avian guild structure in four different tropical lowland forest sites, to provide a base line for a monitoring programme.

5.2 APPROACH AND METHODOLOGY

Avian guild structure was analysed for Northern Sierra Madre Natural Park Northern Sierra Madre Natural Park (NSMNP) and three tropical lowland sites in Cameroon, Indonesia and Colombia. The results of various studies covering the logging-effects on birds within and between different continents are often difficult to compare due to different census-techniques and environmental parameters (see chapter 4). In order, therefore, to find out whether trends are valid throughout the tropics, it may be desirable to execute a pan tropical study where locations representative for the region, are investigated in the same way. Only forest dependent resident lowland birds were listed for the present study. One important reason for this is the fact that most “Certification” systems refer to forest dependent species in their indicator/verifiers requirements. Non-breeding visitors, even if they are forest dependent, were not included for the simple reason that this introduces seasonal bias. For the identification of guilds, use was made of the guild classification according to Mac Kinnon et al.(1996) and Johns (1997). Species lists were obtained from van Weerd (2002) for Sierra Madre Natural Park in the Philippines, Tye (2002) and Hoogeland and Van Leeuwen (2002) (Amacayacu in Colombia), Languy and Demey (2000) (Campo Ma’an in Cameroon), Fredriksson unpublished (Sungai Wain in Indonesia). The distribution of species to the different guilds was done using Stotz et al (1996) for Colombia, Borrow and Demy (2002) and Fry et al. (1982-2000) for Cameroon and Smythies (1999) for Kalimantan. The number of species is calculated per guild, with the percentage of the total number of species between brackets. Species are included in the understory guilds only if they are specialized in foraging in this stratum. Several species of arboreal guilds occur also in the understory, but do not depend on it.

Table 4 Summary of forest type, size, conservation status and main disturbance factors of the selected forest sites

Site	Forest type	Size (ha)	Conservation status	Main disturbance factors
Sierra Madre N.P., Philippines	Montane Lowland forest	360,000	Natural Park	Illegal logging Hunting
Amacayacu N.P., Colombia	Lowland forest	293,500	National Park	Hunting
Campo Ma’aan N.P., Cameroon	Montane Lowland forest Coastal forest	264,000	National park	Illegal logging Hunting
Sungai Wain Reserve	Lowland forest	9,762	Forest reserve	Illegal logging Hunting Burning

5.3 SELECTION OF FOREST SITES FOR GUILD ANALYSIS

The forest sites selected for this study had a long-term involvement of Tropenbos International (Cameroon, Indonesia and Colombia) and the Institute of Environmental Sciences of Leiden University (Philippines). From these sites bird checklists, data on forest structure and logging history/ disturbance factors were available. Sungai Wain Reserve is the only smaller sized reserve included in the survey, since in the Province of East Kalimantan this is one of the last remaining areas of lowland forest. The main differences between the rainforest sites are summarized in the Table 4 below;

5.4 RESULTS OF GUILD ANALYSIS

Table 4 presents an overview of the distribution of bird guilds over the different tropical forest sites included in this study. A chi-square analysis (Heath 1995) shows that the proportion of the number of species per guild differs significantly between the selected sites (df: 24, $P<0.001$). Total number of species recorded is highest for Amacayacu N.P. (327), followed by Sungai Wain Forest Reserve (177), Sierra Madre N.P. (139), and Campo Ma'an (149). The proportion of understory insectivores was remarkably similar in all sites (between 13-18%), as well as terrestrial insectivores (between 4-6%), nectarivores/insectivores (7-9%), and terrestrial omnivores (2-3%), (Chi-square test, df = 6, p = 0.971). Important differences exist among the arboreal frugivores, with most in NSMNP (17%) and fewest in Campo Ma'an (5%), among the arboreal insectivores, with most in Campo Ma'an (33%) and fewest in NSMNP (13%). The proportion of carnivores also shows variation and follows the size distribution of the different forest sites with most (10%) in NSMNP, then 8% in Amacayacu N.P., 3% in Campo Ma'an and 2% in Sungai Wain forest reserve.

Table 5 Guild distribution of the avifauna of three Tropenbos field sites. Aerial feeders and non-forest species are not included.

Guild	NSMNP	Amacayacu	Campo Ma'an	Sungai Wain
Carnivores	12 (10%)	27 (8%)	4 (3%)	4 (2%)
Nocturnal carnivores/insectivores	6 (5%)	9 (3%)	3 (2%)	10 (6%)
Nectarivore/insectivores	8 (7%)	22 (7%)	10 (7%)	16 (9%)
Arboreal frugivores	20 (17%)	42 (13%)	7 (5%)	12 (7%)
Arboreal frugivore/insectivores	17 (15%)	53 (16%)	28 (19%)	19 (11%)
Arboreal frugivore/carnivores	0 (0%)	8 (2%)	11 (7%)	7 (4%)
Arboreal insectivores	18 (16%)	70 (21%)	49 (33%)	53 (30%)
- bark-gleaning	2 (2%)	32 (10%)	6 (4%)	16 (9%)
- foliage-gleaning	7 (6%)	27 (8%)	24 (16%)	20 (11%)
- sallying	7 (6%)	10 (3%)	9 (6%)	8 (5%)
- sallying/foliage-gleaning	2 (2%)	1(0%)	10 (7%)	9 (5%)
Understory frugivore	0 (0%)	8 (2%)	0	0
Understory frugivore/insectivores	3 (3%)	5 (2%)	6 (4%)	7 (4%)
Understory insectivores	19 (17%)	56 (17%)	20 (13%)	31 (18%)
- bark-gleaning	1 (1%)	0	1 (1%)	0
- foliage-gleaning	5 (4%)	37 (11%)	13 (9%)	19 (11%)
- sallying	13 (11%)	15 (5%)	4 (3%)	7 (4%)
- sallying/foliage-gleaning	0 (0%)	4 (1%)	2 (1%)	5 (3%)
Terrestrial frugivores	2 (2%)	5 (2%)	0	2 (1%)
Terrestrial omnivores	4 (3%)	8 (2%)	3 (2%)	6 (3%)
Terrestrial insectivores	6 (5%)	14 (4%)	8 (5%)	10 (6%)
Total	115	327	149	177

Note: Species are included in the understory guilds only if they are specialized in foraging in this stratum. Several species of arboreal guilds occur also in the understory, but do not depend on it.
Species lists were obtained from Van Weerd (2002) for Sierra Madre N.P.,Tye (2002) (Amacayacu), Languy and Demey (2000) (Campo Ma'an) and Fredriksson unpublished (Sungai Wain). The distribution of species to the different guilds was done using ecological information found in Hilty and Brown (1985), Borrow and Demy (2002), Frye et al. (1982-2000) and Smythies (1999) and Kennedy et al. (2000). Per guild the number of species is given, with the percentage of the total number of species between brackets.

6 DISCUSSION AND CONCLUSIONS

6.1 DISCUSSION

In the introduction we stated that this report covers the use of avian guilds to monitor the responses of avian communities to forest disturbance such as logging.

The following discussion should be read within this context. Although the outline of a possible standard protocol is presented, follow up studies are needed to fill in elements of the protocol.

Pantropical trends in the effects of logging on birds

Table 6 summarises the number of studies reporting negative, neutral or positive impacts on avian community diversity/abundance or avian guilds diversity/abundance.

Table 6 Effects of selective logging in tropical forests on avian community parameters and different feeding guilds in the Neotropics, Africa and the Oriental region. - = negatively affected, + = positively affected and 0 = unaffected

Guild	Neotropics	Africa	Oriental
Community–diversity/ abundance	4 (0) 7 (-)	7 (+) 4 (0) 2 (-)	2(+) 4 (0) 8(-)
Carnivores	2 (+) 1 (-)	--	1 (+)
Nectarivores	3 (+) 2 (0)	--	3 (+)
Frugivores	6 (+) 1(-)	3 (+) 2 (-)	4 (+) 4 (0) 4 (-)
Insectivores	7 (-)	2 (+) 3 (-)	5 (-) 5 (0)
Total number of studies	15	9	14

Impacts of logging on community diversity/abundance showed different effects, with a total of 12 studies reporting neutral impacts, 17 with negative impacts and 9 with positive impacts. This confirms the variable response of this parameter to logging and the conclusion that species richness may not be a good indicator for ecosystem health. Too few studies of carnivores are available, to draw any conclusion. Similarly, for nectarivores in 13 studies positive impacts are reported, in 4 studies neutral impacts and in 7 studies negative impacts. The clearest negative result is on insectivores; in 15 studies a negative impact is reported, in 2 studies a positive impact and in 5 a neutral impact.

Species richness of the community shows neutral, negative or positive impacts of logging in most studies in all three continents (Table 4). This confirms the earlier suggestion of Ghazoul and Hellier (2000) that species richness is no good indicator for logging disturbance.

Understory insectivore species and arboreal frugivores seem particularly sensitive. Arboreal frugivores are both affected by logging (reduction of canopy cover) and hunting.

Marked differences show between guilds. In Asia and South America, the studies that dealt with raptors (Thiollay, 1992) showed increases in the number of species. However, overall abundance declined.

Nectarivores seem to be generally unaffected by logging or even show an increase in abundance in various studies in the Neotropics and the Oriental. This probably originates in a higher number of flowering lianas in gaps in logged forests.

The guild of frugivores seems generally unaffected in some studies, but affected in others, with some increases in some studies, and slight decreases in others. If there is a significant loss of fruit trees, however, decreases are recorded. In Asia, especially frugivores that use both canopy and understory showed a marked decrease. Contrary to this, understory frugivores are expected to benefit from logging because of the abundance of small berries of shrubs and secondary species.

Insectivores are most sensitive guild when it comes to logging disturbance. Although most species persist, the abundance is often much lower in disturbed forest. Understory insectivores are especially affected by logging: the foraging techniques of sallying, mixed-flock and ground insectivores seem to be less effective in the dense vegetation following gap creation. Only in Kibale Forest in Uganda higher densities of understory insectivores were found. Strangely, the authors give the higher vegetation density as possible explanation, whereas most other studies suggest the opposite. Perhaps this maybe explained by the 70 years of logging history in the forest, permanently creating a more open canopy, and a species-assemblage adapted to this situation. Canopy species seem more resilient, probably because of their higher mobility and often more opportunistic feeding habits.

Can avian guilds be used as indicator for the responses of avian communities to forest disturbance?

Most Criteria and Indicator systems for sustainable forest management use species richness of flora and fauna for monitoring and assessment purpose, without indicating standards of performance (chapter 2.2). The weaknesses of existing certification systems are partly covered by the proposed protocol of Ghazoul and Hellier (2000), who suggested a monitoring framework on a) forest structure b) bird community structure c) butterfly species richness and d) forest disturbance through dead wood and decomposition (chapter 2.4). Their monitoring protocol included suggestions for the use of insectivore avian guilds, but lacked further detail on the approach.

The use of faunal indicators by logging companies and most NGO's (non-governmental organisations) needs improvement, so that the right indicators are implemented in forest management and some harmonization takes place of the different criteria and indicator systems (FAO, 1995). CIFOR proves that a generic set-up, which is applicable worldwide, is possible without lacking clear conservation goals.

Avian guilds are proposed as good candidates by various authors (e.g. Severinghaus 1981, Mannan *et al*. 1984, Van der Hoeven *et al*. 2000). When looking at effects of logging disturbance, a quick validation of their use is possible using the stepwise decision-making framework of Hilty and Merenlender (2000) chapter 2.3) and the trends revealed (chapter 3).

Birds are probably the best-studied species group, and will therefore fit better in the demand on clear taxonomy and life history information than any other group. Understory insectivores show a fairly clear response to selective logging (chapter 3) The exception in Uganda is mentioned above. It is suggested, however, that a monitoring protocol should not exclusively cover understory insectivores, but preferably include other avian guilds. The understory avian guild should be a major focus in the protocol considering its special pan tropical vulnerability.

Therefore the use of avian guilds is proposed for consideration in future monitoring, since these a) represent energy and nutrient flows in the forest ecosystems b) can be calculated from existing species lists with relatively little effort and c) are therefore relatively cost effective

It is important to investigate understory insectivores and other sensitive avian guilds further as they fit a number of demands mentioned in the framework. They are in a medium trophic level and most are food and/or habitat specialists. Almost all species from this group are immobile and resident. On each continent only a few species are migrants; mostly thrushes (Turdidae). These need to be excluded from analysis as their abundance may reflect changes outside the investigated area. They are fairly easy detectable by sound or sight and do not need special capture methods. . When using point counts, a large (up to 10 per morning) number of plots can be censured in a short time. Transect counts can be done fairly quickly and can give relatively accurate information over time-intervals. Existing species lists can be used and transformed into guild structure tables relatively easily. Therefore the use of avian guilds is proposed for consideration in future monitoring, since these a) represent energy and nutrient flows in the forest ecosystems b) can be calculated from existing species lists with relatively little effort and c) are therefore relatively cost effective

It can be concluding that if vertebrate indicators are desired in assessing the effects of logging disturbance in tropical forests, understory insectivores may very well prove to be valuable. It is possible to subdivide understory insectivores further, using only one of the foraging specialisations thereby simplifying census techniques. Mixed-flock members and terrestrial species could then be used.

An important pre-condition for meaningful monitoring is a matching of the scale of the pressure indicator (e.g., logging) with the scale of the performance indicator (e.g., avian guild). In the comparative analysis summarised above we have assumed that forest disturbances taking place in the four compared tropical forest sites (some illegal logging in the Sierra Madre and Sungai Wain, utilisation of non-timber forest products in Campo Ma'an and Amacayacu) have not affected overall species composition in these large protected areas, and that the guild distribution we used in the comparative analysis reflects general guild distributions of lowland forest birds in the Philippines, Cameroon and Colombia. Abundance data was not included in this comparative study. The lack of this data is a limitation of this study. The presented guild distributions could be used, however, as baseline data for future biodiversity monitoring in these three sites.

For future studies, we recommend including an analysis at the lower scale levels of the pressure indicators (e.g. the level of logging blocks or sub sectors of protected forest areas), and to include in the analysis of the performance indicators both the fractions of avian guilds (as a percentage of total species numbers), as well as species-abundance indices per avian guild (as a percentage of total species abundance).

The aim of such follow up studies should be to set (local, regional or global) standards for ecosystem health in tropical lowland forest, using certain sensitive groups like understory insectivores as a bench mark. The strong similarities in the fractions of understory insectivores suggests that comparable standards of performance for the fractions of this guild in the selected forest areas may be used to indicate ecosystem health although this hypothesis needs further testing with much more data than we have used here.

6.2 MAIN CONCLUSIONS OF THIS STUDY

The need for more harmonization of existing biological criteria and indicator systems for sustainable forest management as described by the FAO/ITTO Expert Consultation in 1995 still stands.

1) The present system of using species richness in most Criteria and Indicator systems for sustainable forest management is not feasible.
2) The use of vertebrate indicators/verifiers is poorly defined. Only CIFOR and ITTO recommend the use guilds, which are the most promising indicators, and the use of standards of performance.
3) In order to improve monitoring systems a protocol should be developed, that includes avian guilds, to measure the responses of bird communities to forest disturbance
4) The literature review reveals a consistent pattern that understory insectivores form the most sensitive group when it comes to logging disturbance,
5) We recommend a pilot study on the use of the avian guilds as a possible part of a suggested standard protocol for the monitoring the responses of avian communities to the impact of logging on biological diversity in tropical production forest. This standard protocol should cover both inventories of species diversity as well as abundance figures.
6) Point counts are the best census technique to assess the effects of habitat disturbance on (understory insectivorous) birds. Mist netting is a good complimentary method for some specific understory groups. Including vegetation in an analysis is important, when assessing habitat alteration.

6.3 PILOT STUDY

For a future monitoring protocol we propose to use the guild structure, to complement species richness, in a pilot study lasting at least five years. The monitoring protocol will include the following elements.

1) recording of species richness and abundance in time and space.
2) guild structure will be defined using Excel sheets linking taxonomic classification with guild,
3) species composition, in particular of the guilds of understory insectivores, terrestrial insectivores, arboreal frugivores and nectarivores in all sites will be determined
4) within the understory insectivore guild particular attention will be given to bark gleaning/foliage-gleaning, sallying and sallying/foliage cleaning guilds
5) surveys should be carried using a combination of plot transect counts (1.5 km per track) and plot counts (20 minutes per plot, plots at every 500 m).

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