

The birds of the Ambatovy-Analamay region

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Abstract

Despite previous research on the birds of the Ambatovy-Analamay region, current information was insufficient to characterize the avifauna occurring in each of the nine local habitats. In order to complete the needed data, an ornithological inventory was conducted between 6 January and 21 February 2009 at nine sites: eight forested areas and one in an open zone. Three complementary methods were used: general observations, mist-netting, and transects. Eighty-one species belonging to 38 families were encountered in the region. These species occur in different types of habitats: 57 are forest species, 18 frequent open habitats, and six are found in aquatic zones. The rate of endemism is notably high as 70 of the 81 species (85%) are Malagasy endemics, including 49 endemic to Madagascar and 21 endemic to the Malagasy region. Results have highlighted the high number of bird species in the "Transitional Benchmark" and "Zonal Benchmark" habitats, which contain 51 and 48 species, respectively, and in contrast, the paucity in the "Azonal Impacted Good Quality" habitat, which holds 36 species. In addition, the relative abundance (number of contacts per km of trail) in the "Azonal Benchmark" and "Zonal Impacted Good Quality" habitats are the most elevated, with about 128 and 123 birds/km, respectively. Overall, the Ambatovy-Analamay avifauna is a subset of that of the eastern rainforest, with many species being widely distributed across this zone. With the exception of *Anas melleri*, which is an endangered species, no bird species occurs in the Ambatovy-Analamay forest that is locally restricted in its distribution or considered rare.

Key words: Aves, species diversity, distribution, Ambatovy-Analamay forests, Madagascar

Résumé détaillé

Les informations relatives aux oiseaux des différents types d'habitats de la région d'Ambatovy-Analamay dont huit sont forestiers et un ouvert, sont insuffisantes pour caractériser sur le plan ornithologique chacun de ces habitats malgré les diverses études antérieures réalisées dans la région. Ces habitats ont fait l'objet d'un inventaire rapide entre le 6 janvier et 21 février 2009. Trois méthodes complémentaires ont été utilisées, à savoir, les observations générales, la capture à l'aide de filets et le transect. Bien que les résultats ne présentent qu'une partie des informations sur l'avifaune de la région à cause de la période au cours de laquelle l'inventaire a été mené, ils montrent que 81 espèces réparties dans 38 familles ont été répertoriées dans la région. Ces espèces fréquentent différents types d'habitats dont 57 espèces sylvoles, 18 espèces des milieux ouverts et six espèces aquatiques. Le taux d'endémisme est élevé puisque parmi ces 81 espèces, 70 sont endémiques dont 49 endémiques de Madagascar et 21 endémiques de la région. Les informations récoltées au cours de cette évaluation biologique ont permis de mettre en évidence la richesse spécifique élevée de la « Transitional Benchmark » et de la « Zonal Benchmark » qui abritent respectivement 51 et 48 espèces et la pauvreté de l'avifaune de « Azonal Impacted Good Quality » qui ne semble héberger que 36 espèces. En outre, les résultats de capture à l'aide de filets des oiseaux de sous-bois dans quatre sites ont montré une abondance relative plus notable dans la forêt de « Azonal Benchmark » de ce groupe par rapport à celle des autres types de forêt. Le taux de capture de ce site était égal à 1,8 oiseaux/filet/jour. Les populations de *Foudia omissa* et *F. madagascariensis* représentent plus de 68,5 % des individus pris dans ce type d'habitat et plus de 27,0 % des oiseaux capturés dans tous les sites concernés. Les abondances relatives (nombre de contacts par kilomètre) de tous les oiseaux de deux habitats qui sont « Azonal Benchmark » et « Zonal Impacted Good Quality » sont probablement les plus importantes par rapport à celles des autres. Elles sont respectivement de l'ordre de 128 et 123 oiseaux/km. Dans l'ensemble, l'avifaune de la région constitue un

sous-ensemble de celle de la forêt humide orientale et la plupart des espèces rencontrées au cours de cet inventaire est à large distribution. Aucune particularité frappante n'a été trouvée, aucune espèce restreinte à la région ni espèce rare à l'exception d'*Anas melleri* qui est une espèce en danger.

Mots clés : Aves, diversité spécifique, distribution, forêts d'Ambatovy-Analamay, Madagascar

Introduction

In order to advance aspects of biodiversity conservation in the context of the Ambatovy mineral project, the forests of Ambatovy and Analamay region, the zone where the exploitation will take place, were the subject of rapid ornithological inventories between 6 January and 21 February 2009. This region, located to the northwest of the well-known Réserve Spéciale d'Analamazaotra, is of ornithological interest as a variety of vegetational formations, from largely intact montane forests to secondary habitats, are represented as well as atypical forests resting on carapace ferruginous and ultra basic soils.

Nine different habitats, composed of three different forest types (transitional, zonal, and azonal - see Goodman & Raselimanana, pp. 36-37) were the subject of the ornithological investigations. Eight of these nine habitats are covered by natural humid forests with varying degrees of anthropogenic impact, which include: Azonal Benchmark, Azonal Impacted Good Quality, Transitional Benchmark, Transitional Impacted Good Quality, Transitional Impacted Degraded, Zonal Benchmark, Zonal Impacted Good Quality, and Zonal Impacted Degraded. The ninth habitat is not considered a forest formation and was dominated by *Erica* (Family Ericaceae) bush and in close proximity to vestiges of degraded natural forest. The research presented herein on the avifauna of the Ambatovy-Analamay region adds to previous surveys, particularly environmental impact and environmental monitoring studies, associated with the mineral exploitation project.

The objectives of our inventories were to obtain detailed information on the avifauna occurring in the different surveyed habitats, specifically, species composition, species richness, measures of relative abundance, and analysis of the biogeographic affinities of the avifauna between the different sites and in a larger regional context. The data and conclusions presented herein provide considerable insights into the forest-dwelling avifauna of the Ambatovy-Analamay region.

Methods

Data collection

In order to inventory the birds of the Ambatovy-Analamay region, three different field methods were used: general observations, capture of understory birds with mist nets, and line transects.

General observations

This technique consists of walking along forest trails, without a fixed schedule, and noting the different bird species observed or heard vocalizing. As the majority of bird species are most active in the first portion of the morning or the late afternoon, general observations were normally conducted between 5 h 30-10 h 30 and 14 h 30-16 h 30. Additionally, birds noted during other portions of the day or night were also included. This qualitative technique is largely utilized to document the species present at a given site without any intention of standardization of effort or technique (Hawkins & Goodman, 1999; Raherilalao & Goodman, 2003).

Capture of understory birds with mist nets

Mist net captures were used as a means to provide relative abundance measures for the local avifauna, particularly understory species, and is expressed as the number of birds captured per mist-net day (Karr, 1981). Mist nets were installed in four vegetational formations: Transitional Benchmark, Transitional Impacted Good Quality, Zonal Benchmark, and Azonal Benchmark (see Goodman & Raselimanana, pp. 36-37, for their definitions). At each site, 10 mist-nets were installed, all 12 m in length, 2.6 m in height, with 4 shelves, and mesh size of 36 mm. They were placed in three different topographic settings: valleys, slopes, and hillcrests. The lowest shelf of each net was placed about 20 cm above the ground. Mist nets were visited at least once each hour from sunrise to one hour after sunset. The nets were open throughout the night, allowing the capture of nocturnal bird species. The geographical coordinates of the placement of each mist net are given in Table 1. Altitudes for a given site are those calculated with a GPS.

For each captured individual bird the following information was recorded: site, date, time, net number, and shelf the animal was captured. Netted animals were identified to species, weighed, marked, and then released near to where they were captured. The marking technique at each site consisted of coloring the primary feathers with a black indelible marker, with animals captured the first day having the first primary colored, those the second day the second

Table 1. Geographical coordinates for the different mist net sets used in this study to capture understory birds in the Analamay-Ambatovy forests. “SRT” indicates the start of a grouped series of mist nets and “FIN” the end of the respective net line. See Goodman & Raselimanana (pp. 36-37) for a description of the vegetational formations.

Type of vegetational formation	Mistnet	Latitude	Longitude	Alt (m)
Transitional Impacted Good Quality	Net1-SRT	18°47'55"S	48°19'27"E	1110 m
	Net1-FIN	18°47'58"S	48°19'26"E	1116 m
	Net2-SRT	18°47'55"S	48°19'22"E	1079 m
	Net2-FIN	18°47'53"S	48°19'23"E	1079 m
	Net3-SRT	18°01'03"S	48°10'38"E	1081 m
	Net3-FIN	18°47'56"S	48°19'12"E	1081 m
Transitional Benchmark	Net4-SRT	18°47'03"S	48°20'02"E	1107 m
	Net4-FIN	18°47'35"S	48°20'00"E	1115 m
	Net5-SRT	18°47'36"S	48°20'10"E	1065 m
	Net5-FIN	18°47'38"S	48°20'12"E	1065 m
	Net6-SRT	18°47'35"S	48°20'13"E	1051 m
	Net6-FIN	18°47'34"S	48°20'14"E	1033 m
Azonal Benchmark	Net7-SRT	18°48'30"S	48°20'20"E	1095 m
	Net7-FIN	18°48'31"S	48°20'21"E	1087 m
	Net8-SRT	18°48'28"S	48°20'16"E	1067 m
	Net8-FIN	18°48'27"S	48°20'17"E	1063 m
	Net9-SRT	18°48'27"S	48°20'13"E	1049 m
	Net9-FIN	18°48'27"S	48°20'15"E	1046 m
Zonal Benchmark	Net10-SRT	18°48'24"S	48°21'32"E	1001 m
	Net10-FIN	18°48'25"S	48°21'34"E	1002 m
	Net11-SRT	18°48'26"S	48°21'34"E	1015 m
	Net11-FIN	18°48'28"S	48°21'35"E	1018 m
	Net12-SRT	18°48'23"S	48°21'35"E	1000 m
	Net12-FIN	18°48'24"S	48°21'36"E	991 m

primary, etc. until the fifth and last day of netting. This technique allowed the recognition of previously netted birds and the chronology of their previous capture.

The results of the mist-netting work are presented as the number of birds captured per net and per day, which is expressed by the term “mist-net day”. Capture rate is a relative abundance measure used to compare the densities of birds between sites within the same forest block and between different forests.

Line transects

The method used at each site to quantify the local avifauna was line transects conducted along prearranged 1 km trails. The observer walked at a consistent speed of approximately 1 km/h and noted all birds heard and observed. These transect counts were made between 5 h 30-8 h 30, the period of maximum activity for most diurnal birds. For each detected bird, the perpendicular distance between the animal and the trail was calculated and noted. The geographic coordinates of the transects at the different sites are provided in Table 2. Inherent in this technique is that not all locally occurring bird species

in a forest block or habitat are recorded along a given transect.

Taxonomy and terminology

The higher-level systematics and species taxonomy follow Goodman & Hawkins (2008). A number of changes have taken place in the systematics of Malagasy birds since Langrand (1995), including former Malagasy members of the genus *Phyllastrephus*, which are now placed within two different endemic genera (Cibois *et al.*, 2001); the recognition of a previously unrecognized endemic radiation of the family Bernieridae (Cibois *et al.*, 2001), which has resulted in numerous changes in the family designation of different Passeriformes; notable modifications in the species composition of the Vangidae (Yamagishi *et al.*, 2001); the genus *Otus* is considered monospecific in Madagascar (Fuchs *et al.*, 2008); the genus *Pseudocossyphus* is a synonym of *Monticola* (Goodman & Weigt, 2002); and the genus *Ispidina* is a synonym of the genus *Corythornis* (Marks & Willard, 2005). With a few modifications, the classification of the forest habitat types used by a given species generally follows Wilmé (1996).

Definitions of endemism

Species endemic to Madagascar are those that occur on the island and its near shore islands and islets (e.g., Nosy Be and Ile Sainte Marie). Regional endemics are defined as those species shared between Madagascar and other islands in the region including the Comoros, Mascarenes (La Réunion, Maurice, and Rodrigues), and the Seychelles Archipelago.

Forest-dwelling bird species

Endemic species are those that depend on the presence of relatively intact forest at least part of their life cycle.

Similarity indices and biogeographic analyses

In order to determine the biogeographic affinities of the avifauna occurring in the different study zones, data from other inventoried sites at similar elevations in the eastern humid forest are used herein. The field techniques employed at these other sites follow those in the Ambatovy-Analamay region. On the basis of presence-absence data of bird species, the Jaccard Index (Magurran, 1988) was calculated to determine

the faunistic similarity between the different study zones, using the following formula:

$$\text{Jaccard Index} = \frac{C}{N_1 + N_2 - C}$$

with N_1 = specific richness at site 1, N_2 = specific richness at site 2, and C = number of species occurring at both sites.

The associated coefficients were entered into the "Hierarchical clustering" (Linkage = Complete, Distance = Euclidean) program of SYSTAT 10 to produce a branching diagram illustrating the biogeographic affinities of birds at the different sites.

Analysis of species diversity of understory birds

To measure patterns of specific diversity, the Shannon-Weaver H' diversity index was employed (Magurran, 1988), which was calculated with the following formula:

$$H' = - \sum (ni/N) \log(ni/N)$$

where ni : number of individuals of a given species and N : number of individuals censused.

Table 2. The geographic coordinates of line transects at the different sites in the Ambatovy-Analamay forests based on types of vegetational formations defined in Goodman & Raselimanana (pp. 36-37). The letter "T" indicates transect trails.

Type of vegetational formation	Transect number	Length (m)	Orientation	GPS coordinates	
				Start	End
Azonal Benchmark	T7	1000	SE	18°48'29"S, 48°20'14"E, 1053 m	18°48'41"S, 48°20'37"E, 1080 m
Azonal Impacted Good Quality	T15	1000	SW	18°49'33"S, 48°20'01"E, 1031 m	18°49'58"S, 48°19'40"E, 1026 m
Azonal Impacted Degraded	T2	1000	NW	18°48'30"S, 48°19'59"E, 1083 m	18°48'11"S, 48°19'44"E, 1095 m
Transitional Benchmark	T3	1000	NE	18°47'51"S, 48°19'53"E, 1160 m	18°47'36"S, 48°20'16"E, 1029 m
Transitional Impacted Good Quality	T1	1000	NW	18°47'58"S, 48°19'39"E, 1088 m	18°47'55"S, 48°19'07"E, 1055 m
Transitional Impacted Degraded	T14	1000	NE	18°49'18"S, 48°20'08"E, 1085 m	18°48'46"S, 48°20'13"E, 1049 m
Zonal Benchmark	T9	1000	NE	18°48'25"S, 48°21'33"E, 1001 m	18°48'02"S, 48°21'55"E, 1038 m
Zonal Impacted Good Quality	T13	1000	NE	18°49'33"S, 48°18'53"E, 1181 m	18°49'02"S, 48°19'00"E, 1094 m
Zonal Impacted Degraded	T8	1000	SW	18°48'25"S, 48°21'27"E, 1020 m	18°48'51"S, 48°21'08"E, 1054 m

This measure considers both the presence/absence of species of a given zone, as well as the relative abundance of each taxon. Further, the Shannon-Weaver index takes into account the distribution of the number of individuals by species or their evenness (E, which range from values of 0 to 2) based on the following formula:

$$E = H'/\log S$$

where S is the total number of species.

The calculated evenness value is a function of diversity, with higher values indicating that all species present have similar abundances, with no taxa being dominant or rare with respect to the others, and hence,

in a faunistic sense homogenous. The inverse, with low evenness figures, represent cases where there are certain species dominant at a given site.

Results

Species composition

The birds of the Ambatovy-Analamay region form a sub-group of the community occurring in the mid-altitude eastern humid forests of Madagascar. Certain species considered typical of this formation at other sites in central eastern portion of the island were not identified during our ornithological inventories of the Ambatovy-Analamay region. The bird species found in each of the habitats are presented in Table 3.

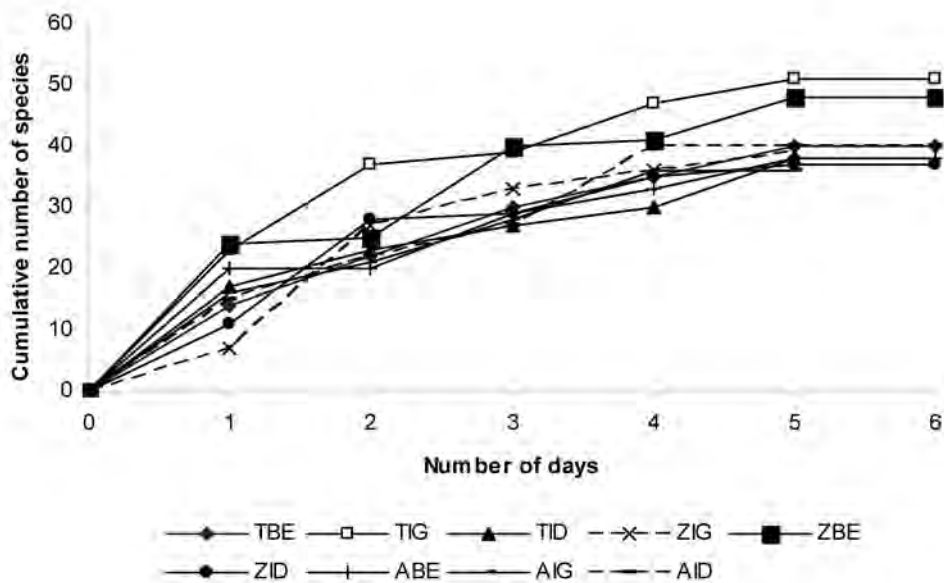


Figure 1. Species accumulation curves for all bird species inventoried in the Ambatovy-Analamay region. ABE: Azonal Benchmark, AIG: Azonal Impacted Good Quality, AID: Azonal Impacted Degraded, TBE: Transitional Benchmark, TIG: Transitional Impacted Good Quality, TID: Transitional Impacted Degraded, ZIG: Zonal Impacted Good Quality, ZBE: Zonal Benchmark, and ZID: Zonal Impacted Degraded.

Species richness

On the basis of different survey techniques (general observations, capture of understory birds with mist nets, and line transects) used during the course of the inventories in the Ambatovy-Analamay region, the cumulative number of species recorded in each habitat generally reached a plateau after the fifth day of sampling (Figure 1). The attainment of these asymptotes shows that the vast majority of locally occurring species were documented. In the case of the Transitional Impacted Degraded and Zonal Impacted Good Quality, the curve increases slightly towards the end of the survey, indicating that a few additional species may have been missed.

Eighty-one different bird species were recorded in the region, representing 38 different families. On the basis of habitat preferences, these 81 taxa are divided into six aquatic species, 58 forest species, and 17 open habitat species. In comparison to other sites at similar elevations in the humid forests of central-eastern Madagascar (e.g., Goodman & Putnam, 1996; Raherilalao *et al.*, 2001), the species richness in the Ambatovy-Analamay region is relatively low; this aspect is addressed in detail in the Discussion section. The highest species richness of birds in the different surveyed areas was in the Transitional Impacted Good Quality habitat, with 51 species, followed by the Zonal Benchmark habitat, with 48 species. The lowest

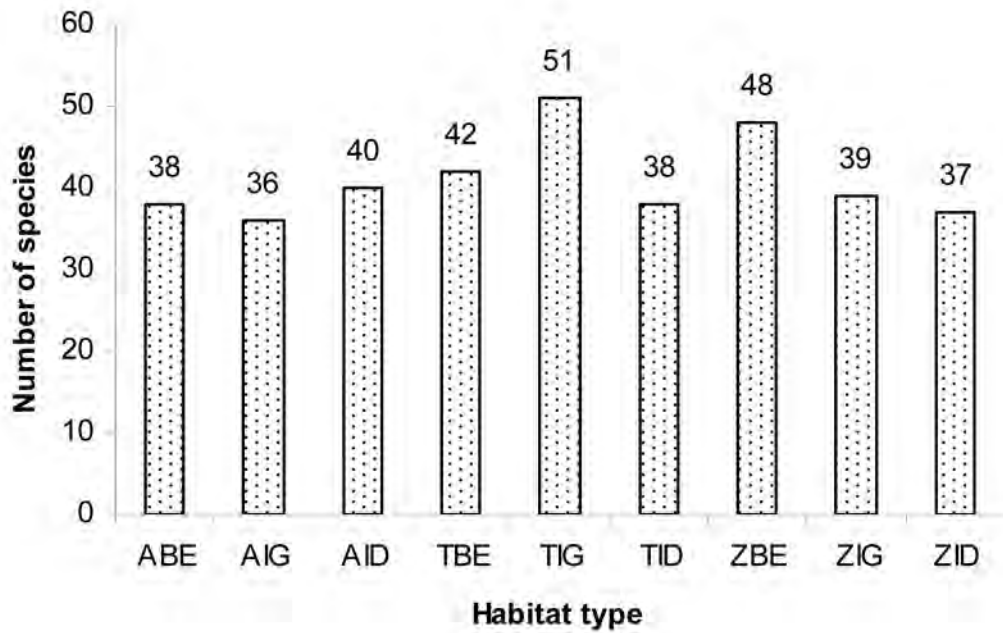


Figure 2. Species richness of birds inventoried in the Ambatovy-Analamay region based on different habitat types. ABE: Azonal Benchmark, AIG: Azonal Impacted Good Quality, AID: Azonal Impacted Degraded, TBE: Transitional Benchmark, TIG: Transitional Impacted Good Quality, TID: Transitional Impacted Degraded, ZIG: Zonal Impacted Good Quality, ZBE: Zonal Benchmark, and ZID: Zonal Impacted Degraded.

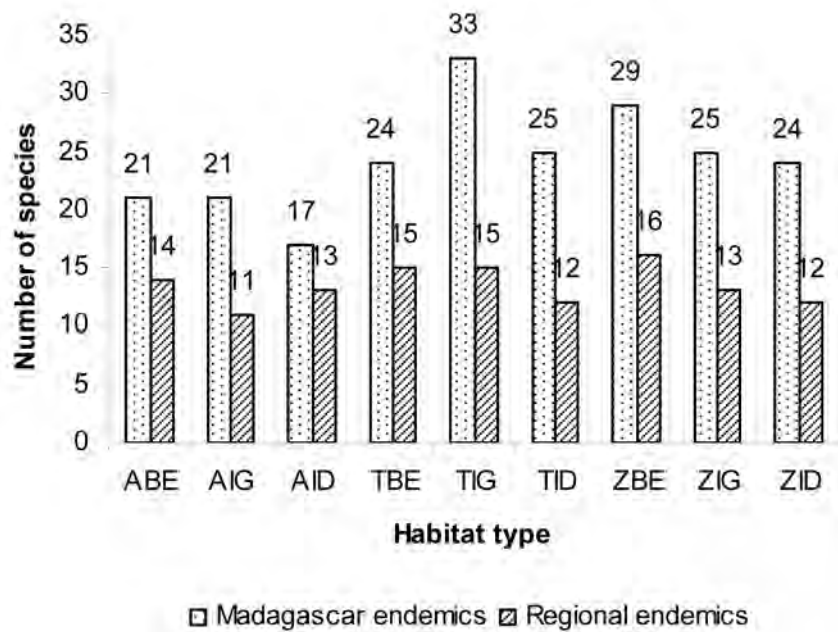


Figure 3. Number of endemic bird species inventoried in the Ambatovy-Analamay region. See Methods section for definitions of endemism. ABE: Azonal Benchmark, AIG: Azonal Impacted Good Quality, AID: Azonal Impacted Degraded, TBE: Transitional Benchmark, TIG: Transitional Impacted Good Quality, TID: Transitional Impacted Degraded, ZIG: Zonal Impacted Good Quality, ZBE: Zonal Benchmark, and ZID: Zonal Impacted Degraded.

Table 3. (cont.)

Taxon	Habitat type	Endemicity	IUCN Status (2008)	ABE	AIG	AID	TBE	TIG	TID	ZBE	ZIG	ZID
<i>Coracopsis vasa</i>	Forest	EndReg		*		9	*	*		*		
<i>Coracopsis nigra</i>	Forest	EndReg		3	3	5	4	6	3	2	1	2
Cuculidae												
<i>Cuculus rochii</i>	Forest	EndMad						*				
<i>Coua reynaudii</i>	Forest	EndMad		1	1	*	2	2	*	1	2	1
<i>Coua serriana</i>	Forest	EndMad		*			1	*		*		
<i>Coua caerulea</i>	Forest	EndMad		6	1	*	3	1	*	2	4	3
<i>Centropus toulou</i>	Forest	EndReg				*	*		*			1
Tytonidae												
<i>Tyto alba</i>	Open habitat				*							
Strigidae												
<i>Otus rutilus</i>	Forest	EndMad		*	*	*	*	*	*	*	*	*
<i>Ninox superciliosus</i>	Forest	EndMad			*							
<i>Asio madagascariensis</i>	Forest	EndMad						*				
Caprimulgidae												
<i>Caprimulgus enarratus</i>	Forest	EndMad						*				2
<i>Caprimulgus madagascariensis</i>	Open habitat	EndReg				*	*	*				
Apodidae												
<i>Cypsiurus parvus</i>	Open habitat					*						
<i>Apus barbatus</i>	Open habitat					*						
Alcedinidae												
<i>Alcedo vintsioides</i>	Aquatic	EndReg		*		*	*	2	1	*	1	
<i>Corythornis madagascariensis</i>	Forest	EndMad										
Meropidae												
<i>Merops superciliosus</i>	Open habitat			2	*	*	6	*		*		
Coraciidae												
<i>Eurystomus glaucurus</i>	Open habitat			*	*	*	2	*		*		
Brachypteraciidae												
<i>Atelornis pittoides</i>	Forest	EndMad						*			*	
Leptosomatidae												
<i>Leptosomus discolor</i>	Forest	EndReg		*	2	2	2	2	*	1	1	
Eurylaimidae												
<i>Philepitta castanea</i>	Forest	EndMad							1	2	1	2
<i>Neodrepanis coruscans</i>	Forest	EndMad								*		*

Table 3. (cont.)

Taxon	Habitat type	Endemicity	IUCN Status (2008)	ABE	AIG	AID	TBE	TIG	TID	ZBE	ZIG	ZID
Alaudidae												
<i>Mirafr hova</i>	Open habitat	EndMad				*						
Hirundinidae												
<i>Phedina borbonica</i>	Open habitat	EndReg				*						
Motacillidae												
<i>Motacilla flaviventris</i>	Open habitat	EndMad	1									
Campephagidae												
<i>Coracina cinerea</i>	Forest	EndReg		2	*		*	2	4	2		2
Pycnonotidae												
<i>Hypsipetes madagascariensis</i>	Forest			10	4	10	10	8	4	8	4	6
Bernieridae												
<i>Bernieria madagascariensis</i>	Forest	EndMad		3	5		1	4	5	2	5	5
<i>Xanthomixis zosterops</i>	Forest	EndMad		3	*		7	1	*	*	7	3
<i>Oxylabes madagascariensis</i>	Forest	EndMad		8			2	4	*	7	*	8
<i>Cryptosylvicola randrianasoloi</i>	Forest	EndMad			1		1	2	*		1	
Turdidae												
<i>Copsychus albospecularis</i>	Forest	EndMad		4	3		3	3	6	2	5	7
<i>Saxicola torquata</i>	Open habitat											
<i>Monticola sharpei</i>	Forest	EndMad				3						1
Sylviidae												
<i>Nesillas typica</i>	Forest	EndReg		7	3	9	*	5	3	2	5	3
<i>Randia pseudozosterops</i>	Forest	EndMad						2				
<i>Cisticola cherina</i>	Open habitat	EndReg				*						
<i>Neomixis tenella</i>	Forest	EndMad		2	12	2	2	8	10	1	2	4
<i>Neomixis viridis</i>	Forest	EndMad					1	1		*	1	1
<i>Neomixis striatigula</i>	Forest	EndMad						2	*	*		
Monarchidae												
<i>Terpsiphone mutata</i>	Forest	EndReg		4	5		2	1	3	5	2	7
Nectarinidae												
<i>Nectarinia notata</i>	Forest	EndReg		1	*		1	1	*	*	1	1
<i>Nectarinia souimanga</i>	Forest	EndReg		7	5	6	13	11	8	8	12	11
Zosteropidae												
<i>Zosterops maderaspatana</i>	Forest	EndReg		6	*	11	4	6	*	2	*	4

Table 3. (cont.)

Taxon	Habitat type	Endemicity	IUCN Status (2008)	ABE	AIG	AID	TBE	TIG	TID	ZBE	ZIG	ZID
Vangidae												
<i>Calicalicus madagascariensis</i>	Forest	EndMad		8	6		*	3	4	3	1	3
<i>Vanga curvirostris</i>	Forest	EndMad		1	1		1	*	1	1	2	
<i>Leptopterus chabert</i>	Forest	EndMad		*		7	3	*				3
<i>Cyanolanius madagascarinus</i>	Forest	EndReg							2	*	*	2
<i>Hypositta corallirostris</i>	Forest	EndMad							*			
<i>Tylas eduardi</i>	Forest	EndMad		1				*	2	*	*	
<i>Mystacornis crossleyi</i>	Forest	EndMad		1	2		1	*	*	*	1	*
<i>Pseudobias wardi</i>	Forest	EndMad						2	*	*	2	*
<i>Newtonia amphichroa</i>	Forest	EndMad		*	*		5	4	*	1	3	2
<i>Newtonia brunneicauda</i>	Forest	EndMad		13	10	2	5	7	8	8	8	9
Dicruridae												
<i>Dicrurus forficatus</i>	Forest	EndReg		2	1	*	1	4	3	2	2	2
Sturnidae												
<i>Hartlaubius auratus</i>	Forest	EndMad			*		*	*		*		
Ploceidae												
<i>Ploceus nelicourvi</i>	Forest	EndMad					*	*		2	1	6
<i>Foudia omisa</i>	Forest	EndMad		22	*	1	4	2	2	10	3	16
<i>Foudia madagascariensis</i>	Open habitat	EndMad		10	7	12	4	3	*			
Estrildidae												
<i>Lonchura nana</i>	Open habitat	EndMad				3						
Total number of species				38	36	40	42	51	38	48	39	37
Aquatic species				3	0	4	0	0	0	2	1	0
Forest species				31	31	19	36	46	36	43	37	36
Open habitat species				4	5	16	5	5	2	3	1	1
Endemic Madagascar species				22	22	18	25	34	26	30	26	25
Endemic regional species				13	10	12	14	14	11	15	12	11
Total endemic species				35	32	30	39	48	37	45	38	36
Relative abundance (number of contacts/km)				128	75	83	97	99	71	76	80	123

Table 4. Distribution of the different habitat types used by birds in the Ambatovy-Analamay region associated with the level of human degradation. ABE: Azonal Benchmark, AIG: Azonal Impacted Good Quality, AID: Azonal Impacted Degraded, TBE: Transitional Benchmark, TIG: Transitional Impacted Good Quality, TID: Transitional Impacted Degraded, ZIG: Zonal Impacted Good Quality, ZBE: Zonal Benchmark, and ZID: Zonal Impacted Degraded.

Habitat class	Habitat type	Species richness	Aquatics	Forest	Open	Madagascar endemics	Regional endemics	Total endemics	Habitat description
	ABE	38	3	31	4	21	14	35	<ul style="list-style-type: none"> Canopy relatively closed, with certain sections of the zone lacking trees; trees in general are 5 to 10 m with small diameters, although other sections have trees reaching 20 m with more substantial diameters; understory relatively lush with a continuous herbaceous layer. Ground humus is notably thin, except in sections with large trees where it is slightly thicker. There are clear signs of previous selective logging, including cut trunks of large trees and non-rotten cut logs resting on the ground.
Azonal	AIG	36	0	31	5	21	11	32	<ul style="list-style-type: none"> Canopy relatively closed, trees in general are 5 to 8 m with small diameters, although other sections, particularly in valleys, have trees reaching 20 m and more substantial diameters; understory relatively lush with a continuous herbaceous layer. Ground humus is notably thin, except in sections with large trees where it is slightly thicker. There are clear signs of previous selective logging, including cut trunks of large trees, non-rotten cut logs resting on the ground, and numerous trails. Further, there are signs of the passage of fire.
	AID	40	4	19	16	17	13	30	<ul style="list-style-type: none"> The vast majority of this zone is a continuous formation of <i>Erica</i> (Family Ericaceae) growing to 1 to 3 m in height. The zone is largely monospecific with the exception of low-lying areas with small lakes and seasonal marsh habitat and widely dispersed small vestiges of the former forest habitat. Ground humus is very thin. There are signs of previous selective logging, numerous trails, and the passage of fire.

Table 4. (cont.)

Habitat class	Habitat type	Species richness	Aquatics	Forest	Open	Madagascar endemics	Regional endemics	Total endemics	Habitat description
	TBE	42	0	36	5	24	15	39	<ul style="list-style-type: none"> • Canopy generally closed, although certain areas are completely open. In one section, tree height is reduced to 5 to 10 m, with small diameters, and the understorey is relatively dense with lianescent bamboo. In other sections of this forest the tree reach 10-20 m in height, with considerable girth, and the understorey is lush and forms a continuous herbaceous layer. • Ground humus relatively thick. • There are signs of previous selective logging, with remaining trail systems particularly along the hillcrests and nearby secondary forest habitat.
Transitional									
	TIG	51	0	46	5	33	15	48	<ul style="list-style-type: none"> • Canopy relatively closed, trees reaching 8 to 15 m in height, and understorey lush with a continuous herbaceous layer. • Ground humus relatively thick. • There are signs of previous selective logging.
	TID	38	0	36	2	25	12	37	<ul style="list-style-type: none"> • Canopy relatively closed, tree reaching 10 to 15 m in height, understorey relatively dense with a discontinuous understorey layer. • Ground humus relatively thick. • There are signs of previous selective logging and associated trail system.
	ZBE	48	2	43	3	29	16	45	<ul style="list-style-type: none"> • Canopy relatively closed, trees reaching 10 to 20 m in height and with considerable diameters, and understorey not particularly lush with a discontinuous herbaceous layer. Tree-ferns of the genus <i>Cyrtosperma</i> abundant in valleys. • Ground humus distinctly thick. • There are signs of previous selective logging based on remaining trunks of cut trees.
Zonal									
	ZIG	39	1	37	1	25	13	38	<ul style="list-style-type: none"> • Canopy relatively closed, trees reaching 8 to 20 m in height and with considerable diameters, and understorey dense with a discontinuous herbaceous layer. • Ground humus distinctly thick. • There are signs of previous selective logging and trail system associated with extraction.
	ZID	37	0	36	1	24	12	36	<ul style="list-style-type: none"> • Canopy relatively closed, trees reaching 10 to 20 m in height, understorey dense with a discontinuous herbaceous layer, and understorey not particularly lush with a discontinuous herbaceous layer. • Ground humus distinctly thick. • There are signs of previous selective logging based on remaining trunks of cut trees.

species richness was in the Azonal Impacted Good Quality habitat with 36 species (Table 3, Figure 2).

On the basis of the three major forest habitat types (azonal, transitional, and zonal), not one shows a notable preponderance in species richness for any of the different habitat types used by the local avifauna (aquatic, forest, and open habitat or combined), regardless of habitat quality, and to a large extent, the locally occurring bird community is adaptable to different ecological conditions (Table 4; also see next section).

Endemism

Among the 81 species recorded in the Ambatovy-Analamay region during these surveys, 70 (86.4%) are endemic, comprising 49 (60.5%) Malagasy endemics and 21 (25.9%) regional endemics. On the basis of the different habitat types, the number of endemic species declines directly with the level of habitat degradation especially in the azonal and zonal habitats; the greater the level of disturbance the lower the endemic species richness (Table 3, Figure 3).

IUCN Status

Five bird species found during the course of this field research have received IUCN Red List categories (IUCN, 2008). *Anas melleri*, considered “Endangered”, was found in the marsh formation in the Azonal Impacted Degraded habitat and along the Sakalava River, which passes through the Azonal Benchmark habitat. The other four species, which have “Near Threatened” status, include *Lophotibis*

cristata in the Azonal Impacted Good Quality habitat; *Accipiter henstii* in five different habitats (Azonal Impacted Good Quality, Azonal Impacted Degraded, Transitional Impacted Degraded, Zonal Benchmark, and Zonal Impacted Degraded) habitats; *Accipiter madagascariensis* in the Zonal Impacted Good Quality habitat; and *Gallinago macrodactyla* in the Azonal Impacted Good Quality habitat.

Measures of relative abundance

Capture of understory birds with mist nets

In total, 225 birds, composed of 24 different species, were netted during the course of these field studies in four different habitats. A total of 50 net-days were accrued in each of the sampled forest habitats, resulting in the capture of 89 individuals of 12 species in the Azonal Benchmark habitat, 45 individuals of 12 species in the Transitional Benchmark habitat, 64 individuals of 17 species in the Transitional Impacted Good Quality habitat, and 27 individuals of 14 species in the Zonal Benchmark habitat. Netting in the Azonal Benchmark resulted in the capture of a considerable number of *Foudia omissa* (26 individuals) and *F. madagascariensis* (35 individuals), representing 68.5% of the individuals captured in this habitat and more than 27% of all birds netted. In considering habitat type, capture rates were highest in the Azonal Benchmark habitat (average 1.8 birds per net-day) and lowest in the Zonal Benchmark habitat (average 0.5 birds per net-day) (Figure 4). Table 5 presents a summary of capture rates in the four different sites. Amongst the different habitats where mist-netting

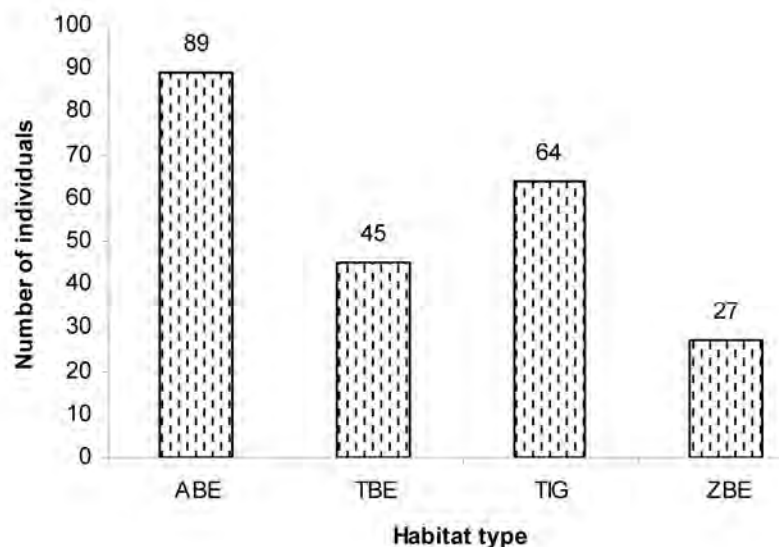


Figure 4. Capture rates of understory birds in four different habitats in the Ambatovy-Analamay region. ABE: Azonal Benchmark, TBE: Transitional Benchmark, TIG: Transitional Impacted Good Quality, and ZBE: Zonal Benchmark.

was conducted, the evenness measure associated with the Shannon-Weaver Index is the highest in the Transitional Benchmark habitat, indicating the peak level of avifaunal homogeneity (Table 5).

Line transects

Using the line transect method and the number of individuals per species in the different forest habitats, an estimation of the relative abundance of most taxa was calculated. The data divided by habitat type are presented in Table 3. It is important to note that these estimations concern only a portion of the locally occurring bird community, specifically the area along the line transects and are not necessarily extractable to the complete specific habitat.

In general, two habitats appear to have greater relative abundances than the others: Azonal Benchmark and Zonal Impacted Degraded habitats have contact frequencies of 128 birds/km and 123 birds/km, respectively. Amongst the habitats with the lowest measured bird abundance are the Transitional Impacted Degraded with 71 birds/km, Azonal Impacted Good Quality with 75 birds/km, and the Zonal Benchmark with 76 birds/km (Figure 5). Three species are relatively abundant in all of the different habitat types, and include *Hypsipetes madagascariensis*, *Newtonia brunneicauda*, and *Nectarinia souimanga*. Some species are dominant in particular habitat types, while in other habitats their relative densities are distinctly low, examples include: *Oxylabes madagascariensis*, *Nesillas typica*, *Neomixis tenella*, *Zosterops maderaspatana*, *Calicalicus madagascariensis*, *Foudia omissa*, and *F. madagascariensis* (Table 3). In other cases, taxa such as *Lophotibis cristata*, *Atelornis pittoides*, and *Hypositta corallirostris* are notably uncommon in certain habitats and their local documentation during the line transects was simply a matter of chance.

Specificity based on habitat preferences

Aquatic species

Six species (7.4%) of those recorded during the inventory are associated with aquatic habitats and these are distributed as three taxa (*Anas melleri*, *Dryolimnas cuvieri*, and *Alcedo vintsioides*) in the Azonal Benchmark habitat; four (*Anas melleri*, *A. erythrorhynca*, *Gallinago macrodactyla*, and *Alcedo vintsioides*) in the Azonal Impacted Degraded habitat; two (*Dryolimnas cuvieri* and *Alcedo vintsioides*) in the Zonal Benchmark habitat; and one (*Dryolimnas*

cuvieri) in the Zonal Impacted Good Quality habitat (Table 6, Figure 6).

Open habitat species

In total, 18 species (22.2%) of those inventoried during this study occur in open habitat, most were found in *Erica* bush in the Azonal Impacted Degraded habitat. In a few cases, these species were also recorded in forest habitats, such as *Caprimulgus madagascariensis* and *Foudia madagascariensis*.

Forest species

Given that eight of the nine surveyed habitats are natural forests at different stages of degradation, forest-dwelling bird species make up the majority of those inventoried, representing 57 (70.4%) of the 81 species found in the region. The proportion of species in this category is notably high in each of the eight forest habitats.

Similarity of the bird fauna between inventoried habitats

In order to understand the differences and similarities of the bird fauna in the three major habitat types (azonal, transitional, and zonal), specifically associated with habitat quality (habitat preference and levels of intactness/degradedness), a comparative analysis based on presence-absence data in each habitat was conducted. The distribution of each species in the different habitats is presented in Table 6.

Azonal formations

Of the 62 bird species recorded in the different azonal formations, the number of species common to all three habitats is 17 or 27.4% and the number found in two of the three habitats is 19 or 30.6%. Further, 26 species (41.9%) only occurred in one of the three habitats: three in the Azonal Benchmark, six in the Azonal Impacted Good Quality, and 17 in the Azonal Impacted Degraded.

Transitional formations

During the course of the inventories, 56 birds were identified in the transitional formations, of which 29 (51.8%) were found in all three habitat types and 17 (30.4%) in two of the three habitat types. In total, 10 (17.9%) of these 56 bird species were only located in a single transitional formation: six in the Transitional Impacted Good Quality and four in the Transitional

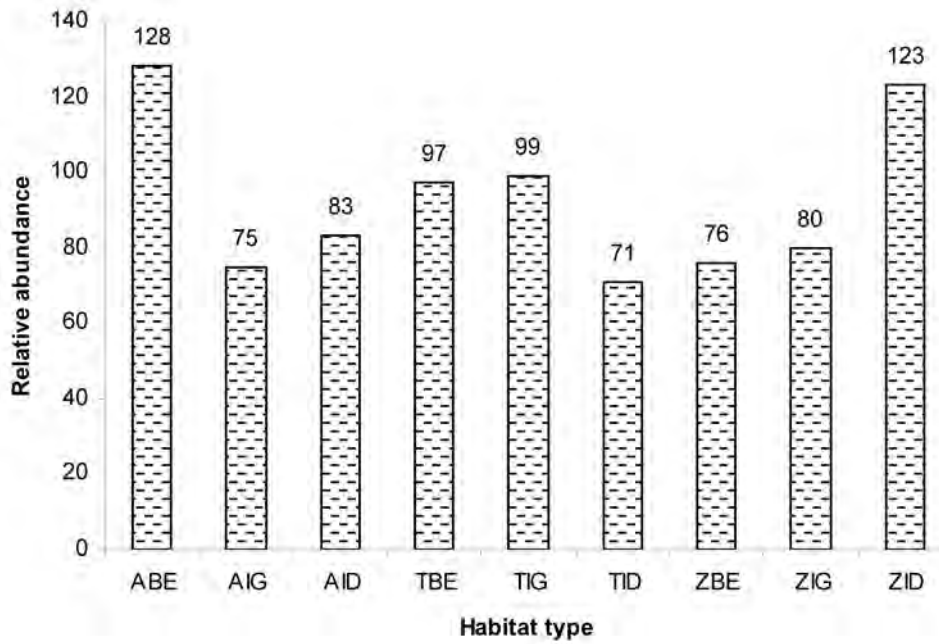


Figure 5. Relative abundance of birds inventoried in the Ambatovy-Analamay region based on different habitat types. ABE: Azonal Benchmark, AIG: Azonal Impacted Good Quality, AID: Azonal Impacted Degraded, TBE: Transitional Benchmark, TIG: Transitional Impacted Good Quality, TID: Transitional Impacted Degraded, ZIG: Zonal Impacted Good Quality, ZBE: Zonal Benchmark, and ZID: Zonal Impacted Degraded.

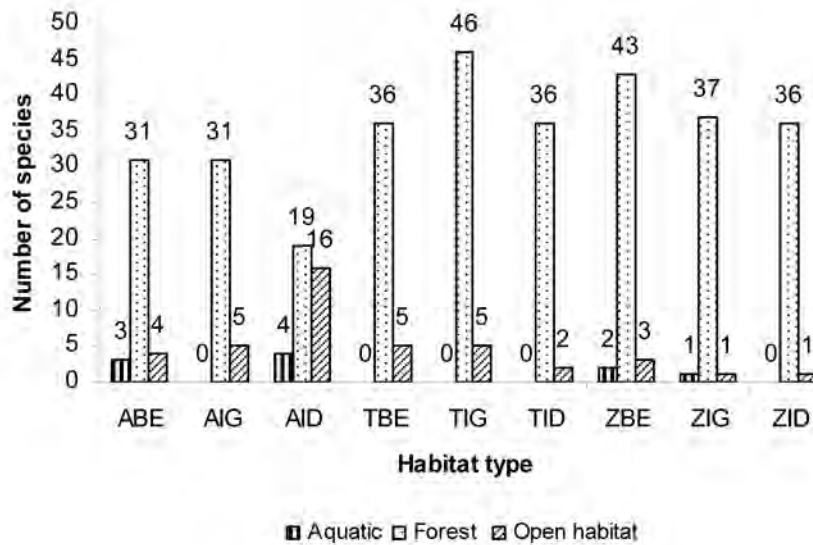


Figure 6. Number of species of birds based habitat utilization for the different study sites in the Ambatovy-Analamay region. ABE: Azonal Benchmark, AIG: Azonal Impacted Good Quality, AID: Azonal Impacted Degraded, TBE: Transitional Benchmark, TIG: Transitional Impacted Good Quality, TID: Transitional Impacted Degraded, ZIG: Zonal Impacted Good Quality, ZBE: Zonal Benchmark, and ZID: Zonal Impacted Degraded.

Table 5. Summary of understory birds captured in four different habitats in the Ambatovy-Analamay region. ABE: Azonal Benchmark, TBE: Transitional Benchmark, TIG: Transitional Impacted Good Quality, and ZBE: Zonal Benchmark.

Taxon	ABE	TBE	TIG	ZBE
<i>Canirallus kiolooides</i>			1	
<i>Sarothrura insularis</i>			1	
<i>Coua reynaudii</i>			1	
<i>Corythornis madagascariensis</i>			1	1
<i>Philepitta castanea</i>				2
<i>Hypsipetes madagascariensis</i>	2	4		1
<i>Bernieria madagascariensis</i>	6	5	6	1
<i>Xanthomixis zosterops</i>	2	3	2	1
<i>Oxylabes madagascariensis</i>		3	3	1
<i>Copsychus albospecularis</i>	8	6	7	4
<i>Nesillas typica</i>	1		3	2
<i>Terpsiphone mutata</i>	1	1	5	4
<i>Nectarinia souimanga</i>		3	2	
<i>Zosterops maderaspatana</i>	1		1	1
<i>Calicalicus madagascariensis</i>	3		1	
<i>Vanga curvirostris</i>		1		
<i>Mystacornis crossleyi</i>	1			1
<i>Newtonia amphichroa</i>		3	5	2
<i>Newtonia brunneicauda</i>	3	5		
<i>Ploceus nelicourvi</i>			1	2
<i>Foudia madagascariensis</i>	26	8	13	
<i>Foudia omissa</i>	35	3	11	4
Number of captured individuals	89	45	64	27
Number of species	12	12	17	14
Number of accrued net-days	50	50	50	50
Capture rate (birds /net-day)	1.8	0.8	1.3	0.5
Shannon-Weaver Index	0.75	1.02	1.06	1.07
Evenness Index	0.69	0.95	0.86	0.93

Impacted Degraded; no taxon was restricted to the Transitional Benchmark.

Zonal formation

Of the 57 bird species recorded in the zonal formation, 28 (49.1%) occurred in all three habitats and 11 (19.3%) in two of the three. Eighteen (31.6%) species were restricted to a single zonal habitat, which includes nine in the Zonal Benchmark, five in the Zonal Impacted Good Quality, and four in the Zonal Impacted Degraded.

Distribution and biogeographic affinities of the Ambatovy-Analamay region avifauna

During the course of the ornithological work in the Ambatovy-Analamay region, no unusual or unexpected species of bird was found. Given that most taxa living in the mid-elevation eastern humid forests have broad distributions, this result is not unexpected. In a few cases, certain species occur outside of their preferred habitat, such as open habitat species in the forest

or forest species in open habitats. For example, the three raptors *Polyboroides radiatus*, *Accipiter henstii*, and *Otus rutilus*, which are normally forest-dwelling, were found in the small relict forest parcels in the Azonal Impacted Degraded habitat or in the case of *Centropus toulou* and *Foudia madagascariensis*, two open habitat species, were encountered in certain forested zones.

In order to examine in more detail the biogeographic of the different habitats inventoried during the course of these inventories, as well as have a broader regional context for the homogeneity or heterogeneity of the species composition, data from several other mid-elevation central eastern humid forest sites were added to the analysis. These include: Maromiza at 980 m (Raherilalao, unpublished data); Vatoharanana at 1025 m, Andrambovato at 1075 m, and Vinanitelo at 1100 m (Raherilalao *et al.*, 2001); and Andringitra at 1210 m (Goodman & Putnam, 1996). The original data set for these comparisons is presented in Table 7. The coefficients of the Jaccard Index, which provides

Table 6. The number of bird species inventoried in the different habitats in the Ambatovy-Analamay region. ABE: Azonal Benchmark, AIG: Azonal Impacted Good Quality, AID: Azonal Impacted Degraded, TBE: Transitional Benchmark, TIG: Transitional Impacted Good Quality, TID: Transitional Impacted Degraded, ZIG: Zonal Impacted Good Quality, ZBE: Zonal Benchmark, and ZID: Zonal Impacted Degraded.

General habitat type	Number of species	Percentage (%)
Total number of species	62	
Species found in all three habitats	17	27.4
Species found in two habitats		
ABE, AIG	12	19.4
ABE, AID	6	9.4
AIG, AID	1	1.6
Sub-total	19	30.6
Species found in only one habitat		
ABE	3	4.8
AIG	6	9.7
AID	17	27.4
Sub-total	26	41.9
Total number of species	56	
Species found in all three habitats	29	51.8
Species found in two habitats		
TRE, TIG	12	21.4
TRE, TID	1	1.8
TIG, TID	4	7.1
Sub-total	17	30.4
Species found in only 1onehabitat		
TRE	0	0
TIG	6	10.7
TID	4	7.1
Sub-total	10	17.9
Total number of species	57	
Species found in all three habitats	28	49.1
Species found in two habitats		
ZBE, ZIG	6	10.5
ZBE, ZID	5	8.8
ZIG, ZID	0	0
Sub-total	11	19.3
Species found in only one habitat		
ZBE	9	15.8
ZIG	5	8.8
ZID	4	7.0
Sub-total	18	31.6

a measure of the faunistic relationships between different sites within and outside the Ambatovy-Analamay region, are presented in Table 8.

The dendrogram constructed based on the matrix of coefficient values (Table 8), show two distinct groups separated by a moderate Euclidian metric unit (e.m.u.) of 0.30 e.m.u. The first group is composed of eight of the nine surveyed sites in the Ambatovy-Analamay region, which only show some slight differences in species composition and are notably homogenous to one another (Figure 7, Table 3). The major outlier in the Ambatovy-Analamay region is the bird fauna of the Azonal Impacted Degraded habitat, which forms a separate branch of the dendrogram, with a considerable number of open habitat species. The second major grouping within this analysis is the other mid-elevation central eastern humid forests

used in the comparisons. Although these forested areas fall within the same elevation range as those from the Ambatovy-Analamay region, they show notable faunistic differences.

Discussion

Species composition and species richness

Although several different studies have been conducted on the avifauna of the Ambatovy-Analamay region, our inventories revealed eight species that had not been previously figured in the 2007-2008 Ambatovy project database (Appendix 1). These include two aquatic species, *Scopus umbretta* and *Gallinago macrodactyla*; four forest species, *Accipiter madagascariensis*, *Ninox superciliaris*, *Corythornis madagascariensis*, and *Monticola sharpei*; and two

Table 7. Distribution of bird species in the Ambatovy-Analamay region and other central eastern humid sites at approximately the same elevation. The symbol “*” = presence of a species. ABE: Azonal Benchmark, AIG: Azonal Impacted Good Quality, AID: Azonal Impacted Degraded, TIG: Transitional Benchmark, TIG: Transitional Impacted Good Quality, TID: Transitional Impacted Degraded, ZIG: Zonal Impacted Good Quality, ZBE: Zonal Benchmark, and ZID: Zonal Impacted Degraded. Data on the avifauna of the Réserve Spéciale d’Analamazaotra is from Wilimé *et al.* (1997); given these data were not obtained using the same techniques and survey effort of the other sites listed in the table, they are not included in the biogeographic analysis.

Taxon	ABE	AIG	AID	TBE	TIG	TID	ZIG	ZBE	ZID	Maromiza 980 m	Vatoharanana 1025 m	Andrambovato 1075 m	Vinanitelo 1100 m	Andringitra 1210 m	Analamazaotra circa 950 m
<i>Tachybaptus pelzelinii</i>															*
<i>Phalacrocorax africanus</i>															*
<i>Anhinga melanogaster</i>															*
<i>Ardeola ralloides</i>															*
<i>Ardeola idae</i>															*
<i>Bubulcus ibis</i>															*
<i>Butorides striatus</i>															*
<i>Casmerodius albus</i>															*
<i>Ardea purpurea</i>															*
<i>Ardea humbloti</i>															*
<i>Anas melleri</i>	*														*
<i>Anas erythrorhyncha</i>			*												*
<i>Scopus umbretta</i>			*												*
<i>Lophotibis cristata</i>										*			*		*
<i>Aviceda madagascariensis</i>										*			*		*
<i>Milvus migrans</i>															*
<i>Euriorchus astur</i>															*
<i>Polyboroides radiatus</i>	*	*	*	*	*	*	*	*	*	*		*	*	*	*
<i>Accipiter henslii</i>	*	*	*				*	*	*		*	*	*	*	*
<i>Accipiter madagascariensis</i>						*									*
<i>Accipiter francesii</i>				*	*	*	*	*	*	*		*	*	*	*
<i>Buteo brachypterus</i>	*	*	*	*	*	*	*	*	*	*		*	*	*	*
<i>Falco newtoni</i>															*
<i>Falco zoniventris</i>															*
<i>Falco eleonorae</i>															*
<i>Falco concolor</i>															*
<i>Falco peregrinus</i>			*											*	*
<i>Margaroperdix madagarensis</i>			*												*
<i>Turnix nigricollis</i>			*												*
<i>Numida meleagris</i> (presumed introduced)											*	*	*	*	*
<i>Mesitornis unicolor</i>											*	*	*	*	*

Table 7. (cont.)

Taxon	ABE	AIG	AID	TBE	TIG	TID	ZIG	ZBE	ZID	Maromiza 980 m	Vatoharanana 1025 m	Andrambovato 1075 m	Vinanitelo 1100 m	Andringitra 1210 m	Analamazaotra circa 950 m
<i>Atelornis crossleyi</i>										*	*	*	*	*	*
<i>Leptosomus discolor</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Philepitta castanea</i>					*	*	*	*	*	*	*	*	*	*	*
<i>Neodrepanis coruscans</i>					*	*	*	*	*	*	*	*	*	*	*
<i>Neodrepanis hypoxantha</i>										*	*	*	*	*	*
<i>Riparia paludicola</i>															*
<i>Mirafra hova</i>			*												*
<i>Phedina borbonica</i>			*												*
<i>Motacilla flaviventris</i>			*								*				*
<i>Coracina cinerea</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Bernieria madagascariensis</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Xanthomixis zosterops</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Xanthomixis cinereiceps</i>										*	*	*	*	*	*
<i>Xanthomixis tenebrosus</i>					*	*	*	*	*	*	*	*	*	*	*
<i>Oxylabes madagascariensis</i>	*			*	*	*	*	*	*	*	*	*	*	*	*
<i>Crossleyia xanthophrys</i>					*	*	*	*	*	*	*	*	*	*	*
<i>Cryptosylvicola randrianasoloi</i>		*		*	*	*	*	*	*	*	*	*	*	*	*
<i>Hypsipetes madagascariensis</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Copsychus albospectularis</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Saxicola torquata</i>			*												*
<i>Monticola sharpei</i>									*	*	*	*	*	*	*
<i>Acrocephalus newtoni</i>		*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Nesillas typica</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Randia pseudozosterops</i>					*					*	*	*	*	*	*
<i>Cisticola cherina</i>			*												*
<i>Dromaeocercus brunneus</i>		*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Neomixis tenella</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Neomixis viridis</i>					*	*	*	*	*	*	*	*	*	*	*
<i>Neomixis striatigula</i>					*	*	*	*	*	*	*	*	*	*	*
<i>Hartertula flavoviridis</i>					*	*	*	*	*	*	*	*	*	*	*
<i>Terpsiphone mutata</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Nectarinia notata</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Nectarinia souimanga</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Zosterops maderaspatana</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Calicalicus madagascariensis</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Schetba rufa</i>					*	*	*	*	*	*	*	*	*	*	*
<i>Vanga curvirostris</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Leptopterus viridis</i>										*	*	*	*	*	*

Table 7. (cont.)

Taxon	ABE	AIG	AID	TBE	TIG	TID	ZIG	ZBE	ZID	Maromiza 980 m	Vatoharanana 1025 m	Andrambovato 1075 m	Vinanitelo 1100 m	Andringitra 1210 m	Analamazaotra circa 950 m
<i>Leptopterus chabert</i>	*		*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Cyanolanius madagascarinus</i>				*	*	*	*	*	*	*	*	*	*	*	*
<i>Tylas eduardi</i>		*		*	*	*	*	*	*	*	*	*	*	*	*
<i>Xenopirostris polleni</i>											*	*	*	*	*
<i>Euryceros prevostii</i>				*	*	*	*	*	*	*	*	*	*	*	*
<i>Hypositta corallirostris</i>				*	*	*	*	*	*	*	*	*	*	*	*
<i>Mystacornis crossleyi</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Pseudobias wardi</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Newtonia amphichroa</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Newtonia brunneicauda</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Dicrurus forficatus</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Hartlaubius auratus</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Corvus albus</i>															*
<i>Acridotheres tristis</i> (introduced)															*
<i>Ploceus nelicourvi</i>				*	*	*	*	*	*	*	*	*	*	*	*
<i>Foudia omissa</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Foudia madagascariensis</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Lonchura nana</i>			*												*

Table 8. Jaccard's Similarity indices for bird species occurring in different habitats in the Ambatovy-Analamay region, as well as different humid forest sites at middle elevations in the eastern central portion of the island. ABE: Azonal Benchmark, AIG: Azonal Impacted Good Quality, AID: Azonal Impacted Degraded, TBE: Transitional Benchmark, TIG: Transitional Impacted Good Quality, TID: Transitional Impacted Degraded, ZIG: Zonal Benchmark, ZBE: Zonal Impacted Good Quality, ZID: Zonal Impacted Degraded.

Site	ABE	AIG	AID	TBE	TIG	TID	ZIG	ZBE	ZID	Maromiza	Vatoharanana	Andrambovato	Vinanitelo	Andringitra
ABE -- 1031 m														
AIG -- 1045 m	0.67													
AID -- 1082 m	0.40	0.29												
TBE -- 1095 m	0.69	0.65	0.33											
TIG -- 1106 m	0.65	0.58	0.31	0.80										
TID -- 1105 m	0.57	0.64	0.24	0.62	0.59									
ZIG -- 1125 m	0.53	0.49	0.22	0.64	0.61	0.63								
ZBE -- 1005 m	0.69	0.59	0.30	0.71	0.73	0.66	0.65							
ZID -- 1023 m	0.57	0.53	0.28	0.59	0.56	0.64	0.59	0.66						
Maromiza -- 980 m	0.52	0.40	0.27	0.51	0.59	0.49	0.54	0.62	0.52					
Vatoharanana -- 1025 m	0.44	0.43	0.25	0.50	0.55	0.56	0.50	0.60	0.53	0.61				
Andrambovato -- 1075 m	0.44	0.43	0.19	0.52	0.57	0.56	0.58	0.63	0.56	0.64	0.77			
Vinanitelo -- 1100 m	0.49	0.44	0.24	0.53	0.63	0.49	0.51	0.63	0.54	0.64	0.71	0.80		
Andringitra -- 1210 m	0.46	0.43	0.23	0.50	0.58	0.53	0.50	0.55	0.56	0.59	0.64	0.69	0.67	

open habitat species, *Falco peregrinus* and *Cypsiurus parvus*.

Three species presented in the 2007-2008 Ambatovy project database (Appendix 1) were each double-counted based on confounded nomenclatural changes (name in **bold** is the one used herein): *Artamella viridis*/***Leptopterus viridis***, *Phyllastrephus madagascariensis*/***Bernieria madagascariensis***, and *Phyllastrephus zosterops*/***Bernieria zosterops***/***Xanthomixis zosterops***. Hence, 83 taxa are listed in the 2007-2008 database.

Eleven species reported from the region in previous studies were not observed during this study, even though our inventory work was rather extensive and covered a wide variety of forested habitats. These include *Egretta dimorpha*, *Milvus migrans*, *Sarothrura watersi*, *Philomachus pugnax*, *Agapornis cana*, *Apus melba*, *Dromaeocercus seebohmi*, *Acrocephalus newtoni*, *Crossleyia xanthophrys*, *Leptopterus viridis*, and *Riparia paludicola*. In some cases, there are anomalous circumstances that are difficult to explain with regards to these records. For example, *Dromaeocercus brunneus* and *Crossleyia xanthophrys* are species generally occurring above 1200 m (Hawkins *et al.*, 1998; Goodman *et al.*, 2000), an elevational zone outside of the range of the inventoried sites; hence, their absence from our surveys is not surprising. Both of these species have broad distributions, generally above 1300 m elevation, across the montane zone of eastern Madagascar.

Five species that were not noted during the 2009 inventories are largely restricted to marsh settings, a habitat that was not extensively visited during our research in the area and maybe locally confined to the Torotorofotsy area. These include *Egretta dimorpha*, generally occurring in marsh areas, open rice paddy, or estuaries; *Philomachus pugnax*, a Eurasian breeding bird that is a rare migrant and boreal winter visitor to coastal areas of Madagascar (Langrand, 1995); *Sarothrura watersi*, a reclusive marsh-dwelling species and *Rallus madagascariensis*, an aquatic species, both documented in the Torotorofotsy marshes (ZICOMA, 1999, 2000); and *Dromaeocercus seebohmi*, which can be found in highland ecotones between densely vegetated marsh habitats/open stagnant water and montane eastern humid forest formations and known from the Torotorofotsy marshes (Langrand, 1995; ZICOMA, 1999).

The other taxa not found during our 2009 field inventories and with broad distributions at least in the eastern humid forest zone of Madagascar include *Acrocephalus newtoni*, a species generally

occupying reed beds at the edge of marshes and lakes; *Leptopterus viridis* found in a variety of different forested habitats, and *Milvus migrans*, *Agapornis cana*, *Apus melba*, and *Riparia paludicola* generally occurring in more open forested or non-forested habitats. On the basis of our evaluation of these records, we do not accept those of *Philomachus pugnax* until further evidence of its local occurrence is available. Hence, using the combined information from our surveys and the reevaluated 2007-2008 Ambatovy project database (Appendix 1), 91 bird species are known to occur in the Ambatovy-Analamay region, including the Torotorofotsy marsh system.

The compilation of the avifauna occurring in the "Périnet area" (Réserve Spéciale d'Analamazaotra, Parc National de Mantadia, and surrounding areas conducted by Wilmé *et al.* (1997) shows 24 species known from this zone which were not recorded in the Ambatovy-Analamay region (Table 7). These taxa occur in a variety of habitat types, including aquatic areas, forests, and open areas. While it is true that the Périnet region has been extensively explored and visited by ornithologists over numerous decades, the differences in species richness between Mantadia-Analamazaotra (n=115) and Ambatovy-Analamay (n=91) is probably associated with habitat quality and the size of remaining forest blocks, which are distinctly reduced in the Ambatovy-Analamay region. A number of species typical of mid-elevation eastern humid forests are unknown from the Ambatovy-Analamay region. Examples include *Brachypteracias leptosomus* and *Hartertula flavoviridis*, which have broad distributions in the east in the region from Masoala in the north to Andohahela in the extreme south, and are easy to locate during the breeding season (Hawkins & Goodman, 1999; Raherilalao *et al.*, unpublished). Another example is *Xenopirostris polleni*, a species found across the eastern humid forest (Goodman & Putnam, 1996; Goodman *et al.*, 1997, 2000; Raherilalao *et al.*, 2003) including the Réserve Spéciale d'Analamazaotra (Wilmé *et al.*, 1997) and the Sahambaky forest (Raherilalao *et al.*, unpublished), which are at the vicinity of Ambatovy-Analamay forest blocks.

As a generalization, our measures of species richness at the nine sites inventoried in the Ambatovy-Analamay region are notably lower than at other sites in the same habitat and elevation in the central eastern humid forests, particularly with regards to forest-dwelling taxa. Several points can be presented to explain these patterns. Many of these taxa need large relatively intact areas of forest, which are

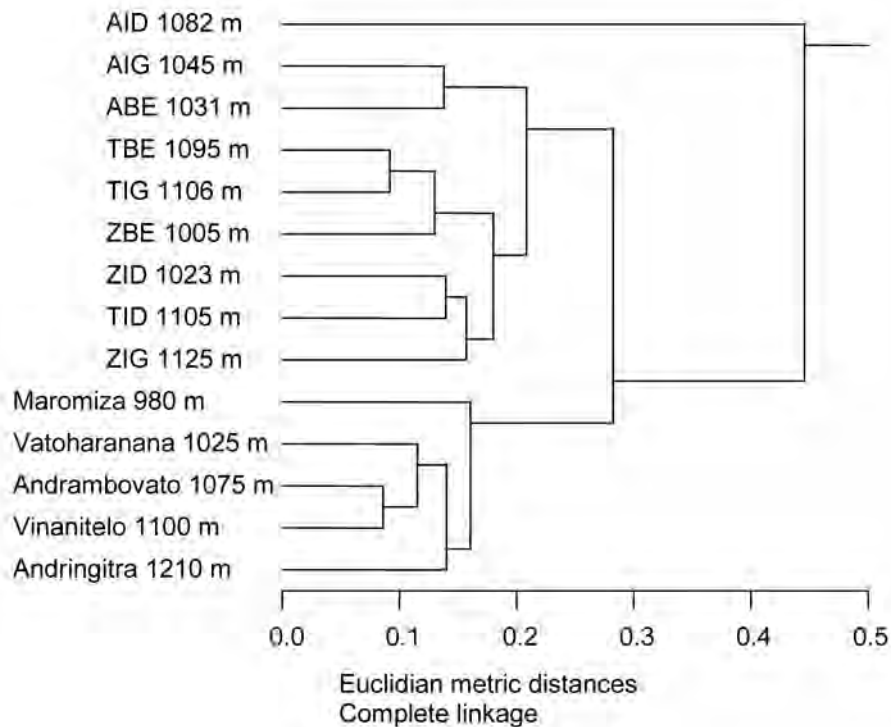


Figure 7. Dendrogram of the similarity of the bird fauna at sites in the different habitats of the Ambatovy-Analamay region and other mid-elevation central eastern humid forest sites based on the Jaccard Index coefficients. ABE: Azonal Benchmark, AIG: Azonal Impacted Good Quality, AID: Azonal Impacted Degraded, TBE: Transitional Benchmark, TIG: Transitional Impacted Good Quality, TID: Transitional Impacted Degraded, ZIG: Zonal Impacted Good Quality, ZBE: Zonal Benchmark, and ZID: Zonal Impacted Degraded.

largely not present amongst the nine study sites. Hence, associated with habitat fragmentation and exploitation of larger trees, these taxa are notably rare in the region or locally extirpated. Further, the hard-packed ferruginous and ultra basic soils characteristic of the Ambatovy-Analamay sites have an important relationship to reduced productivity, tied in to, for example, vegetational structure, organic material in the soil, and associated vertebrate communities.

When examining habitat utilization of the different bird taxa, it was noted in several cases that as the habitat became increasingly degraded, there was an associated decline in species richness. For forest-dwelling taxa, one would anticipate that as a given formation in the sense of habitat group was increasingly degraded, there would be a corollary decrease in species richness, but this pattern is not readily discernable in our data. Whether these patterns are associated with forest productivity, stochastic biogeographic patterns, or habitat degradation remains to be clarified with long-term ecological monitoring studies. Importantly in this regard is that the classification used to separate the different habitat types, particularly the inferred level of habitat quality, is not directly correlated with bird species richness. These circumstances might be associated with

different factors. Some species classified as forest dwelling and occurring in the Ambatovy-Analamay region are mostly generalist birds, often found in a different variety of microhabitats, and with some tolerance of anthropogenic habitat degradation. In comparison, taxa known from the larger forest blocks of the region, but not recorded in the Ambatovy-Analamay region, are more sensitive to different disturbances. Another important point is that the surveys took place between January and February, which is the reproductive period when many adults are feeding and not defending territories in an intensive manner. Hence, the level of song, which is one of the principal ways in identifying certain taxa in the field and quantification of relative abundance during the line transects, was reduced as compared to earlier in the breeding cycle. This seasonal effect was notable during the dawn chorus, which was short as compared to the beginning of the reproductive season, which for many songbirds is from November to December.

Relative abundance

In the absolute sense, the abundance of a given species can vary across different sites within the same habitat, as well as in different habitats. Further, when

aspects of population fluctuations are overlaid on seasonality and other demographic factors, estimates of abundance are naturally variable. These aspects are further complicated in the measure of relative abundance during field inventories by aspects of field techniques used, the identification capacity of different field workers, and natural population variation.

Certain species were common during our field studies in the Ambatovy-Analamay region, such as *Coracopsis vasa*, *C. nigra*, *Hypsipetes madagascariensis*, *Neomixis tenella*, *Nectarinia souimanga*, *Zosterops maderaspatana*, *Calicalicus madagascariensis*, *Newtonia brunneicauda*, *Foudia omissa*, and *F. madagascariensis*. These taxa were regularly encountered on a daily basis in all of the surveyed habitats. In contrast, several species, including *Accipiter madagascariensis*, *Ninox superciliaris*, *Neodrepanis coruscans*, *Monticola sharpei*, and *Hypositta corallirostris*, were only noted on a single occasion during the inventories of the Ambatovy-Analamay region.

In general, after our experience during ornithological inventories in eastern humid forests at the same elevation, as well as the quantitative results of capture and the line transects, the density of birds at the Ambatovy-Analamay region study sites is relatively low. The principal exceptions are the Azonal Benchmark and the Zonal Impacted Degraded habitats. The marked abundance of birds in these two habitats is in part artificial and associated with considerable local populations of *Foudia omissa* and *F. madagascariensis*. These species were found in the other habitats inventoried, where their densities were notably reduced as compared to the Azonal Benchmark and the Zonal Impacted Degraded habitats. The period of the inventories in these two habitats coincided with the seeding of a common species of understory grass (Family Poaceae), and *Foudia* spp. feed extensively on these plants. Given that *F. omissa* is a forest species, the abundance of grass seed may have given rise to high breeding success or local movements between forest blocks. In the case of *F. madagascariensis*, which is an open habitat species, their high densities are presumed to be linked with local movements associated with a concentrated food resource, which maybe accentuated with the opening up of forest associated with habitat degradation.

Several different factors or aspects can be advanced to explain the relatively low measured species richness at the Ambatovy-Analamay region study habitats. Firstly, on a nearly daily basis there was rain (see Goodman & Raselimanana, pp. 42-

43), which to some extent inhibits bird activity, would result in lower measures of density, and perhaps overlooking certain taxa during the inventories. Associated with geology (soil types and exposed rock), the vegetational structure of most of the study habitats is atypical of mid-elevation eastern humid forests. There was a correlation between sites with atypical vegetation and relatively low measures of bird species richness. Finally, associated with historical selective logging of most of the study sites, this may have an impact on the current bird communities of these different habitats.

It is important to underline that the abundance measures presented herein are coarse assessments. More precise data on population estimates need to be conducted during different seasons and the number of contacts for many species needs to be augmented in order to use different programs that can approximate population sizes within a statistical framework (e.g., Buckland *et al.*, 1993; White & Edwards, 2000). Rapid inventories are useful for estimations of species richness and give certain insights into population cycles and measures of relative abundance, but for certain questions, they cannot replace long-term research.

A comparison of birds captured with mist nets in the forest understory of the Ambatovy-Analamay study habitats with other regional sites, such as Maromiza and Lakato, provide important insights into differences in density. Measured densities in the Azonal Benchmark (1.8 birds/mist net day) and in the Transitional Impacted Good Quality (1.3 birds/mist net day) are comparable to measures from Maromiza (1.3 birds/mist net day) and Lakato (1.2 birds/mist net day). The Azonal Benchmark habitat appears to have relatively high populations of understory birds, while the Transitional Impacted Good Quality habitat is comparable to the Maromiza and Lakato sites. In some cases, an examination of the evenness values associated with the Shannon-Weaver index, for example of the Transitional Benchmark and Zonal Benchmark habitats, indicate a certain level of faunal homogeneity and equilibrium. In other comparisons, such as the situation in the Azonal Benchmark habitats with *Foudia omissa* and *F. madagascariensis* this is not the case.

Distribution, similarity, and biogeographic affinities

The bird species inventoried in the Ambatovy-Analamay region are, for the most part, commonly distributed across the eastern humid forests and,

in some cases, across different types of dry forest formations. On the basis of previous ornithological research conducted in different existing parks and reserves, the majority of these forest-dwelling taxa are well represented in the protected area network (Goodman & Putnam, 1996; Hawkins & Goodman, 1999; Goodman *et al.*, 2000; Raherilalao *et al.*, 2001; Raherilalao & Wilmé, 2008), which, at least in theory, assures their long-term survival.

The occurrence of the raptors *Polyboroides radiatus*, *Accipiter henstii*, and *Otus rutilus*, normally forest dwelling taxa, in the degraded Azonal Impacted Degraded habitat can be explained by three different factors. Firstly, in order to find food, they occupy relatively large home ranges, which, due to local habitat degradation, include zones outside the forest area or in relict forest ecotones. These taxa are adapted, at some level, to anthropogenic habitat change and are able to hunt outside of natural habitats. Secondly, for the first two species, their calls carry considerable distances. Hence, the exact habitat a calling animal was noted may have been outside the Azonal Impacted Degraded habitat, which in turn was in close proximity to a forested area. Finally, given the ongoing construction and forest clearing near the mining site, it is possible that nearby degraded habitats act as short-term sinks for displaced individuals.

An examination of the dendrogram associated with the biogeographic analysis (Figure 7), shows a considerable level of homogeneity amongst the eight forested sites inventoried in the Ambatovy-Analamay region. Further, these sites form a separate group from other central eastern humid forest sites at approximately the same elevation. The node in the dendrogram that separates these two groups is relatively short. Further, an examination of the species present in these two groups (Table 7) indicates that the species found in the eight forested Ambatovy-Analamay sites is a subset of those occurring in the other central eastern humid forest sites. Hence, the separation of these two groups is based on differences in species richness. In other words, the species composition of the forested Ambatovy-Analamay sites is relatively homogenous and differs from the other regional forested sites by lower species richness. The major exception is the species composition of the Azonal Impacted Degraded habitat, which is the outlier in Figure 7 and contains a much higher percentage of open habitat species as compared to forest species (Figure 6). The factors to explain this observation might be related to previous exploitation of these forests, or more likely their lower productivity

associated with soil composition (see Goodman & Raselimanana, pp. 40-42).

Conclusion

The ornithological inventory of nine habitats in the Ambatovy-Analamay region provides important insights and new information, which can be summarized as follows:

- The bird fauna occurring at these sites represents a sub-group of the species found in the central eastern humid forests at the same elevation. The exception is that of the Azonal Impacted Degraded habitat, which is largely composed of open habitat bird species.
- In total, 81 bird species were identified during this fieldwork, of which 70 (86%) are endemic (Madagascar and the Malagasy Region).
- The total known avifauna of the Ambatovy-Analamay and the Torotorofotsy regions is 91 species.
- There were differences in species richness between the nine study habitats, with the Transitional Impacted Good Quality habitat having the highest species richness and the Azonal Impacted Degraded habitat the lowest.
- Excluding Torotorofotsy, no unexpected or unusual bird species was found in the Ambatovy-Analamay region, or any rare species that is of particular conservation concern.

Recommendations

On the basis of these ornithological studies in the Ambatovy-Analamay region the following recommendations regarding forest management and conservation can be made:

1. Given that the current study was conducted towards the end of the reproductive season for most forest-dwelling bird species, it would be worthwhile to reconduct the line transects during the months of November and December, when many species are actively singing due to the establishment and defense of territories. These data would provide a better estimate of relative abundance.
2. It would be interesting to conduct follow up studies on *Foudia madagascariensis*, a species generally associated with open habitats, to examine movements and population cycles within the forested habitats, particularly the Azonal Benchmark and Transitional Impacted

Good Quality habitats and the seed production of different grasses.

3. Even though the species present and measures of species richness of the avifauna of the Ambatovy-Analamay region is not exceptional with regards to other central eastern humid forest sites within the protected areas system, its biological value should not to be underestimated, particularly with regards to the contribution these forests make to the long-term maintenance of these taxa.

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APPENDIX 1. List of bird species appearing in the 2007-2008 following the original Ambatovy project database.

Classically used scientific name in database	Current scientific name	Current family designation
<i>Accipiter francesiae</i>	<i>Accipiter francesii</i>	Accipitridae
<i>Accipiter henstii</i>	<i>Accipiter henstii</i>	Accipitridae
<i>Acrocephalus newtoni</i>	<i>Acrocephalus newtoni</i>	Sylviidae
<i>Agapornis canus</i>	<i>Agapornis cana</i>	Psittacidae
<i>Alcedo vintsioides</i>	<i>Alcedo vintsioides</i>	Alcedinidae
<i>Alectroenas madagascariensis</i>	<i>Alectroenas madagascariensis</i>	Columbidae
<i>Amphispiza seelbomii</i>	<i>Dromaeocercus seelbomii</i>	Sylviidae
<i>Anas erythrorhynchos</i>	<i>Anas erythrorhynchos</i>	Anatidae
<i>Anas melleri</i>	<i>Anas melleri</i>	Anatidae
<i>Apus melba</i>	<i>Apus melba</i>	Apodidae
<i>Artamella viridis</i>	<i>Artamella viridis</i>	Vangidae
<i>Asio madagascariensis</i>	<i>Asio madagascariensis</i>	Strigidae
<i>Atelornis ptilorhynchus</i>	<i>Atelornis ptilorhynchus</i>	Brachypteraciidae
<i>Bernieria madagascariensis</i>	<i>Bernieria madagascariensis</i>	Bernieridae
<i>Bernieria zosterops</i>	<i>Xanthomixis zosterops</i>	Bernieridae
<i>Buteo brachypterus</i>	<i>Buteo brachypterus</i>	Accipitridae
<i>Calicalicus madagascariensis</i>	<i>Calicalicus madagascariensis</i>	Vangidae
<i>Canirallus kiolooides</i>	<i>Canirallus kiolooides</i>	Rallidae
<i>Caprimulgus enarratus</i>	<i>Caprimulgus enarratus</i>	Caprimulgidae
<i>Caprimulgus madagascariensis</i>	<i>Caprimulgus madagascariensis</i>	Caprimulgidae
<i>Centropus toulou</i>	<i>Centropus toulou</i>	Cuculidae
<i>Cisticola cherina</i>	<i>Cisticola cherina</i>	Sylviidae
<i>Copsychus albospectabilis</i>	<i>Copsychus albospectabilis</i>	Turdidae
<i>Coracina cinerea</i>	<i>Coracina cinerea</i>	Campephagidae
<i>Coracopsis nigra</i>	<i>Coracopsis nigra</i>	Psittacidae
<i>Coracopsis vasa</i>	<i>Coracopsis vasa</i>	Psittacidae
<i>Coua caerulea</i>	<i>Coua caerulea</i>	Cuculidae
<i>Coua reynaudii</i>	<i>Coua reynaudii</i>	Cuculidae
<i>Coua serriana</i>	<i>Coua serriana</i>	Cuculidae
<i>Coua xanthophrys</i>	<i>Crossleyia xanthophrys</i>	Bernieridae
<i>Cryptosylvicola randrianasoloi</i>	<i>Cryptosylvicola randrianasoloi</i>	Bernieridae
<i>Cuculus rochii</i>	<i>Cuculus rochii</i>	Cuculidae
<i>Cyanolanius madagascarinus</i>	<i>Cyanolanius madagascarinus</i>	Vangidae
<i>Dicrurus forficatus</i>	<i>Dicrurus forficatus</i>	Dicruridae
<i>Dromaeocercus brunneus</i>	<i>Dromaeocercus brunneus</i>	Sylviidae
<i>Dryolimnas cuvieri</i>	<i>Dryolimnas cuvieri</i>	Rallidae
<i>Egretta dimorpha</i>	<i>Egretta dimorpha</i>	Ardeidae
<i>Eurystomus glaucurus</i>	<i>Eurystomus glaucurus</i>	Coraciidae
<i>Falco newtoni</i>	<i>Falco newtoni</i>	Falconidae
<i>Foudia madagascariensis</i>	<i>Foudia madagascariensis</i>	Ploceidae
<i>Foudia omissa</i>	<i>Foudia omissa</i>	Ploceidae
<i>Hypositta corallirostris</i>	<i>Hypositta corallirostris</i>	Vangidae
<i>Hypsipetes madagascariensis</i>	<i>Hypsipetes madagascariensis</i>	Pycnonotidae
<i>Leptopterus chabert</i>	<i>Leptopterus chabert</i>	Vangidae
<i>Leptopterus viridis</i>	<i>Leptopterus viridis</i>	Vangidae
<i>Leptosomus discolor</i>	<i>Leptosomus discolor</i>	Leptosomatidae
<i>Lonchura nana</i>	<i>Lonchura nana</i>	Estrildidae
<i>Lophotibis cristata</i>	<i>Lophotibis cristata</i>	Threskiornithidae
<i>Margaroperdix madagascariensis</i>	<i>Margaroperdix madagarensis</i>	Phasianidae
<i>Merops superciliosus</i>	<i>Merops superciliosus</i>	Meropidae
<i>Milvus migrans</i>	<i>Milvus aegyptius</i>	Accipitridae
<i>Mirafra hova</i>	<i>Mirafra hova</i>	Alaudidae
<i>Motacilla flaviventris</i>	<i>Motacilla flaviventris</i>	Motacillidae
<i>Mystacornis crossleyi</i>	<i>Mystacornis crossleyi</i>	Vangidae

Appendix 1. (cont.)

Classically used scientific name in database	Current scientific name	Current family designation
<i>Nectarinia notata</i>	<i>Nectarinia notata</i>	Nectariniidae
<i>Nectarinia sovimanga</i>	<i>Nectarinia souimanga</i>	Nectariniidae
<i>Neodrepanis coruscans</i>	<i>Neodrepanis coruscans</i>	Philepittidae
<i>Neomixis striatigula</i>	<i>Neomixis striatigula</i>	Sylviidae
<i>Neomixis tenella</i>	<i>Neomixis tenella</i>	Sylviidae
<i>Neomixis viridis</i>	<i>Neomixis viridis</i>	Sylviidae
<i>Nesillas typica</i>	<i>Nesillas typica</i>	Sylviidae
<i>Newtonia amphichroa</i>	<i>Newtonia amphichroa</i>	Vangidae
<i>Newtonia brunneicauda</i>	<i>Newtonia brunneicauda</i>	Vangidae
<i>Otus rutilus</i>	<i>Otus rutilus</i>	Strigidae
<i>Oxylabes madagascariensis</i>	<i>Oxylabes madagascariensis</i>	Bernieridae
<i>Phedina borbonica</i>	<i>Phedina borbonica</i>	Hirundinidae
<i>Philepitta castanea</i>	<i>Philepitta castanea</i>	Philepittidae
<i>Philomachus pugnax</i>	<i>Philomachus pugnax</i>	Scolopacidae
<i>Ploceus nelicourvi</i>	<i>Ploceus nelicourvi</i>	Ploceidae
<i>Polyboroides radiatus</i>	<i>Polyboroides radiatus</i>	Accipitridae
<i>Pseudobias wardi</i>	<i>Pseudobias wardi</i>	Vangidae
<i>Riparia paludicola</i>	<i>Riparia paludicola</i>	Hirundinidae
<i>Sarothrura insularis</i>	<i>Sarothrura insularis</i>	Rallidae
<i>Sarothrura watersi</i>	<i>Sarothrura watersi</i>	Rallidae
<i>Saxicola torquatus</i>	<i>Saxicola torquatus</i>	Turdidae
<i>Streptopelia picturata</i>	<i>Streptopelia picturata</i>	Columbidae
<i>Tachymarpis melba</i>	<i>Apus melba</i>	Apodidae
<i>Terpsiphone mutata</i>	<i>Terpsiphone mutata</i>	Monarchidae
<i>Treron australis</i>	<i>Treron australis</i>	Columbidae
<i>Turnix nigricollis</i>	<i>Turnix nigricollis</i>	Turnicidae
<i>Tylas eduardi</i>	<i>Tylas eduardi</i>	Vangidae
<i>Tyto alba</i>	<i>Tyto alba</i>	Tytonidae
<i>Vanga curvirostris</i>	<i>Vanga curvirostris</i>	Vangidae
<i>Zosterops maderaspatana</i>	<i>Zosterops maderaspatana</i>	Zosteropidae