PUBLICATIONS P. REYNAUD

Functioning and dynamics of natural and perturbed ecosystems – D. Bellan, G. Bonin, C. Emig, Eds.

Avifauna diversity and human population in some West African urbanized areas; comparison with the tropical town of Cayenne, French Guiana

Pierre A. Reynaud

Orstom, BP 165, 97323 Cayenne (France)

RESUME

Cet article met en relation la croissance des populations urbaines et la diversité de l'avifaune en zone tropicale. Pour analyser la répartition des oiseaux sur 14 stations d'Afrique de l'Ouest, nous avons compulsé les listes d'espèces établies durant les 15 dernières années en retenant les espèces de l'avifaune observées en zones anthropiques, c'est-à-dire observées dans les villes (immeubles, parcs, cimetières et ponts compris), dans les jardins d'agrément et dans les jardins potagers, dans les hameaux, les décharges et les aéroports.

Les peuplements d'oiseaux de la zone urbaine et semi-urbaine de Cayenne, Guyane, ont été analysés par une méthode dérivée des points d'écoute. Les deux séries d'analyses sont comparables et révèlent les résultats suivants:

Jusqu'à un million d'habitants en zone urbaine, il n'y a pas d'incidence sur la richesse d'une population aviaire; par contre le taux de croissance de la population est bien un facteur limitant. Lorsque le pourcentage de croissance annuel dépasse 10 %, le nombre d'espèces est diminué de moitié par rapport à une croissance nulle. Si les oiseaux migrateurs ne semblent pas affectés, les pics et alliés ainsi que les frugivores voient leur nombre d'espèces diminuer très rapidement. Chez les passereaux la diminution est plus progressive et elle affecte tout d'abord les insectivores puis les omnivores. En zone tropicale urbanisée, une structure minimum de l'avifaune représentée par une vingtaine d'espèces devrait comprendre une proportion équivalente d'omnivores et d'insectivores,

quelques granivores, au moins un rapace ubiquiste et un nectarivore. La diminution du nombre d'espèces ou le changement du rapport entre elles indiquerait un seuil de destruction des niches biologiques trop important pour ne pas être pris en compte par les décideurs.

ABSTRACT

The relationships between expansion of human habitats and bird communities are delicate mainly at the border of urban areas. Bibliographical data on bird field lists in 14 African anthropic stations were compiled and analyzed. Bird species number reaches a maximum value when the human population is around 1,000,000 inhabitants. Due to the fast rise in human population, the number of bird species in African towns is decreasing. If the annual population increase rate is above 10%, bird species number is never more than 35, although it can be up to 60 species just under 10 %. Migratory birds are not affected by increase in human population, but the number of resident passerines drops markedly.

In order to closely follow the changes in avifauna diversity in a developing anthropised area - the tropical town of Cayenne - 111 stations are surveyed with an extensive point count method. Results are similar to those in West African towns; a decrease in diversity is induced by increased rate of the human population. A basic composition of the avifaunian structure is established; it is considered as the break-point before irreversible deterioration of bird habitats in tropical anthropised area.

Keywords: Avifauna diversity, Human density, West Africa, French Guiana, Tropical towns.

Introduction

The growth of metropolitan areas indicates that a knowledge of urbanisation influenced ecosystems can only become increasingly important (McDonell and Pickett 1990). Due to their mobility, birds can give a quick answer on the effects of their habitats modifications (Hilden 1965). The relationships between expansion of the human habitat and bird communities are mainly noticeable at the border of urban areas. In Europe and North America,which have a long urban settlement history, bird colonisation of urban areas took place well before ornithologists were able to record this process (Diamond 1986; Dowd 1992). It is therefore possible to follow changes in avifauna diversity in built-up towns: in northern Europe (Hohtola 1978), Oceania (Mason 1985, Lenz 1990).

In West Africa, ornithologists first focused their interest on editing regional atlases, or family and species monographs, in order to establish a basic representation of bird species in each country. Unfortunately, country borders do not correspond to biogeographical zones. Apart from Moreau's (1966) extended study on the avifauna of Africa, other geographical analysis of bird species in Africa have seldom been attempted (Pomeroy and Ssekabiira 1990; Fry 1992).

The avian interest of West Africa is that this area not only has its own resident species, but also receives an important migratory population from paleartic regions and, to a smaller extent, from central and south Africa. Geographically, West Africa can be divided, from North to South, into three zones: the Sahelian zone, the dry tropical zone and the wet tropical zone. Even though there is a large species inter-coverage between these zones, each zone is colonized by different migratory birds species and has its own resident population .

For the last 20 years, the biological balance between human and avian communities has changed. There has been a dramatic population increase in the cities. Natural areas have been fragmented, the vegetation has been cut down, ponds are polluted or drained, cultivated areas have been replaced by slums or disposal sites.

The tropical town of Cayenne in French Guyana has a short history, but around the small old city, forest habitats have been fragmented by residential and industrial development. This fragmentation results from changes in population density; people leave the old city to build houses in the suburbs.

Firstly, this study analyses published West African avifauna field lists and qualitatively compares the avian population of urban communities having different geographic positions and expansion ranges. Secondly, conclusions are presented by a study concerning avifauna in relationship with urbanisation increase around Cayenne (French Guyana).

This study is conducted on 111 stations. Stations are surveyed by an extensive point count method to enable a qualitative and quantitative investingation on the effects of human population density changes on avifaune diversity.

Material and methods

Geographical information

West Africa

Data on latitude, longitude, altitude, annual rain fall, and on total and relative evolution of the human population for each station between 1976 and 1983, is presented in table 1.

The percentage of annual increase of human population is calculated by subtracting most recent (N1) and oldest (N2) population estimation, dividing by N2 and then by the number of years between the two estimations.

Cayenne

The tropical town of Cayenne (52°20W 4°56N, French Guyana, northern Amazon) is surrounded north, by the Atlantic ocean, east and west by two large rivers and south by a succession of marshes. Annual precipitation is about 3 000 mm. The study's surface area is 1924 ha; the human population was registered to be 37 647 inhabitants in 1982 and 40 993 in 1990. Annual increase rate of human population is only 1%, however more interesting is to compare decreasing, stabilised, or increasing population, amongst different stations. Habitats vary from urbanised areas in the old city to patches of old secondary forest.

Census methods

West African stations

Data on West African avifauna were compiled from 28 publications, from comments kindly provided by Dr G. Morel and Dr B. Treca and from personal observations. These data provide a qualitative estimation of bird population in 14 stations. A bird is noted as "in contact" with the human community if it is mentioned as: very common, common, seen several times or occasionally in the city (buildings, gardens, cemeteries, bridges), in suburban gardens, in villages, near airports, in rubbish dumps or on irrigated fields. This classification is to be interpreted with caution as it is largely dependant on the way it is presented and thereby, on data interpretation. Some papers are very clear; each habitat, as in Richards (1982), is well defined: ex. suburban garden, heavily populated suburb, typical airport, or villages.

Stations are grouped according to the three geographical locations:

a) in the dry tropical zone: Nouakchott, Mauritania (Browne 1981,1982; Ge1984); Dakar, Senegal (Smet de and van Gompel 1980; Morel 1985; Morel and Morel 1990), Conakry, Guinea (Richards 1982Browne 1984), northern Sierra-Leone (Field 1978; Harding and Harding 1982; Happel 1985), Bamako, Mali (Lamarche 1980, 1981);

b) in the wet tropical humid coastal area: Abidjan, Ivory Coast (Macdonald 1979; Thiollay 1985; Demey 1986, Walsh 1986), Calabar, Nigeria (Mackensie 1979.), Lome, Togo (Davaud 1956; Greig-Smith 1976; Browne 1979; Cheke et al. 1986), Lagos, Nigeria (Sander 1956; Wallace 1973; Gee and Heigham 1977; Alexander-Marrack P.D. et al.1985) and Sapele, Nigeria (Marshall 1977; Heaton and Heaton 1980);

c) the continental stations: Niamey, Niger (Cheke et al.1985), north Benin (Green and Sayer 1979; Thonnerieux 1985) and Kano, Nigeria (Heigham 1976; Sharland and Wilkinson 1981);

the Central African station, CAR (Green 1983-84) is a little further from the others will sometimes be considered as a control.

Calculation of dominance:

The abundance of each bird species is estimated by summing the minimum distances between the different stations where it was observed. Once the stations with the same species are located on a map, the nearest neighbouring ones are connected by straight lines, forming a tree with all its nodes connected. Then the distances are measured and summed up.

Abundance (x): number of km covered by a species according to the maximum number of km covered by a species; frequency (y): number of stations where a species was found compared to the total number of stations(14).

A species is widespread when $x > 0.7$ and $y > 0.65$; a species is relatively widespread when $0.45 > x > 0.7$ and $0.30 > y > 0.65$; a species is uncommon when $x < 0.45$ and $y < 0.30$.

The choice of these values is conducted by the fact that some stations are very close (Sierra-Leone and Conakry for instance). A species present in two close stations has a small range size in comparison with a species present in two far stations. The probability that the latter is also present in stations between the two where it is recorded is more important than with a species only recorded in close stations.

Cayenne census method.

Bird censoring in Cayenne requires large and quiet places so as not to disturb them; most species are secretive, living in dense vegetation or in high canopy and have short singing periods. To cover a large number of habitats and to reduce the bias resulting from unequal detectabilities, a fixed radius point count method is chosen, derived from circular plots (Blondel et al. 1970). My central point was the car with which I silently reached the station.

The use of 10 X 42 binoculars makes it possible to identify species as far as 25 meters away from each side and in front of a slowly progessing car; the average plot area is 0.10 ha. Birds singing, hunting on the ground and up to 25 m high, nesting, or crossing the plot volume are taken into account. Observations were done in fine weather, between 6:30 and 10:00 am, during 20 mn from February 4 to May 6 1992.

Mean body weight in grams is estimated mainly from birds caught in midnests and by records in Thiollay, (1990) and Terborgh et al.(1990).

Principle of the wrapping-curve:

If a biological activity is limited only by one parameter at a time, the points at the upper limit of the cloud of points obtained by the measure of this activity in regards to the variations of this parameter will represent the activity curve (Monod, 1942). The point placed on the upper part of the cloud fit the limiting action of the parameter studied. The activity of the points under this curve is limited by one or more parameters (Balandreau et al., 1977). An interpretation of this kind proves very useful for the comparison of bird species number in different stations, especially in the case of qualitatively underestimated avian populations due to an incomplete list or because of lacking information as in some papers.

Results and discussion

Analysis of field lists in African tropical stations

Figure 1 shows the relationship, in 14 selected West African stations, between bird species number and a twice censored human population. Inhabitant number correlates with species number ; according to the estimations obtained between 1967 and 1980 one observes that, above 400,000 inh., there is a saturation of bird species number. This assumption is confirmed by the town's second population censore between 1976 and 1983 (corr. coeff.= 0.667): the diversity richness reaches a maximum value for 1,000,000 inhabitants. This conclusion confirms the fact that, as population increases, anthropised areas parallely increase and that there is a multiplication of exchange perimeters between patches of wilderness and the suburbs; which is the reason why it is possible to make an observation on a vagrant species in large towns.

In regards to the position of points on figure 1: for example for a human population of 1,000,000, observers enumerate 168 bird species in Dakar and 70 in Abidjan, a second factor therefore has to be considered in this avifauna analysis: the human population annual increase rate. The wrapping-curve of figure 2 shows that total bird species number decreases with increased rate of the human population. For paleartic migrants, decrease in species number is more progressive. The point on the right corresponds to Nouakchott where migrant bird population was carefully estimated in each human settlement; this point is therefore more accurate than the one underneath it. It shows that migrant bird populations are only slightly affected by town expansion, supporting Moreau's paradox which suggests that many migrants enter and remain in the Sahel despite deteriorating conditions(Fry 1992).

There is a gap when the increase rate is more than 10% a year: the number of species which can reach up to 120, drops suddenly to a maximum of 60. The four stations, with a more than 10% population increase rate, ranging from lowest to highest, are: Conakry, Bamako, Niamey, Nouakchott. These stations belong to one of the three defined geographical groups: the dry tropical zone, the continental zone and the wet tropical humid coastal area which means, in this case, that factors such as latitude, longitude or precipitations are not dominant.

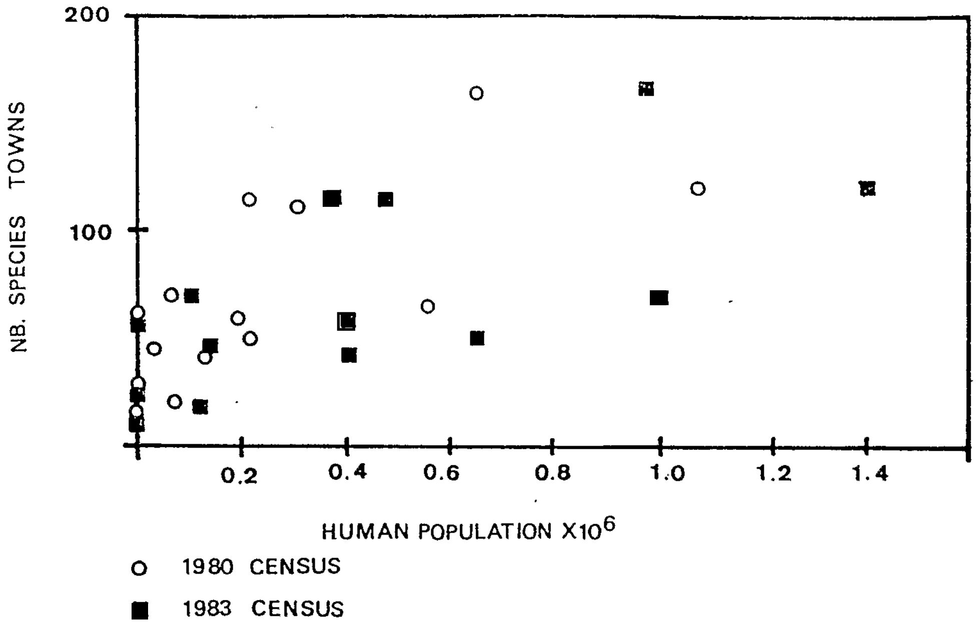

Figure 1: Number of species for each station according to their human population; census between 1967 and 1980: corr. coeff = 0.717; census between 1976 and 1983: corr. coeff.= 0.667; see table 1 for details.

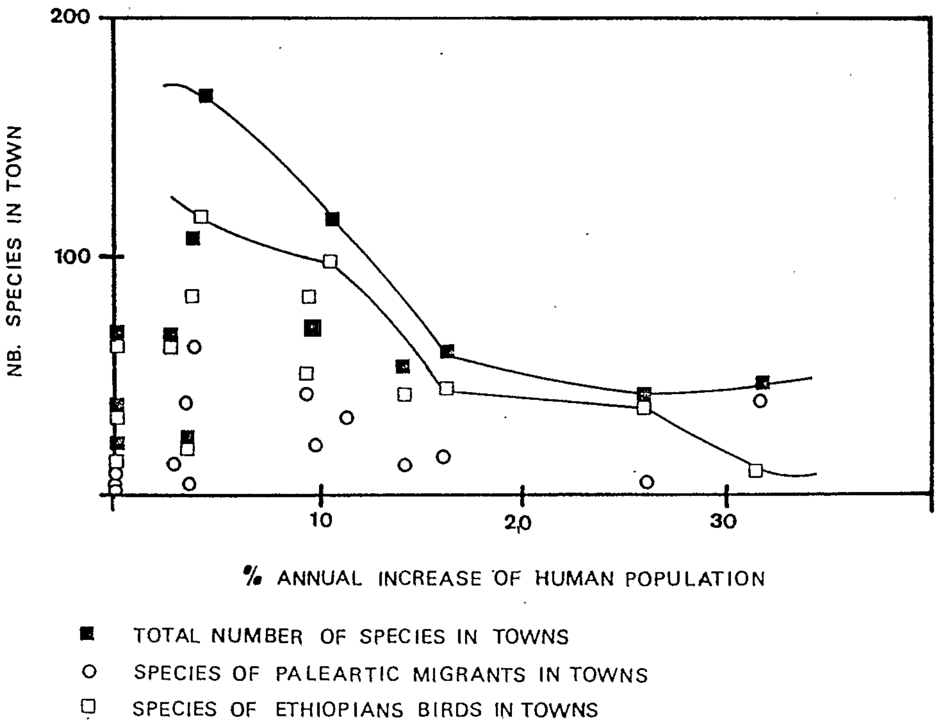

Figure 2 : Wrapping-curve of the number of bird species in the West African stations in regards to the annual rate of increase of the human population.

Table 1 : Geographical data for the 14 West Africa stations.

	Latitude N	Longitude	altitude m	rain mm	Population hab.	in	% increase hab/year	between
Abidjan	05°19	04°01W	0	1900	1000000	83	10.02	75-83
Lagos	06°12	04°20E	0	1850	1404000	83	10.82	80-83
Lome	06°08	01°13E	0	1780	366476	83	9.96	77-83
SapeleNg	09°15	04°10E	10	1800	98110	82	3.21	82-83
Sierra-Leone	09°37	12°13W	200	5080	500	83	0	83
Conakry	09°93	10°03W	0	2400	656000	83	14.53	67-83
Kano	12°01	08°30E	350	711	487000	83	4.05	67-83
Calabar	04°58	08°17E	0	2000	122800	82	4.06	67-83
Niamey	13°32	02°08E	150	400	399100	83	25.79	75-83
Dakar	14°20	16°20W	0	300	978553	81	4.61	70-81
Bamako	12°39	08°00W	300	300	404000	76	16.22	69-76
Nouakchott	18°09	15°58W	5	150	135000	80	31.75	71-80
Benin	11°29	01°30E	200	1000	100	83	0	
CAR	07°80	20°20E	1000	1365	750	83	0	83

Table 2: Cumulative representation of the number of resident species in regards to the annual increase of the human population: villages with no variations (Benin, Car, Sierra-Leone); towns with an increase around 5% (Sapele, Kano, Calabar, Dakar); around 10% per year (Lagos, Abidjan, Lome); towns with an annual population increase rate of more than 14% (Conakry, Niamey, Nouakchott, Bamako).

	group A	group B	group C	group D	group E	Total
Villages						
No. of species	2	2	1	9	42	56
% of the total	8.7	8.3	33	22.5	37.5	28
Towns with 5% increase						
No. of species	11	16	2	30	80	139
% of the total	48	67	66	75	71	69
Towns with 10% increase						
No. of species	11	12	2	31	63	119
% of the total	48	50	66	77	56	59
more than 14% increase						
No. of species	6	13	1	18	40	78
% of the total	26	54	33	45	36	39
Total of resident species	23	24	3	40	112	202
% Total	11	12	1.5	20	55.5	

Table 3: Richness of the avifauna for the four classes of population in Cayenne.

Population classes	1: decrease more than - 2%	2: from -1.9 % to +2 %	3: from + 2.1 % to +5%	4: more than +5%
N= No. of stations	29	32	28	22
area coverage ha.	140	392	240	360
No. species	45	68	45	47
A= No. of species with frequency =1	12	29	14	21
A/N	0.4	0.9	0.5	0.95

It is not the human population size that is harmful for breeding avifauna but more likely, the increase rate of this population, i.e. decrease rate of birds habitats.

In regards to station classification as a fonction of human population increase rates, the next step in this analysis is to establish the relative sensitivity of bird groups, and then of species, affected by this marked decrease in habitat. Bird species are separated into groups of main feeding habits and habitat interest according to Moreau (1966) in table 2.

In the villages, birds from groups A and B: families typically dependent on watery habitats; predatory and scavenging birds, are few because of the lack of diversity in habitat.

A higher richness is found in towns having a low human population increase rate (5%); species number then decreases slowly until the demographic rate reaches 10%, and quickly after 14%. Group C, ground birds, will not be taken into account as there are only three species present. The variations in group A are mainly due to town locations: in vicinity of the sea shore or not. The group B population, predatory and scavenging birds, is not markedly affected by human population increase rate. Since in the last two classes, group B represents 50% of raptors species enumerated in towns, it would be interesting to see if there is a change in species diversity.

The marked decrease of group D species, when population increase is more than 14 %, is directly related to decrease of unspoilt areas; since these species (kingfishers, swifts, hornbills, nighjars, doves, rollers, bee-eaters, turacos, woodpeckers, hoopoes) need clear water and large trees for hunting and breeding.

The decrease of group E species, passerines, occurs progressively; these species seem more sensitive than others to a decrease of their living standard conditions; it may be in this group that we will note the most important number of receptive species as some will disappear and others will increase drastically. Both effects will be considered as biological marks indicating different steps of urbanisation.

Dominant birds amongst the four classes are: one in group A, *Bubulcus ibis*; two raptors: *Milvus migrans* and *Neophron monachus*, two aerial insectivores: *Apus affinis* and *Cypsiurus parvus*, two granivores: *Streptopelia senegalensis* and *Ploceus cucullatus*, two gleaning insectivores *Pycnonotus barbatus* and *Camaroptera brachyura*, a nectarivore: *Nectarinia chloropygia* and three omnivores: *Passer griseus, Corvus albus, Ptilostomus afer*. Notice that the two raptors are mainly omnivorous and that *Pycnonotus barbatus* is considered as a generalist. We therefore consider that this is the basic composition of avifauna in West African anthropised areas. Amongst the ten most widely-spread birds in

Africa south of 20°N (Pomeroy and Ssekabiira 1990), three are typically anthropised birds: *Milvus migrans*, *Pycnonotus barbatus* and *Streptopelia senegalensis.*

Cayenne habitat diversity

This area's total richness is of 87 species; 36 species however, were seen only once. The wrapping-curves of figure 3 are similar to figure 2: where we observe a marked decrease in richness related to increased rate in human density. This decrease is bound to, and accentuated with, the number of birds on each station. Human population increase not only induces less diversity but the bird density is also less important. Decrease in human population rates are associated with slums and others bad levels of urbanisation. Stations are classified to enable an easier discussion of these facts.

The map in figure 4 shows classes of changes in human population density in the city of Cayenne between 1982-1990. There was a general population decrease in the old town (class 1) were trees and gardens are enclosed between buildings or concrete walls, and in some old colonised areas (as low as -10 % a year), compensated with a marked increase (as high as 12 % a year) in the country side and in some patches around the town were blocks of flats where built (class 4). Between both extreme situations, the suburban zone shows a relative stability due mainly to an equilibrium in human population (class 2). The same relative stability is observed for a fast growing (since the last five years), residential zone (class 3) composed of a mosaic of ornamental gardens since native plantations have mainly been cut off, forming an homogenous habitat.

This ecological complexity is a patchwork of the following bird habitats: old houses with little gardens with fruit trees; parks, stadiums, cemetery in the city: high trees, grass, quickset hedges; patches of secondary forest surrounding cottages with gardens; patches of secondary forest with traditional farming; secondary forest with some residual primary forest trees; marshes along streams.

Class richness is highly dependent on diversity and number of observed bird habitats (table 3). An A/N ratio means that ten more observations are necessary to add a new species to the population richness (Blondel 1975). In the case of this study, A/N ratios are very high, meaning that we need many more observations to reach the asymptote of the cumulative richness curve. We are closer to it in classes 1 and 3 than in classes 2 and 4. In

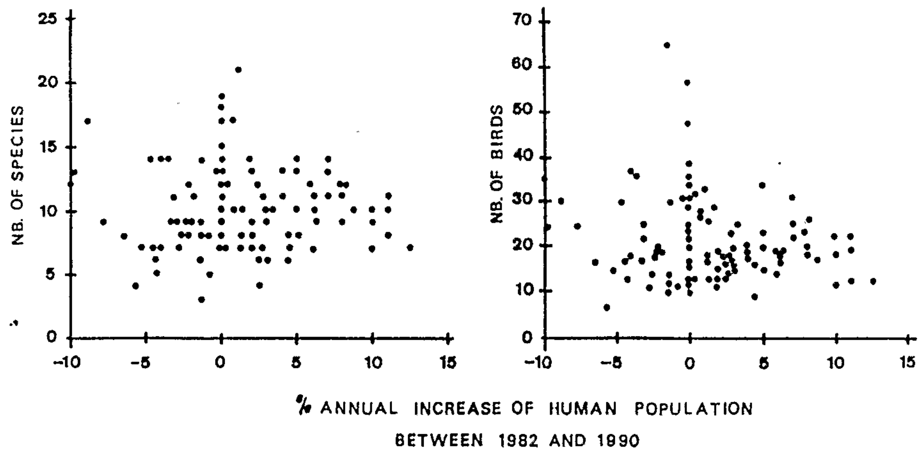

Figure 3 : Wrapping-curves of the number of species of birds and of their quantity in the 111 stations in Cayenne in comparison to the annual rate of changes of the human population .

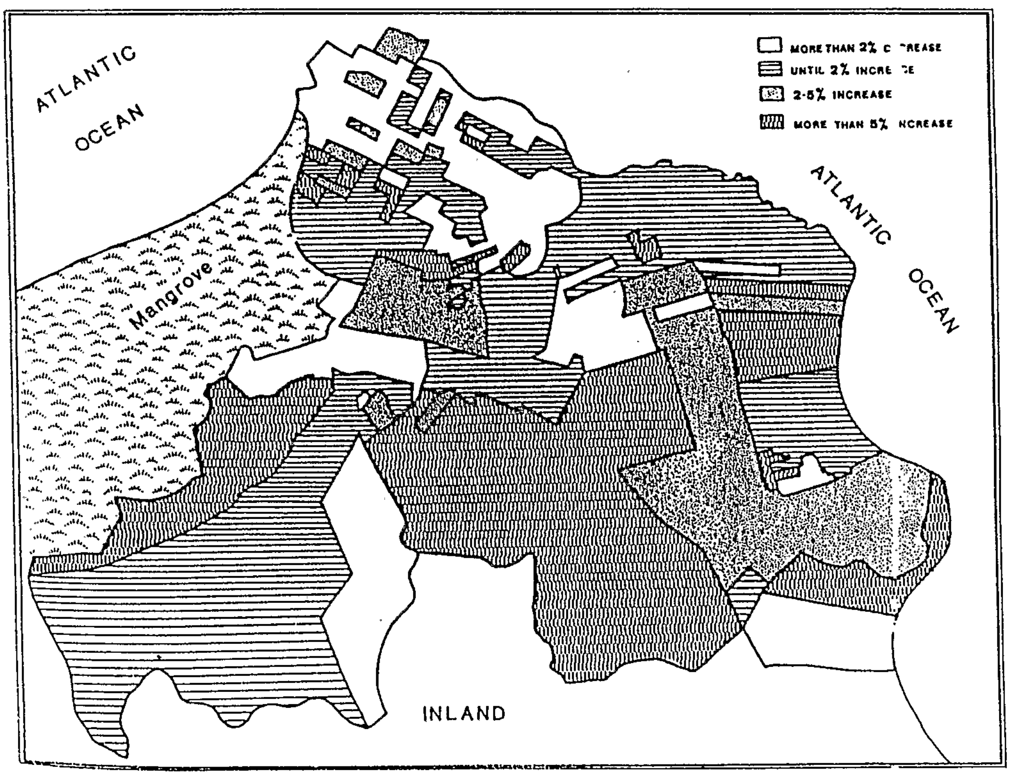

Figure 4 : Characterization of the classes of human population density rate in the city of Cayenne, French Guyana. The width of the frame is equal to 9.5 km.

fact Classes 1 and 3 represent mature biotopes with less diversity than classes 2 and 4. The population decreases in "in town" habitats (class 1); the population slightly increases in cottage habitats (class 3). Class 2 covers the largest area including parks, the cemetery, patches of secondary forest and undisturbed places; which is why there is the highest richness. Class 4 withstands the highest perturbations; it consists of a large surface area, has a lot of undestroyed places, and is found mainly at the suburbs' limit allowing contact for vagrant species. This explains why 45 % of the species where seen only once.

Thirty species are present in the four classes; the vulture *Cathartes atratus* was removed from the analysis as this opportunist bird can be seen everywhere, depending on the leftovers, and its weight gives an excessive bias in the calculation of relative biomass.

In class 1, omnivores biomass is not only four times more important than insectivores but also represent more than half the biomass of all birds in this class.

In class 2, biomass is similar to class 1 because of the increase in diversity but not in density. The omnivore with most important biomass *Quiscalus lugubris* is three times less important (reduced from 18 kg to 6 kg), than in class 1 but insectivore biomass increases from only 11.8 kg to 14.5 kg. Nectarivores species are 6 instead of 2, their biomass is however twice less than *Amazilia fimbriata* a dominant species in class 1.

In class 3, a noticeable diversity decrease occurs, mainly amongst insectivores: 17 species instead of 29. The bark-dwelling insectivores have disappeared since old trees are very scarce in cottage-ornamental garden type habitats.The scarcity of old trees also explains why only one raptor species was found.

In class 4 omnivore number and quantity also decreases: *Quicalus lugubris* is not found anymore in this class; two ubiquist birds, *Pitangus sulfuratus* and *Turdus leucomelas* are twice less important in class 4 than in class 2.

Water birds, such as herons, rails and kingfishers are rare in our observations due to the fact that their correct census needs another type of blind than a car. We noticed however, that *Tringa solitaria* is ubiquist as it is associated with almost any little puddle, since numerations took place during the migration time. *Butorides striatus* was noticed in class 3 and 4 it is however so few in number that it would be delicate to say that it is associated with anthropised biotopes.

The three *Columbina*, terrestrial granivores are ubiquist.*Columbina passerina* is dominant in Class 1. The grass granivores are also homogenously distributed within all

Table 4: Some characteristics of the bird communities in four classes of human population in the city of Cayenne.

Population classes	group A water-birds	group B raptors	group C graniv.	group D frugiv.	nectar.	group E insectiv.	omniv.	Total
1: Decrease more than - 2 %								
No. of species	2	3	7	2	2	15	14	45
% for the group	33	42	70	66	33	42	74	
abundance								
g/10 ha	2932	2750	5768	3846	662	12606	47355	75919
% in the group	100	43	81	100	100	81	100	98
No of dominant sp.			1		1	6	5	13
2: From -1.9 % to + 2 %								
No. of species	2	5	9	3	6	29	14	68
% for the group	33	71	80	100	100	81	74	
abundance								
g/10 ha	2000	6406	7119	1413	397	15493	44947	77775
% in the group	68	100	100	37	60	100	94	100
No of dominant sp.			1			4	5	10
3: From + 2.1 % to + 5 %								
No. of species	2	1	8	2	3	17	13	46
% in the group	33	14	80	66	50	47	68	
abundance								
g/10 ha	1428	2357	5064	150	350	11070	36295	56714
% in the group	48	37	71	4	53	71	77	73
No of dominant sp.					1	4	5	10
4: More than + 5 %								
No. of species	4	2	8	1	4	18	11	48
% in the group	66	28	80	33	66	50	58	
abundance								
g/10 ha	1523	3636	6899	1136	327	12326	29315	55162
% in the group	52	57	97	30	49	82	62	71
No of dominant sp.			1			3	5	
Total No. of species per group	6	7	10	3	6	36	19	87
Total biomass per group g/10 ha	7883	15149	24850	6545	1736	51495	157912	265570
% of total biomass	3	5.7	9.4	2.4	0.7	19.4	59.5	100

Table 5: Comparison between classes of human population rate and avifauna habitats for West Africa stations and Cayenne.

	Evolution of human population annual rate		Bird habitats	Avifauna diversity
Class	*Cayenne*	*West Africa*		
1	decrease more than 2%	Village	poor diversity	variable, many omnivores
2	From -1.9% to 2% increase	less or around 5% increase	wide patches diversity	all groups increase
3	From +2.1 to 5% increase	less or around 5% increase	increase area of ornamental gardens	group B, C and D decrease
4	More than 5% increase	around 10 % increase	highly discontinuous	insectivore decrease
	No found	more than 14 % increase	destruction of all naturals habitats	omnivore decrease

Table 6: Classification of main species in each population class for Cayenne avifauna. Species are classified according to their richness/abundance ratio; richness being preferential. Guilds are from Terborgh *et al.*(1990): O,A: arboreal omnivore; I,A,G: arboreal, gleaning insectivore; I,A,S: arboreal, sallying insectivore; N: nectarivore; I,Aer: aerial insectivore; G,T: terrestrial granivore; G,G: grass granivore; G,A: arboreal granivore.

Species	Guilds	decrease more than - 2 %	from -1.9 % to +2 %	from 2.1 % to +5%	more than +5%
Pitangus sulphuratus	O,A	1	1	2	2
Thraupis episcopus	O,A	2	2	1	4
Thraupis palmarum	O,A	3	3	3	6
Troglodytes aedon	I,A,G	4	7	4	1
Phaeomyias murina	I,A,S	5	4	5	7
Amazilia fimbriata	N	6	12	7	12
Quiscalus lugubris	O,A	7	16	17	
Turdus leucomelas	O,A	8	6	6	8
Elaenia flavogaster	I,A,S	9	5	8	5
Progne chalybea	I,Aer.	10	14	11	9
Myiozetetes cayanensis	I,A,S	11	8	9	13
Columbina passerina	G,T	13	18	14	17
Volatinia jacarina	G,G.	14	20	14	3
Sporophila castaneiventris	G,G.	15	13	13	10
Ramphocelus carbo	O,A	16	9	10	8
Tachyphonus rufus	I,A,G.	17	11	12	14
Columbina minuta	G,T.	18	10	18	15
Tachycineta albiventer	I,Aer.	19			20
Forpus passerinus	G,A				16
Tyrannus dominicensis	O,A				18
Columbina talpacoti	G,T			19	11
Tolmomyias poliocephalus	I,A,S		17		19
Thamnophilus doliatus	I,A,G		15		
Dendroica petechia	I,A,G		19		
Crotophaga ani	I,A,G.			14	

classes, *Sporophila castaneiventris* is dominant in class 2 and *Volotinia jacarina* is dominant in class 4.

Frugivores are not very significant in bird diversity, but an interesting fact concerns the little parrot *Forpus passerinus*; this rather omnivorous bird, since it also eats insects, is ubiquist with a higher attendance in class 2 and 4 where there are patches of secondary forest. But since it was also found in the old city, it is possible that it is well adapted to anthropised habitats.

The omnivorous *Quiscalus lugubris* can be considered as an invader as its main habitat is the coastal mangrove. Since the mangrove has been cut down, it now nests on the trees in the old city, where it is biomass wise dominant. Its occurrance disappears quickly when moving away from the coast line but this situation can be temporary; it may come back on the coast line if a newly grown mangrove gives suitable habitats or if it can invade a larger area, killing clutchs of other birds, thus decreasing the bird diversity.

Comparing the area of Cayenne with African stations (table 5), the bird groups follow the same classes as in table 2 with a few exceptions in table 4 where all granivores are in group C (doves and passerine seed-eaters), group D is separated into frugivores and nectarivores and group E is separated into insectivores and omnivores.

Class 1 is to be compared with the village class in West Africa: we observe lowest species number, mainly passerines with an equal proportion of insectivores and omnivores.

Class 2 is similar to towns in West Africa with an about 5%, or less, demographic increase: species number is highest, mainly because of increase in the number of insectivores (twice the omnivores), granivores and nectarivores.

In regard to Cayenne class 3 and 4, the noticeable diminution in the number of species of group E: passerines (table 2) in West Africa is a two steps decrease. First insectivores, then omnivores have lost their favorites habitats.

Conclusions

The list of 25 dominant species of Cayenne, table 6, is in close relation with that of West Africa: it shows the relative importance of omnivores: 7 species, and the distribution of hunting volume amongst insectivores: 5 arboreal gleaning species, four arboreal sallying species and two aerial species. A nectarivore is always present and five granivores seed gleaners, which feed partly on the soil and partly on weeds, are always present. An opportunist raptor (kite or vulture) is always present, representing the top of the food chain.

The guild composition of this list can be considered as the basic structure of a bird population under a tropical anthropised condition. It is highly possible that an unbalance between the guilds will be the starting point of an irreversible deterioration in bird habitats in tropical anthropised areas and thus of the human habitats themselves.

Acknowledgements.

I thanks Mrs. Daniela Toriola-Marbot for her wise analysis and her accurate english translation.

References

Alexander-Marrack, P.D., Aaronson, M.J., Farmer, R., Houston, W.H. and Mills, T.R. 1985. Some changes in the birds faune of Lagos, Nigeria. - Malimbus 7: 121-127.

Balandreau, J., Ducerf, P., Hamad-Fares, I., Weinhard, P., Rinaudo, G., Millier, C. and Dommergues, Y. 1977. Limiting factors in grass N2 fixation.- In: Dobereiner, J. et al. (eds.), Symp. on the limitations and potentials for nitrogen fixation in the tropics". Basic life sciences Vol. 10. Plenum Press, N.Y., London, pp.275-302.

Blondel, J. 1975. L'analyse des peuplements d'oiseaux, éléments d'un diagnostic écologique 1; La méthode des échantillonnages fréquentiels progressifs(E.F.P.). - La Terre et la Vie 29: 533-589.

Blondel, J. Frochot, B. and Ferry, C. 1970. La méthode des Indices Ponctuels d'Abondance (I.P.A.) ou des relevés d'avifaune par "stations d'écoute".- Alauda 38: 55-71.

Browne, P.W.P.1979. Birds observed near Lome, Togo in 1976 and 1977. - Malimbus 2: 51-55.

Browne, P.W.P.1981. New bird species in Mauritania. - Malimbus 3: 63-72.

Browne, P.W.P.1982. Paleartic birds wintering in South Mauritania: species, distribution and population estimates. - Malimbus 4: 69-92.

Browne, P.W.P.1984. Seven new species for Conakry, Guinea. - Malimbus 6: 74.

Cheke, R.A., Walsh, J.F. and Fishpod L.D.C.1985. Birds records from the Republic of Niger. - Malimbus 7: 73-90.

Cheke, R.A., Walsh, J.F. and Sowah S.A.1986. Records of birds seen in the Republic of Togo during 1984-1986. - Malimbus 8: 51-72.

Davaud, J.1956. Les oiseaux des monts du Togo (Afrique occidentale). - Alauda 25: 241-266.

Demey, R.1986. Two new species for Ivory Coast. - Malimbus 8:44.

Diamond, J.M. 1986. Rapid evolution of urban birds. -Nature 324: 107-108.

Dowd, C. 1992. Effect of development on bird species composition of two urban forested wetlands in Staten Island, New York.- J. Field Ornithol. 63: 455-461.

Field, G.D.1978. Status of Ciconiiformes in Sierra Leone. - Bull. Niger. Orn. Soc. 14: 42-46.

Fry, C.H. 1992. The Moreau ecological overview. -Ibis 134: 3-6.

Gee, J.P. and Heigham, J.B.1977. Birds of Lagos, Nigeria. - Bull. Niger. Orn. Soc. 13: 43-52 and103-132.

Gee, J.P.1984. The birds of Mauritania. - Malimbus 6: 31-66.

Green, A.A. and Sayer, J.A.1979. The birds of Pandjari and Arli National parks (Benin and Upper Volta). - Malimbus 1:14-28.

Green, A.A. 1983. Bird records from Bangui-Bangaran National Park, Central African Republic. - Malimbus 5:17-30.

Green, A.A. 1984. Additional bird records from Bangui-Bangaran National Park, Central African Republic. - Malimbus 6:70-72

Greig-Smith, P.W.1976. The composition and habitat preferences of the avifauna of Male National Park, Ghana.- Bull. Niger. Orn. Soc. 12: 49-66.

Happel, R. E.1985. Birds of Outamba area, Northwest Sierra Leone. - Malimbus 7: 101-102.

Harding, D.P. and Harding, R.S.O. 1982. A preliminary checklist of birds in the Kilimi area of Northwest Sierra-Leone. - Malimbus 4: 64-68.

Heaton, M. and Heaton, A.E.1980.The birds of Obudu, Cross River State, Nigeria. - Malimbus 2: 16-24.

Heigham, J.B.1976. Birds of Mid-West Nigeria. - Bull. Niger. Orn. Soc. 12: 76-93.

Hilden, O. 1965. Habitat selection in birds; a review.- Ann. Zool. Fenn. 2: 53-75.

Hohtola, E. 1978. Differential changes in bird community structure with urbanisation: a study in central Finland.- Ornis Scand. 9: 94-100.

Lamarche, B.1980. Liste commentée des oiseaux du Mali. - Malimbus 2: 121-158.

Lamarche, B.1981. Liste commentée des oiseaux du Mali; 2ème partie Passereaux. Malimbus 3: 73-102.

Lenz, M. 1990. The breeding communities of three Canberra suburbs.- Emu 90: 145-153.

Macdonald, M.A.1979. Breeding data for birds in Ghana. - Malimbus 1: 36-37.

Mackensie, P.1979. Birds of the Calabar area. -Malimbus 1: 47-55.

Marshall, H.J. 1977. Supplement to annoted list of birds observed in Mid-West Nigeria. - Bull. Nigerian Orn. Soc. 13: 100-102.

Mason, P.1985. The impact of urban development on bird communities of three victorian town-Lilydale, Coldstream and Mt Evelyn. - Corella 9:14-21.

McDonnell, M.J. and Pickett, S.T.A. 1990. Ecosystem structure and function along urban-rural gradients: an unexploited opportunity for ecology. - Ecology 71: 1232-1237.

Monod, J. 1942. Recherches sur la croissance des cultures bactériennes. - Thèse, 210 p., Hermann, Paris.

Moreau, R.E. 1966. The Bird Faunas of Africa and its Islands.- Academic Press, London, GB.

Morel, G.1985. Les oiseaux des milieux rocheux au Sénégal. - Malimbus 7: 121-127.

Morel, G. and Morel, M.Y. 1990. Les Oiseaux de Sénégambie; notices et cartes de distribution. - Editions de l'ORSTOM, 178 p., Paris.

Pomeroy, D. and Ssekabiira, D. 1990. An analysis of the distributions of terrestrial birds in Africa. - Afr. J. Ecol. 28: 1-13.

Richards, D.K.1982. The birds of Conakry and Kakulimba, Democratic Republic of Guinee. - Malimbus 4: 93-103.

Sander, F.1956. A list of birds of Lagos and its environs, with brief notes on theis status. - Niger. Field. 21: 147-162; 22: 5-17, 55-69.

Sharland, R.E. and Wilkinson, R. 1981. The birds of Kano State, Nigeria. - Malimbus 3: 7-30.

Smet de, K. and van Gompel, J. 1980. Observations sur la cote sénégalaise en décembre et janvier. - Malimbus 2:56-70.

Terborgh, J., Robinson, S.K., Parker, T.A.III, Munn, C.A. and Pierpont N. 1990. Structure and organisation of an Amazonian forest bird community. - Ecological Monographs 60: 213-238.

Thiollay, J. M.1985. The birds of Ivory Coast. - Malimbus 7: 1-59.

Thiollay, J.M. 1990. Comparative diversity of temperate and tropical forest bird communities: the influence of habitat heterogeneity. - Acta Oecologica 11: 887-911.

Thonnerieux , Y. 1985. Notes complémentaires sur l'avifaune des parcs nationaux de l'Arli (Burkina) et de la Penjari (Benin). - Malimbus 7: 137-139.

Wallace, D.I.M.1973. Sea-birds at Lagos and in the Gulf of Guinea. - The Ibis 115: 559-571.

Walsh, J.F. 1986. Notes on the birds of Ivory Coast. - Malimbus 8: 89-93.