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The Biology and Management of Wild Helmeted Guineafowl (*Numida meleagris galeata* Pallas) in the Waza Region of North Cameroon

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1. Parcs (1963) and Szabo and Bankay (1974) observed that egg production in guineafowl could drop by as much as 20 to 30% after their first laying season, but the Waza guineafowl just does the opposite. Their egg production increases after the first laying season (this thesis).

2. Guineafowl are reckoned to be poor mothers (Farkas 1965), and this may explain why they hatch many keets (young guineafowl). Some keets will thus still survive after many are killed through bad motherhood.

3. Guineafowl look very sluggish at a first glance but are more clever than they look. One has to try to catch them to know this fact (this thesis).

4. Although local participation in the design and implementation of conservation projects is said to be a prerequisite for conservation projects, it is not a magic option for project success, and might needs to be complemented with other policy measures.

5. In most parts of Cameroon, cultural taboos appear to be more effective as a conservation tool than policy by game guards.

6. It appears that people appreciate the value of resources mostly when they are gone. This may explain why people in developed countries are very sensitive to environmental problems. Most of the Africans who are still lucky to have abundant natural resources might only realise the importance of nature conservation when most of these resources are completely depleted through over exploitation.

7. Some local communities in Africa are less harmful to their environment than asserted by some scientists. If all local communities were a real danger to the environment, we would have no natural resources left to be able to create protected areas in Africa today.

8. Local people and their environment form a complex system which has developed over hundreds of years in response to environmental changes. Any abrupt change imposed by outsiders into this complex system might have disastrous result.

9. Nobody will practise effective conservation of natural resources on an empty stomach.

10. Inviting a Cameroonian friend on his first visit to Europe for a drink and asking him to pay for his, is as shocking to him as it will be to a white friend who on a first visit to Africa is asked to become a polygamist.

Contents

Preface

This thesis is a compilation of published and submitted articles. Together, these articles demonstrated some of the ecological, economic and sociological processes that must be addressed for the sustainable use of a wildlife species (guineafowl, *Numida meleagris galeata* Pallas in this case).

It is the result of both field work and laboratory analysis in the Centre for Environmental Studies and Development in Cameroon (CEDC). This centre's major objectives are conservation and sustainable exploitation of natural resources and it is a result of a cooperative agreement between the ex-Ministry of Higher Education, Computer Services and Scientific Research (ex-MESIRES) in Cameroon and the Leiden University (RUL) in the Netherlands. CEDC has been investigating possibilities of reducing human pressure on wildlife in protected areas of north Cameroon through the provision of alternative sources of wildlife income and proteins (e.g. village hunting zones, game farming and domestication). In this respect, the guineafowl was chosen as a test species for investigation on such possibilities.

Field studies for this thesis was financed by the Netherlands Government through the Directorate General for International Co-operation (DGIS) and the Netherlands Organisation for International Higher Education (NUFFIC). The Institute of Animal and Veterinary Research (IRZV), Cameroon also provided financial and logistic support. Most field data was collected between 1991 and 1995 with the help of a permanent field assistant and 8 biology students. This thesis provides one possible approach to guineafowl management and exploitation. However, it should not be considered as the only feasible approach.

Acknowledgements

This study was supported by a grant from the Netherlands Ministry of Foreign Affairs (Directorate General for International Co-operation) and the Netherlands Organisation for International Co-operation in Higher Education (NUFFIC), through the Centre for Environmental Studies and Development in Cameroon (CEDC), Maroua. The Institute of Animal and Veterinary Research (IRZV), Cameroon paid my salaries during the study. WWF-Netherlands also provided some financial support during field studies of the guineafowls' diet (Chapter 4). I am very grateful to all of them. Special thanks also go to Cameroon's Ministry of Environment and Forestry for authorising this study.

This thesis could never have been completed without the criticisms, constant help and advice from my promoters, Professor Dr. H.H.T. Prins of Wageningen Agricultural University and Professor Dr. H.A. Udo de Haes of Leiden University, the Netherlands. Dr. Hans de Iongh of Leiden University (and Drs. Jeroen van Wetten during the initial phase) gave me advice throughout the study and Professor Dr. Wouter de Groot of the same institution commented on some chapters. I am greatly indebted to all of them.

The Wardens of the Waza National Park , and some game guards especially Mr. P. Amadou and Mr. K. Justine were very helpful in the field. Special mention must made of Mr. E. Kouahou of IRZV Maroua who worked assiduously as my field assistant for all the study years. Mr. A. Don and Mr. J. Onana of the Wildlife school Garoua and IRZV Garoua and Dr. Ekokole of IRA (Maroua) were helpful at various stages. The Biochemistry Laboratory of Wageningen Agricultural University (The Netherlands) also helped in the analysis of the mineral content of the guineafowl food (chapter 4).

Eight students, some of whom are co-authors of some chapters worked with me during the data collection phase. These included 5 Dutch students; Jan-Peter de Krijger, Katia Hueso Kortekaas, Pim Edelaar, Arnold Bodenkamp and Aat Schaftenaar who were in the field for six months each, and 2 Cameroonian students Hebou Luc and Kongape Jean Avit, who were with me for 5 months each.

Many of my colleagues at CEDC not only commented but gave useful suggestions during the preliminary draft stages. The English of this thesis was corrected by Dr Andrew Spink. Lastly, I also want to thank my family, especially my spouse Mary who took off time as an English teacher to read the manuscripts and my kids for accepting my prolonged absence from home.

General Summary and Outline of Thesis

Criticisms have arisen with respect to the way protected areas in Africa are being managed in a top-down fashion, with the state as the sole owner. Such an approach has failed in a number of protected areas because of encroachment (mainly poaching and habitat destruction), socioeconomic instability, and conflicts of interests with local communities. The long-term conservation of wildlife and the future of many protected areas in Africa today requires a review of present management strategies. In the general introduction (Chapter 1), some of the major problems of protected areas of Africa in general and of Cameroon in particular are discussed.

One of the major problems facing the managers of protected areas is poaching of wildlife by both local communities and outsiders. 'Bushmeat' (meat from wild animals) is a major source of animal proteins in most parts of Africa. In the two Northern provinces of Cameroon, meat from wildlife is widely consumed. The North African Porcupine (*Hystrix cristata*) and the guineafowl (*Numida meleagris*) top the list among the wildlife species that are consumed (Chapter 2). Since wildlife utilisation by local communities cannot be completely stopped, it is important that some way be found to make such use sustainable. A good sustainable use scheme may also be a way of getting local communities involved in nature and wildlife conservation. Such a scheme could take the form of a regulated hunting arrangement for villages in the area adjacent to protected areas. However, if local communities are to be legally authorised to exploit any natural resources, the exploitation must be sustainable. For the exploitation to be sustainable, there must be a good management strategy based on sound ecological knowledge of the resources.

The guineafowl was chosen as a species that could possibly be exploited by local communities around the Waza National Park of North Cameroon. The biology of this bird was investigated from 1991 to 1995 to establish an ecological basis for such exploitation. Censuses in and around the Waza National Park showed that the population density of guineafowl in this area could be up to 216 ± 108 birds/km^2. This density varies with habitat type, year, and level of human activity (Chapter 3). Investigation of the diet of this bird from crop content analysis (Chapter 4) showed that it is omnivorous. It feeds on a wide variety of plant seeds, roots and insects, but especially on the rhizomes of *Stylochiton lancifolius* (a plant) and on termites (an insect). A study of the breeding performance of the guineafowl inside the National Park (Chapter 5) showed that the annual rainfall plays an important role in its annual breeding success. Nest abandonment, predation of both eggs and guineafowl hens, trampling by elephants and floods were found to be principal causes of nest losses, but play a lesser role in the total breeding success.

An investigation of mortality and mortality factors (Chapter 6) showed that the annual mortality rate varied slightly with sex, age and year. A multifactorial analysis of population parameters showed that variations in annual breeding success resulting from variation in annual rainfall could explain most of the population density changes in the region. Hence annual rainfall can be used to estimate annual production and possible harvesting strategy for the Waza guineafowl population.

Studies on the home range size, emigration, and social organisation (Chapter 7) showed that the home range size varied with season (rainy and dry season). Group size varied with month, being largest between March and April and smallest in August. Young birds and birds in large groups had a higher tendency to emigrate. Information from previous chapters is used to develop a model for predicting annual guineafowl productivity and assess the possible magnitude of harvesting quota for the Waza region (Chapter 8). In the last chapter (Chapter 9), information from a socioeconomic survey in the Waza region and those from other chapters are used to propose a hunting zone for the management of hunting of guineafowl by villagers. A possible set-up of an organisation for running this hunting zone is also proposed.

Samenvatting

Er is in toenemende mate kritiek op het top-down beheer van beschermde gebieden in Afrika door overheden. Deze benadering heeft gefaald in een aantal beschermde gebieden omdat deze werden aangetast door illegale immigratie in het gebied (vooral gerelateerd aan stroperij en habitat vernietiging), sociaal-economische instabiliteit en belangenverschillen tussen overheid en de lokale bevolking.

De lange termijn bescherming van wild en de toekomst van veel beschermde gebieden in Afrika vraagt vandaag een herziening van de bestaande beheersstrategieën.

In de Algemene Introductie (Hoofdstuk 1) worden de belangrijkste problemen van beschermde gebieden in Afrika in het algemeen en Kameroen in het bijzonder besproken. Eén van de belangrijkste problemen, waar de beheerders van beschermde gebieden in Afrika mee worden geconfronteerd is de stroperij van wild door zowel lokale bewoners rond de parken als stropers van elders. Vlees van wild is een belangrijke eiwit-bron in grote delen van Afrika. In de twee Noordelijke provincies van Kameroen wordt het vlees van wild veel gegeten door de lokale bevolking.

Het Noord-Afrikaanse stekelvarken (*Hystrix cristata*) en de parelhoen (*Numida meleagris*) hebben van de gegeten soorten de hoogste voorkeur (Hoofdstuk 2). Omdat het gebruik van wild door de lokale bevolking niet compleet kan worden gestopt, is het belangrijk duurzame exploitatie te stimuleren. Een goed programma voor duurzaam gebruik is ook een manier om lokale gemeenschappen te betrekken bij een programma voor natuur - en wildbeheer. Een dergelijk programma kan worden uitgevoerd in de vorm van een gereglementeerde jachtvergunning voor dorpen in de zone rond een park. Een voorwaarde voor het verstrekken van een dergelijke vergunning is, dat de exploitatie duurzaam is. Om tot een duurzame exploitatie te komen is een goede beheers-strategie vereist die gebaseerd is op gefundeerde kennis van de natuurlijke hulpbronnen.

De parelhoen is gekozen als soort voor de mogelijke exploitatie door lokale gemeenschappen rond het Waza Nationaal Park (WNP) in Noord-Kameroen. De biologie van deze soort werd onderzocht van 1991 tot 1995 met het doel een ecologische basis te ontwikkelen voor een duurzame exploitatie. Populatie-censi

in en rond het WNP gaven aan dat de gemiddelde dichtheid van parelhoenders er lag op 216 ± 108 vogels/km². Deze dichtheid varieerde per habitat-soort, per jaar, per seizoen en was ook gerelateerd aan de intensiteit van menselijke activiteit in het gebied. (Hoofdstuk 3).

Onderzoek naar het dieet van de vogels op basis van krop-inhoud analyse (Hoofdstuk 4) wees uit dat de parelhoen omnivoor is. De vogels foerageren op een grote verscheidenheid van plantenzaden, wortels en insecten, maar in het bijzonder op de wortels van de plant *Stylochiton lancifolius* en termieten.

Een onderzoek naar het broed-succes van de parelhoen in het WNP (Hoofdstuk 5) bewees dat de jaarlijkse regenval een belangrijke rol speelt in het jaarlijkse broed-succes. Het verlaten van nesten, de predatie van eieren en hennen, vertrapping door olifanten en overstroming waren de belangrijkste oorzaken voor nest-verliezen, maar waren minder bepalend voor het uiteindelijke broed-succes.

Een analyse van mortaliteit en mortaliteitsfactoren (Hoofdstuk 6) toonde aan dat de jaarlijkse mortaliteit varieerde per geslacht, jaar en leeftijdsklasse. Een multi-factor analyse van populatie-parameters toonde aan dat de wisselingen in het jaarlijkse broed-succes als gevolg van de wisselingen in jaarlijkse regenval de meeste veranderingen in populatiedichtheid van het onderzoeksgebied konden verklaren. De jaarlijkse regenval kan dus gebruikt worden om de jaarlijkse produktie te bepalen en een mogelijke oogststrategie te ontwikkelen voor parelhoenderpopulatie in en rond WNP.

Onderzoek naar de home range, emigratie en sociale organisatie (Hoofdstuk 7) toonde aan dat de grootte van de home range varieerde per seizoen (regenseizoen en droog seizoen). De groepsgrootte varieerde per maand, met de grootste groepen in maart en april en de kleinste in augustus. Jonge vogels en vogels uit de grote groepen vertoonden een hogere emigratie.

Informatie verkregen uit dit onderzoek is gebruikt om een voorspellend model te ontwikkelen voor de jaarlijkse productiviteit van parelhoenders en om mogelijke oogstquota vast te stellen voor de gebieden rond WNP (Hoofdstuk 8). Het model voorspelt een lineaire toename van de productiviteit van parelhoenders met regenval, beginnend bij een niveau gelijk aan of minder dan 450 mm (Hoofdstuk 9).

Informatie verkregen uit een sociaal-economische survey in het Waza gebied en de informatie verkregen middels het model worden gebruikt voor een voorstel tot de inrichting van een jachtzone onder het beheer van lokale gemeenschappen. Tevens is een voorstel opgenomen voor de organisatie van het beheer.

Chapter 1

General Introduction

1.1 Present conservation problems in Africa and in Cameroon

Much energy and resources have been spent in Africa this century to develop protected areas. However, some of these efforts have been in vain because of conflicting interest between the objectives of these conservation areas and those of local communities. In most cases local people were never consulted during the design, planning and implementation of the protected areas, resulting in passive or active rejection of their establishment (see Dalal-Clayton, 1984; Lewis & Carter, 1993; Njiforti & Tchamba, 1994). Much attention has of late been focused on problems of African protected areas (cf. Anderson & Grove, 1987; Kiss, 1990; West & Brechin, 1991; Brown & Wyckoff-Baird, 1992; Lee, 1992; USAID, 1993; IIED, 1994). Uncontrolled exploitation of natural resources both in and around some protected areas by local communities and outsiders, has reduced the biomass and the biodiversity of these areas.

Poaching and the destruction of wildlife habitat (both in and out of protected areas) are major causes of decline in biodiversity in most parts of Africa. The picture is the same in Cameroon, but the situation there is aggravated by the persistent socioeconomic crisis coupled with the devaluation of the regional currency (CFA), which have still increased the dependence of the local population on nature for their livelihood. Around most protected areas, natural resources have been so depleted that only the protected areas can now provide what people need. This has led to persistent encroachment into the national parks and nature reserves. An increase in the number of game guards and in the number of people sent to prison each year for wildlife offences has not solved the problem. Njiforti & Tchamba (1994) observed that most people living near national parks in North Cameroon had little or no interest in the conservation of these parks because they derived no legal direct benefits from them. This is also supported by the constant confrontation between poachers and game guards. Taking the Waza National Park in the Far North province of Cameroon (Fig. 1.1) as an example, the following events may elucidate this:

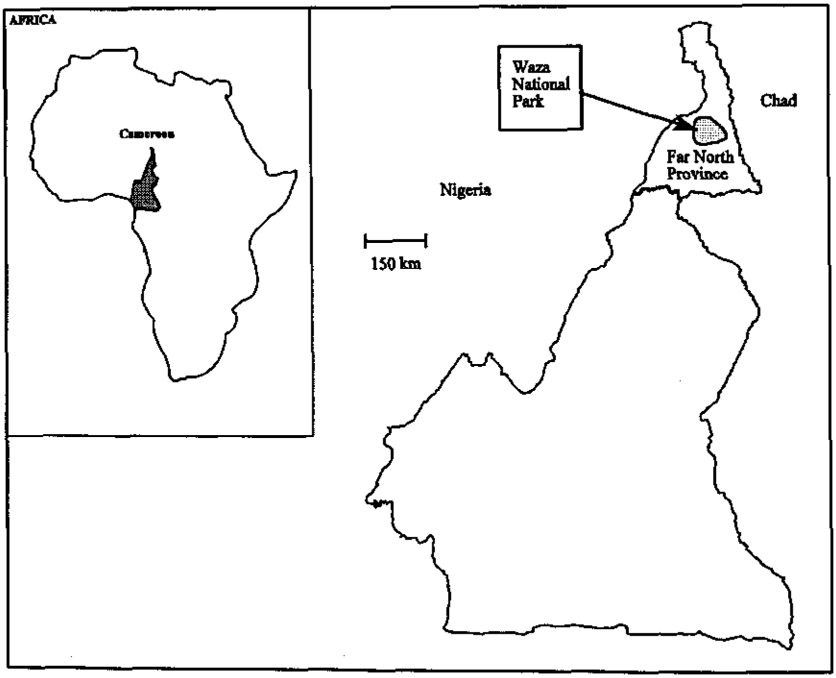

Figure 1.1
A map of Cameroon showing the location of the Far North Province and the Waza National Park.

- A conservator was killed in the Waza National Park in 1980 while on anti-poaching patrol.
- In 1990 another game guard was killed by poachers.
- In 1991 a game guard was handicapped for life by poachers whilst on an anti-poaching patrol.
- A shooting incidence between poachers and game guards of the Waza National Park in 1994 ended with 3 poachers dead.
- Since 1990, more than five people have been charged with wildlife offences in the Waza park each year (park records).

It is commonly known that people take more care for their own property than they do of the property of others. If local people have to effectively participate in the management and conservation of national parks, they must first be convinced that the continuation of the park will also be for their (direct and legal) benefit. They must thus derive some benefit from these parks. Although economic and material benefits may seem to be the most logical gain that local people can get from protected areas, it is important to know that this alone may not stop the human-park conflict in most situations. For example some people around national parks in North Cameroon feel hurt not because they are not having economic or material benefits from the parks, but also because they claim that these resources that are 'theirs' and their traditional practices are refused to them while 'outsiders' can exploit these resources (see Njiforti & Tchamba, 1994). This feeling has developed because safari hunting is practised around the National parks, while many villagers get convicted for even minor wildlife offences.

There is a need for the 'old' concept of conservation by excluding local population to be modified to that of conservation together with the local population. Local communities are closer to the wildlife in their area than most of the decision-makers. They also suffer loss of both agricultural products and livestock through wildlife trampling and predation (Tchamba, 1996).

There are many ways by which local people can be integrated into the present management of national parks and nature reserves. These include:

- Providing villagers with direct benefits from income generated from the parks and reserves. This form of involvement is very little practised in Cameroon today. It seems to be one of the best ways to get local people involved, in particular if the whole village can benefit from it.
- Employment of local people to work as game guards and tourist guides. This is the most commonly practised form of involvement in Cameroon today. The major disadvantage of this form of involvement is that only a few families (those from which individuals are recruited) will reap the benefits of conservation.
- Compensation of people for losses caused by wildlife. This option has been practised in Cameroon from time to time. Its major disadvantage is that local people only become involved when some damage has been done to them. This option also benefits only those who have had property damage, which may lead to false declarations by people to benefit from such compensation schemes.
- Package-deals with local people (e.g. drilling a well in the village) in exchange for their acceptance of conserving the resources in the park. This option could also be used to encourage local people to report poachers. If well arranged, the whole community can benefit from it.
- Letting local people harvest some of the resources of the park. Resources can be harvested directly in the national park or in its buffer zone. This option has not been practised so far in Cameroon. The major disadvantage of this option (for a large scale exploitation) is that two important conditions

have to be met: 1) Ecological information about sustainable yields and 2) a social structure that can regulate the exploitation. In general, such information and structure is lacking and the resources, time and work-force needed to gather the ecological information and set up the control structures might also be limited.

A preliminary survey showed that helmeted guineafowl (*Numida meleagris galeata* Pallas, 1767) was widely available and poached in the Waza region. Taking this species as an example of a natural resource that can be managed and used in a sustainable way, some of the major steps involved in gathering information for such exploitation will be examined in the chapters that follow. In principle there are two approaches to the exploitation of any wildlife population, that is, breeding in captivity or cropping in the wild. Taking the Waza situation and the guineafowl (sometimes also called guinea fowl) as an exploitable resource, the first option can be captive breeding. This seems to be sensible but not an easier option than cropping from the wild.

The following arguments have to be considered in this respect:
- The species is not being domesticated at present by villagers in the area because most people claim they easily revert to the wild.
- High material and human investment will be needed to set up a domestication project comparable to that of the Kainji Lake Research Institute in Nigeria where this bird is bred and distributed to local farmers at subsidised rates.
- Domestication is never complete in the villages and there is high risk of poultry diseases (Ayeni, 1983).
- The insect requirements of young chicks lead to difficulties in feeding them in captivity (Ayeni, 1983).
- Eggs will still have to be collected from the wild in a domestication programme and these have to be hatched either using incubators (as in Nigeria) or using domestic chicken as in most parts of Africa. Thus a domestication programme is still dependent on a viable wild population.

With these in mind, the second option, i.e., cropping the wild population, may be a good alternative. However, as was mentioned earlier, for large scale harvesting to be sustainable, biological information as well as a good social structure is needed; this will be the subject of the chapters that follow.

The following major research questions were asked and investigated:

1. What is the present level of exploitation of wildlife in the Northern Provinces of Cameroon? The answer to this question would determine if there could be a ready market for guineafowl in the two northern provinces.
2. What is the density of guineafowl in the Waza National Park? The answer to this question would determine if the exploitation could be economically profitable.
3. What is the key factor controlling the population dynamics of the Waza guineafowl population? The answer to this question was supposed to be the biological basis for the management of this species, be it for exploitation or just to increased the population. To find out this key factor, the following aspects of the biology of the guineafowl were investigated:
   a. The density and variations of density with time, habitat and human pressure.
   b. The diet and food available to the guineafowl.
   c. The breeding performance of guineafowl in the region.
   d. Annual survival rate and mortality factors in this bird.
   e. The home-range size, emigration, and social organisation.
4. On the basis of these information, how can the villages around the Waza National Park be organised to manage and used guineafowl in the region?

1.2 General ecological background

1.2.1 Population dynamics

One of the most important pieces of information needed, before any wildlife population is harvested or during the harvesting itself, is how the population changes with time (population kinetics). Many approaches are used by population ecologists to gather this information about a given species. One approach considers all individuals in the population as identical, expressing changes in the population as an average for several years, then investigating why there have been such changes. Another approach considers the fluctuation of a population in terms of the whole population and environmental factors, in other words, a holistic approach. Recently, these two methods have been considered too superficial to explain most population changes because factors like mortality, fecundity, breeding success, etc. are known to vary with, e.g., age or with the condition of individuals.

Another approach is to view the environmental variables as acting not directly on numbers as in the first two approaches, but indirectly through their influence on fecundity and survival rates at each age interval (Caughley, 1980).

This approach is not without its shortcomings, the greatest one being the number of (sometime unrealistic) assumptions that have to be made. There are however, several arguments advanced by ecologist in favour of this approach (e.g. Caughley, 1980; Clobert & Lebreton, 1991).

1.2.2 *The key factor analysis theory and its importance to wildlife management*

The key factor analysis is a new concept for explaining population demography. In this analysis, factors that affect the demography of a population are thought to be acting in small units at different levels (age groups, or sex) of the population. These sub-mortality factors are also called k-factors or killing-factors.

In practice, the population is broken down into sub-units (usually age classes) and the gains and losses at these sub-unit levels are measured. The relative importance of these gains and losses are then used to explain population changes (Moss *et al*, 1982). Fig. 1.2 represents a hypothetical bird population controlled by 'killing-factors' or k-factors k1 to k3 at various stages.

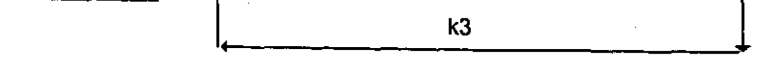

Figure 1.2
A diagrammatic representation of the dynamics of a guineafowl population. Mortality factors controlling the population dynamics are subdivided into k1, between the egg and chick stages, k2 between the chick and adulthood, and k3 during adulthood.
K1 can be subdivided into k_L, mortality factors between the laying and incubation stages and k_I, mortality factors between the incubation and hatching sages.
K2 can be sub-divided into k_n, mortality factors between the hatching and nestling stages and k_Y, mortality factors between the nestling stage and adulthood.

The magnitude of these 'killing factors' are usually estimated from field data, and the one with the greatest influence on the population is taken to be the key factor controlling the dynamics of the said population. A management plan for the species must first direct attention to this key factor. It must be noted that key factor analysis is only suitable for mammalian populations with simple life histories and non-overlapping generations, but it can be used in most bird population (Moss, Watson & Ollason, 1982) and thus appears to be of great importance for the present study on the guineafowl. For a review of pitfalls of key factor analysis, see Manly (1977). Key-factor analysis is thus an important tool for wildlife managers since it identifies the key factor controlling the population dynamics of the wildlife population studied. The wildlife manager can thus focus his attention on this key factor cutting down on managerial cost. From chapter 3 onward, all efforts are to identify the key factor controlling the population dynamics of the Waza guineafowl population through the studies of its biology.

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Chapter 2

Preferences and Present Demand for Bushmeat in North Cameroon: Some Implications for Wildlife Conservation

Summary

Although bushmeat is locally known to be an important source of protein, large-scale patterns of demand are poorly defined. One area for which information is especially lacking is Northern Cameroon, and a survey of 345 households in this region was therefore carried out. Information sought from questionnaire interviews included the frequency of consumption, species preferences, and prices of bushmeat, together with people's perceptions of trends in the wildlife population involved. Bushmeat was estimated to representing *ca.* 24% of the animal protein intake in the region and respondents generally preferred bushmeat to meat from domestic livestock. North African porcupine (*Hystrix cristata*) was the most preferred species, closely followed by guineafowl (*Numida meleagris*), and Buffon's kob (*Kobus kob*). There was a tendency for the price of a kilogramme of bushmeat to decrease with the weight of the animal.

A majority of the respondents said they perceived declines in some wild animal species within the last 10 years. For those who eat bushmeat one ore more times a week, there was a tendency for villagers to eat more bushmeat than people in towns. A number of measures should be taken, including wildlife farming and domestication and anti-poaching measures in national parks.

2.1 Introduction

In Cameroon, one of the greatest threats to nature conservation is the poaching of wild animals. Most of the park wardens and guards of national parks and

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reserves who are supposed to organise the smooth running of these parks and reserves, have seen their role almost limited to a virtually hopeless struggle against increasing poaching. Most rural people in Cameroon still consider wild animals existing in their locality as rightfully theirs. This is explained in most cases by the tradition where by wild animals belonged either to the land owner or to the village chief who then had the right to decide who was allowed to hunt and how the hunting would be done. This has often led to conflicts between wildlife officials of the Ministry of Environment and Forests and local communities (Njiforti & Tchamba, 1993). The problem is worsened by the limited means set aside for implementing conservation measures (e.g. the Waza National Park with a surface area of 170,000 ha, only has 20 game guards).

It is highly questionable if the struggle with poaching may ever be won if the management of national parks continues to be seen as an authoritarian policy pitted against local people. An alternative way of trying to improve nature conservation in general and wildlife conservation in particular is to adopt the sustainable use approach, the success of which has been proven in other African countries, including Operation CAMPFIRE in Zimbabwe, the Mountain Gorilla Project in Rwanda and the Ruwenzori Mountains Conservation and Development Project in Uganda. This new approach to nature conservation is gaining ground in Southern Africa, but little progress has been made in Cameroon.

The sustainable use of wild animals by and for the benefit of people has three major aspects, namely the supply, demand and management. The supply questions are mainly ecological, focusing essentially on which species may be harvested, and to what extent. The demand aspects are of a more economic nature, inter alia seeking to specify the quantities that may be absorbed on a regional market. The third group of questions pertains to the practical organisation and regulations of the off-take practice, including elements of equity with the communities and the defence of community rights against too interested outsiders.

The present paper focuses on demand. Research on this aspect has been carried out in other West African countries, (Ajayi, 1971; Asibey, 1974; Jeffrey, 1977; Martin, 1983; Adeola & Decker, 1987, Adeola, 1992; Balakrishnan & Ndhlovu 1992), but very little has been done for Cameroon as a whole and Northern Cameroon (with 5 out of 7 Cameroon's national parks; Fig. 2.1) in particular. This paper investigates the consumption, preferences and peoples perception of wildlife decline in Northern Cameroon over the past 10 years. This information were needed for the adaptation of the wildlife conservation strategy for Northern Cameroon.

2.2 Methods

2.2.1 Study area and population characteristics

This research has focused on the two Cameroonian provinces, namely North and Far North (Fig. 2.1). Annual average rainfall varies between 500 mm in Far North and 1500 mm in North. The annual average temperatures are between 20° and 30°C, with a minimum of about 12°C in December-January. Vegetation is of the Sudanian woodland type to the South and the Sahelian grassland type in the North. Most of the rivers are seasonal and even permanent ones have a very reduced flow during the dry season.

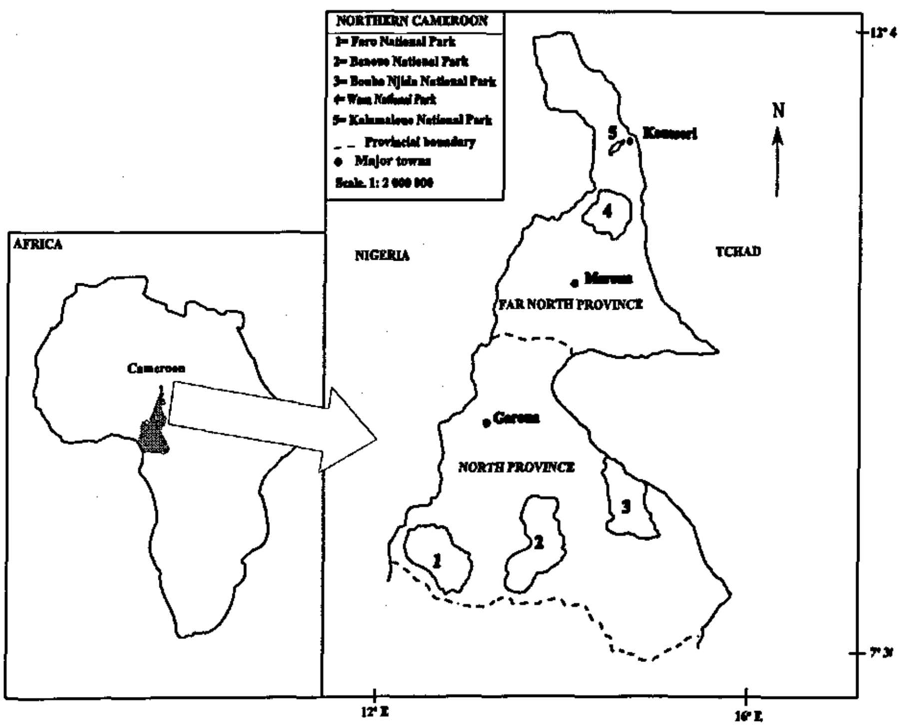

Figure 2.1
Map of northern Cameroon showing the location of national parks and major towns

There are about 2.6 million people in the study region (1987 census), with a greater part of this population in the Far North Province. The population is very heterogeneous, with many languages and cultures. Although the Muslim traditions that came in from Northern Africa in the eighteenth century have gained much ground, many people in the villages have either kept their animist religion, or become Christians. Animal husbandry is an important source of income for the people in this semi-arid region. The Muslims, and especially those from the dominant Fulbe tribe have more domestic livestock than any other tribe (Thys & Ekembe, 1992); they also do less farming. Fishing is equally important, especially in the large Logone flood-plain that is annually flooded and in artificial lakes like Lagdo and Maga. In most villages, the principal crops are millet (*Sorghum* spp.), maize (*Zea mays*), cotton (*Gossypium* spp.), groundnuts (*Arachis hypogaeo*) and rice (*Oriza sativa*). Other crops include yams, beans, pumpkins (*Cucurbito pepo*) and okra (*Hibiscus* spp.). Industries are lacking in the region, but tourism is an important source of income for both the Government and the local population.

2.2.2 *The survey design*

About 2.5 million (85% of total) people in the study area live in villages with only 450 thousand (15%) in big towns. There are, however, many large villages that could be considered as towns (as was the case in this study) resulting in 70% in towns and 30% in villages. The major towns were included in the sample beforehand (Garoua with 140,000 inhabitants, Maroua with 120,000 inhabitants and Kousseri 50,000 inhabitants). Other localities for the survey were selected by drawing from a box previously filled with small sheets of paper with names of localities. The box was shaken after each draw. Households to be interviewed were selected by counting houses on randomly selected streets in the towns and big villages and selecting the tenth one. In small villages of less than 10 households, every third household was interviewed. A total of 345 households were sampled, that is 237 (69% of sample) in the towns and big villages and 108 (31%) in small villages. The samples did not include temporal nomadic villages since they change yearly.

The research team consisted of one researcher and three wildlife technical staff with experience in village interviews. The technicians were carefully briefed on the methods and goal of the survey, and carried out many trial interviews with colleagues in the presence of the researcher. After a week of preparation, a meeting was held for a last briefing. Photographs of common mammals and birds with their local and scientific names were also distributed to help in identification.

Mixed interviews, partly in question form, partly in semi-structured form (Njiforti *et al.*, 1991), were used to collect data from households between January 1991 and June 1992. The questionnaires contained both open-ended and closed questions. The first part of the questionnaire gathered information about the sex, marital status, religion, major occupation (occupation here being the activity generating the highest income) and the consumption of meat by the respondents; the emphasis was on bushmeat. The second section consisted of questions that could identify the scale of preference of respondents for various wild animal species. The third section sought information about general knowledge about wild animals, the species that are eaten, and perceived trend in wild animal population density.

The data collected were stored in a database and later re-coded for statistical analysis. Occupations with less than five respondents were lumped together, a least significant differences range test at 95% confidence limit (95% CL) was used to separate the means and analysis of variance was carried out to determine what the influence of religion, occupation and locality were on the frequency of weekly consumption of animal protein. A Scheffe range test ANOVA at 95% CL was used to find out whether there were preferences for bushmeat or domestic livestock based on religion, occupation and locality. It was hypothesised that people's religion, occupation and locality could influence what they eat and how often. Muslims for example say they only eat meat from animals slaughtered by Muslims; they cannot eat bushmeat caught using traps if the animal died in the process, or was shot with a guns. They are also forbidden to eat some species like the warthog. A Student's t-test was used to verify whether religion influenced the consumption of bushmeat by the respondents.

Locality (town or village) could influence people's choice mostly from the point-of-view of availability of bushmeat. Occupation, which is directly linked to the income, could influence what a person eats by the means at his disposal. The influence of locality and occupation on the frequency of bushmeat consumption were also tested using Student's t-test. The preference ranking of each wild animal species was calculated by summing up the number of respondents who stated it amongst their three most preferred species. The price per kilogram of species was calculated from the market price or by dividing weight determined from the literature (Depierre & Vivien, 1992) and personal data by its whole price. Regression analysis was carried out to determine the effect of prices on respondents' preferences for different species.

A population trend for each wild animal was calculated from the percentage of respondents who mention it as having declined in number during the last ten years. To calculate the monthly and annual regional consumption of bushmeat, respondents were asked questions on how often they consume meat of both wild and domestic origin. The following assumptions were made in the final calculations: the percentages of respondents in each consumption group is representative of the whole region; an average household in the region is made up of six people; and on average, a meal that includes meat is taken to contain 0.25 kg of meat per household.

The number of respondents who eat meat were multiplied by the number of times they eat it per month to arrive at a monthly consumption figure. The annual regional figures were extrapolated from this.

2.3 Results

Occupation had a great influence on meat consumption as a whole. For instance civil servants ate significantly ($p<0.0001$) more meat (mean ± 95% CL, 5.3 ± 4.44 $week^{-1}$) than farmers (3.6 ± 2.70 $week^{-1}$); Table 2.1. Religion had a smaller influence ($p<0.001$). There was no significant influence of the locality of respondents on the overall frequency of meat consumption ($p=0.22$). The (general) mean frequency of meat consumption for all groups (mean ± 95% CL) was 4.6 ± 3.90 $week^{-1}$ (Table 2.1)

Table 2.1
Frequency of consumption of meat from wild and domestic origin among respondents of different occupations, localities and religions

Level	n	Mean number of times meat is consumed per week ± 95% confidence limit
Occupation		
civil servants	114	5.3 ± 4.4
farmers	83	3.6 ± 2.7
carpenters	13	4.6 ± 2.5
students	10	7.1 ± 4.7
company workers	28	5.0 ± 3.5
tailors	10	6.0 ± 3.7
drivers	11	6.5 ± 4.2
mechanics	5	4.7 ± 1.4
traders	34	5.3 ± 3.9
brick-layers	11	5.1 ± 2.9
unemployed	13	5.0 ± 2.9
others	13	4.5 ± 2.5
Locality		
towns	237	4.8 ± 4.1
villagers	108	4.6 ± 3.5
Religion		
Christians	203	4.2 ± 3.5
Muslims	99	5.2 ± 4.4
traditional	43	4.8 ± 3.5
Overall mean	345	4.6 ± 3.9

2.3.1 *Meat consumption and preference*

Sixty-one percent of respondents preferred bushmeat, 35% domestic livestock, and 3% either had no preference or did not know what they preferred Table 2.2, the greater preference for bushmeat was statistically significant ($\chi^2 = 22.5$, df=1, $p< 0.01$).

Table 2.2
Preferences for meat from wild and domestic origin by respondents of different occupation

Occupation	Number of respondents	Preference		
		Bushmeat	Domestic livestock	No preference given
farmers	83	54	26	3
civil servants	114	79	33	2
students	10	6	4	0
company workers	28	20	8	0
carpenters	13	9	4	0
brick-layers	11	4	6	1
unemployed	13	8	4	1
drivers	11	2	9	0
mechanics	5	3	1	1
tailors	10	3	7	0
traders	34	15	16	3
unclassified	13	7	6	0

The North African porcupine (*Hystrix cristata*) topped the taste preference list amongst the wild animals that were eaten by respondents; 28.0% mentioned it amongst the first three species they liked to eat irrespective of price (Table 2.3). It was closely followed by the guineafowl (*Numida meleagris*; 24.0%), Buffon's kob (*Kobus kob*; 20.0%), and warthog (*Phacocherus aethiopicus*; 19.7%). Nineteen other species were recorded in the survey (Table 2.3).

There was a tendency for the mean price per kilogram of large animals to be less than that of the small ones (Table 2.3), with a correlation coefficient of price on weight of $r=-0.33$, ($p=0.05$). There was, however, no significant correlation between respondents' preferences and the per kilogram price ($r=0.13$, $p>0.05$). The most preferred species were not necessarily the most expensive (Table 2.3). The majority of respondents (78.3%) ate bushmeat less than once per week, while 15% ate bushmeat once per week or more.

Table 2.3
Mean weight and per kilogram price for the 23 most preferred wild animals, in order of preference expressed by respondents

Preference ranking and common and scientific names	Respondents (N*)	Mean weight (kg)	Mean price per kg ($US)
1. North African porcupine (*Hystrix cristata*)	95	15	0.5
2. Guinea fowl (*Numida meleagris*)	84	1.5	2.7
3. Buffon's kob (*Kobus kob*)	69	90	0.2
4. Warthog (*Phacocherus aethiopicus*)	68	85	0.3
5. White-bellied hedgehog (*Altererix albiventrix*)	46	3	2.0
6. Monkeys	41	4	2.0
7. Gazelles	40	25	0.5
8½ Pangolin (*Manis gigantea*)	34	40	0.3
8½ Monitor lizard (*Varanus* sp.)	34	3	12.3
10. Whyte's hare (*Lepus crawshayi*)	33	2.5	1.6
10. Duikers	33	125	0.8
12. Francolins (*Francolinus* sp.)	31	0.8	2.0
13. Buffalo (*Syncerus caffer*)	26	700	0.4
14. Wild ducks	22	2.0	2.0
15. Cane rat (*Thryonomys* sp.)	20	1.5	1.6
16½ African brush-tailed porcupine (*Atherurus africanus*)	18	2.5	1.6
16½ Topi (*Damaliscus lunatus*)	18	135	1.3
18. Rats	17	0.2	4.0
19. Squirrels	16	0.6	2.0
20. Giant rat (*Cricetomys* sp.)	15	1.0	2.0
21. Bush pig (*Potamochoerus porcus*)	10	80	0.2
22. Elephant (*Loxodonta africana*)	7	5000	0.1
23. Tortoise	4	2.0	1.2

Respondents of traditional religion did not differ from Christians in the frequency of meat consumption ($\chi^2=0.158$ and 0.127, df=1, $p<0.05$) but they did differ significantly from Muslims ($\chi^2=0.627$, df=2 $p<0.01$). For respondents who ate bushmeat twice weekly or more often, religion had no significant influence ($\chi^2=0.928$, df=2, $P<0.01$), but there were differences in bushmeat consumption frequency among religions for those eating bushmeat less frequently (Table 2.4).

There was no significant overall difference in the consumption of bushmeat between town and in the village people ($\chi^2=0.152$, df=1, $p<0.5$). However, for those who eat bushmeat one or more times a week (Table 2.5), villagers appeared to eat more bushmeat than people in towns ($\chi^2=5.689$, df=1 $p<0.01$).

Table 2.4
Weekly bushmeat consumption among religious groups

Religion	Frequency of bushmeat consumption (number of times per week)				
	0 or do not eat	0.25	1	2	≥3
Christians	5	150	20	10	12
Muslims	13	79	5	1	2
Traditional religion	0	41	1	1	0
Total	18	270	26	12	14

Table 2.5
Differences in the frequency of bushmeat consumption between towns and villages

Locality	Frequency of bushmeat consumption (number of times per week)				
	0	0.25	1	2	≥3
Towns	13	184	21	6	6
Villages	5	86	5	6	6

2.3.2 *Perceived trend in wild animals population and quantity of bushmeat consumed*

Most respondents (79.4%) said they had noticed a decline, and even disappearance, of some wild animals in their region over the last ten years and asserted that it was more difficult to get bushmeat, with prices being much higher now than ten years ago. Another 19.1% said there was no difference from ten years ago and bushmeat availability and price had not changed. There was a significant difference in the appreciation of the decline in wild animals with the locality, with people in villages tending to notice a decline and disappearance of wild animals species more than those in towns ($\chi^2=5.26$, df=1, $p<0.01$). The elephant topped the list among species cited as having declined in number over the last ten years (Table 2.6). It was closely followed by the buffalo, lion and panther.

These data were, however, apparently biased by respondents tending to mention species they knew very well. This resulted in some species that are very rare like the rhinoceros having a low decline index.

Table 2.6
Classification of wild animals in increasing order of decline in number within the last ten years according to respondents (n=345)

Species common name	No. of respondents	Position on preference list	Decline index based on respondents (%)	Comments from field observations and literature
Duikers	2	10	0.6	common
Rhinoceros	3	-	0.9	a few exist in the North province
Ostrich	3	-	0.9	mostly in National Parks
Cane rat	4	15	1.2	common
Hippopotamus	4	-	1.2	common
Ducks	4	-	1.2	very common in flooded parts
Baboons	5	-	1.4	common
Crocodiles	5	-	1.4	common
Guinea fowls	5	2	1.4	common
Civet cat	6	-	1.7	seen in National Park
White-bellied hedgehog	6	5	1.7	common
Francolins	6	12	1.7	common
Boa constrictor	7	-	2.0	common
Squirrels	8	19	2.3	common
Pangolins	8	8	2.3	common
Buffon's Kob	9	3	2.6	common in National Parks
Chimpanzee	10	-	2.9	not seen in the two provinces
Whyte's hare	13	10	3.8	common
Gorillas	16	-	4.6	not seen in the two provinces
Giraffes	17	-	4.9	common in National Parks
Hyenas	23	-	6.7	common
Gazelles	24	7	7.0	common in National Parks
Monkeys	26	6	7.5	common
Porcupines	30	1	8.7	common
Warthog	38	4	11.0	common in National Parks
Panther	63	-	18.3	not seen in the two provinces
Lions	63	-	18.3	common in National Parks
Buffalo	63	13	18.3	extinct in some National Parks
Elephant	78	22	22.6	common in National Parks

Table 2.7 Comparative monthly and annual bushmeat and domestic livestock consumption figures

Number of times meat is consumed per week	Domestic livestock			Bushmeat		
	no. of respondent	% of sample (n=345)	monthly (annual) consumption by respondents (kg)	no. of respondent	% of sample (n=345)	monthly (annual) consumption by respondents (kg)
0	1	0.3	0 (0)	23	6.7	0 (0)
0.25	142	41.1	35.5 (426.0)	270	78.3	67.5 (810.0)
1	40	11.6	40.0 (480.0)	26	7.5	26.0 (312.0)
2	41	11.9	82.0 (984.0)	12	3.5	24.0 (288.0)
≥3	121	35.1	363.0 (4356.0)	14	4.0	42.0 (504.0)
Total	345	100	520.5 (6246.0)	345	100	159.5 (1914.0)

Table 2.8 Comparative monthly and annual regional bushmeat and domestic livestock consumption figures for Northern Cameroon (based on Table 2.7)

Number of times meat is consumed per week	Domestic livestock			Bushmeat		
	no. of respondent	% of sample (n=345)	monthly (annual) consumption by respondents (kg)	no. of respondent	% of sample (n=345)	monthly (annual) consumption by respondents (kg)
0	0.29	1.3	0 (0)	6.7	29.0	0 (0)
0.25	41.17	178.4	44.6 (535.2)	78.3	339.4	84.9 (1018.8)
1	11.59	50.2	50.2 (602.4)	7.5	32.5	32.5 (390.0)
2	11.88	51.5	103.0 (1236.0)	3.5	15.2	30.4 (364.8)
≥3	35.07	152.0	456.0 (5472.0)	4	17.3	51.9 (622.8)
Total	100	433.4	653.8 (7845.6)	100	433.4	199.7 (2396.4)

It was estimated that respondents on average ate 159.5 kg of bushmeat per month compared to 520.5 kg of meat from domestic livestock (Table 2.7). Bushmeat was found to be contributing to some 24% of the monthly or annual animal protein intake in the study region (Table 2.8).

2.4 Discussion

That most West Africans, especially those with small income (villagers in this study), show a preference for bushmeat to domestic livestock has been asserted by Prescott-Allen & Prescott-Allen (1986), De Vos (1978), Ayensu (1984), Ayeni (1977), Afolayan (1980) and Asibey (1974). Some people may prefer bushmeat for socio-cultural or religious reasons. Muslims in Northern Cameroon are said to be forbidden by their religion from eating warthogs and monkeys. Some species are believed to give special powers to the consumer. In Nigeria, for example, the egg of guinea fowl (*Numida meleagris*) is believed to give vitality (Ayeni, 1977). In some parts of Cameroon, eating wild cats is believed to make one more agile and offer protection from death by motor-car accidents.

The price of bushmeat apparently had no overall influence on people's eating preferences, yet I expected that people would eat low-cost species. The lower per kilogram prices of big animals like elephant ($0.1) and buffalo ($0.4), as compared to the small species like rats ($4), and guinea fowl ($2.7) could be explained by the fact that bushmeat was usually sold whole. Only occasionally is bushmeat smoked before being sold, one possible reason being that most of the meat is obtained illegally and the poachers sell it quickly to avoid arrest. Most of the big animals were sold whole by professional hunters after collecting their trophies. If a kilogramme of meat for big animals were to cost the same as for small ones, the whole price would be prohibitive. In other words, there is a market for small animals, with no equivalent market for very large animals that have been cut up.

Although bushmeat consumption figures for the whole of Cameroon are still rare, Balinga (1978) reported some 2000 t of bushmeat was consumed annually in the country and Ajayi (1979) found it could be contributing as much as 20% (in towns) or (in some villages) 90% of animal protein intake in the forest zone of Cameroon. The 24% bushmeat contribution to the monthly animal protein intake by respondents in the Northern provinces of Cameroon is broadly in agreement. Villagers may eat more bushmeat than this because of the greater proximity of wild animals; they also have no money to buy meat of domestic origin, a kilogram of which sold for about $2 at the time of this study.

The cost of bushmeat is merely that of traps or bows and arrows they have to buy or make.

Krostitz (1979) and Prescott-Allen & Prescott-Allen (1986), quoting FAO sources, estimated the bushmeat output for Cameroon from 1972 to 1974 at 4000 t and the same figure for 1977 alone. This gave a percentage contribution of bushmeat to per capita animal protein supply of 2.8% for both periods. The 24% contribution of bushmeat from this study, which is *ca* 2400 t of bushmeat per year, is slightly greater than half of the 1977 estimates for the whole country given above. If all the ten provinces of Cameroon were to consume about the same quantity of bushmeat per year, that would give a national figure of about 12000 t Y^{-1}. Representing an annual increase in bushmeat consumption of about 15%. However, bushmeat consumption figures for most tropical African countries are debatable. Afolayan's (1980) estimation of 50% as the contribution of wild animals to the protein needs of Africans south of the Sahara was said to be very conservative by Ayensu (*op cit.*). Afolayan (1980) estimated the contribution of bushmeat to the protein needs of Ghanaians at 80%, while Asibey (1974) estimated it at 73%.

In some West African villages, bushmeat is still the greatest source of daily animal protein. Von Richter (1969) said that 40 to 60% of the animal protein intake in Botswana was from wild animals. Rothy (1968) observed that the supply of bushmeat in former Rhodesia was 5 to 10% higher than that of domestic meat, constituting *ca* 2.5 million kg y^{-1}. Even higher figures are quoted for Liberia where Ajayi (1979) observed that there was no alternative to bushmeat.

The contributions of wild animals to the livelihood of local people, and the important role these people will play in biodiversity conservation, have, in most cases, been underestimated or even neglected. Ayensu (1984) noted that many people in Africa have protein deficiency problems which even domestic livestock cannot solve; he also thought this was one of the major reasons for the increased pressure on wild animals. Ojeda & Mares (1982) have also noted that most people hunting wild animals in Latin America were those who had little economic alternative.

2.4.1 Wildlife conservation measures

A high percentage of the population, especially those in the villages where more bushmeat is consumed perceived most wild animal population as having declined over the last 10 years. This is information that could be used by conservation organisations to sensitise the population of this region on the need for wildlife conservation.

There is ample evidence from the bushmeat eating preference and prices paid for bushmeat by people in Northern Cameroon that most of the common species in the region are accepted for food, and people would pay a price for them. Considering the percentage contribution of bushmeat to the animal protein intake by people in this region, the following measures could be taken for the long-term preservation of the biodiversity of the region:

1. Wildlife management strategies should be re-adapted to take into account the demand for bushmeat. This could involve providing alternative source of bushmeat by:
   a. Wildlife farming of common and acceptable species that topped the preference list like the North African Porcupine and the Guinea fowl, with experience from other parts of Africa. Village co-operatives in the model of the coffee and cocoa co-operatives which have shown their successes in the south of the country could be formed and adapted to manage these wildlife farms.
   b. Domestication programmes could be established using the same highly acceptable species, with experience drawn from other parts of the world. This could also involve scientific domestication and distribution of the end products to farmers. There should also be advice readily accessible to farmers, through agricultural extension officers, for example. This type of project has worked very well in Nigeria where the guineafowl was domesticated, bred and distributed to farmers at a subsidised rate by the Kainji Lake Research Institute. The influx of both guinea fowl and its eggs from Northern Nigeria to Northern Cameroon is a testimony of the success of this project; numerous examples are also given in Robinson & Redford (1991).

2. Re-enforcement of anti-poaching activities as well as providing basic management tools to the National parks. These parks are the only hope for the long-term survival of most species, and if there is game farming or domestication, they will act as gene banks.

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Chapter 3

Density, Habitat Distribution and the Effect of Human Activities on the Helmeted Guineafowl (*Numida meleagris galeata* Pallas) in the Waza Region of North Cameroon

Summary

The variation of a guineafowl (*Numida meleagris galeata* Pallas) population density over a 4-year period was studied using transects. To correct for variation in detection of birds with increase in distance from the census path, an estimate of the probability of detecting birds with distance was made. This was found to follow a linearly decreasing model when the total width of the transect was less than 140 m. This probability decreased exponentially when the total width of the transect was more than 140 m. Guineafowl population density increased (between 1991 and 1993) to a maximum (215.6 km^{-2} ± 108.0) in March 1993 after which it dropped to about 70% of the 1991 value (37.6 km^{-2} ± 18.5) in March 1994 before gradually recovering in 1995. The population density varied with vegetation type, transect, year, and intensity of human activity. There was a statistically significant difference in the distribution of guineafowl among different vegetation types at low and high population density, (χ^2=3.44, t-value <0.01 for trees and χ^2=5.58, t-value <0.01 for grasses). However, habitat in which the acacia tree (*Acacia* sp.) or sorghum grass (*Sorghum laceolatum*) was dominant and open patches of bare ground were used by many birds at all population densities. The pattern of guineafowl distribution among habitats at high and low population densities suggests that this bird follows a 'despotic distribution' among habitats. There was a decrease in guineafowl population density with increase in the level of human activity in the habitat. The differences in population density among habitats with different levels of

H.L. Njiforti, submitted to *Bird Conservation International*.

human activity was statistically significant (Student's t-test value = 10.57, $p < 0.05$ at high density and 14.12, $p < 0.01$ at low density).

3.1 Introduction

Guineafowl are amongst the most widely distributed gamebirds in the African (Farkas, 1965) and are a good source of animal protein in many villages. However, the only major studies on guineafowl in Africa have been in South Africa (Crowe, 1978) and Nigeria (Ayeni, 1983; Ayorinde, 1987). No information on long term monitoring of the population dynamics or on habitat distribution in the sub-species *Numida meleagris galeata* Pallas in the wild was found in the literature.

It is commonly asserted that human activities (poaching and habitat destruction in various ways) greatly influence guineafowl populations in the wild (see Farkas, 1965; Crowe, 1978; Ayeni, 1980). However, quantitative analyses of the situation are hard to come by. Given that the human population density around the Waza National Park is not very high, (<100 inhabitants/km^2), and considering that guineafowl can benefit from agricultural waste (Skead, 1962; Grafton, 1970; Mentis, Poggenpoel & Maguire, 1975; Swank, 1976; Ayeni 1980), it can be hypothesised that the present level of human activities around the Waza National Park had no influence on the guineafowl population outside the park. It was also hypothesised that habitat type plays a major role in the distribution of the guineafowl in and around the national park. Therefore the following research questions were posed:

1. What is the population density of the guineafowl in the study area?
2. How does this population density vary with time, habitat type and human activity?

3.2 Methods

3.2.1 The study area

The study area covers about 40,000 ha and includes the Western half of the Waza National Park (Fig. 3.1). The average altitude is about 300 m, and the topography is generally flat, sloping gently towards the east. Annual maximum temperature is around 40°C and the minimum is around 18°C. The hottest month is April (average temperature 32.8°C) and the coolest is January (average temperature 26.1°C). There is a rainy season from May to October and a dry

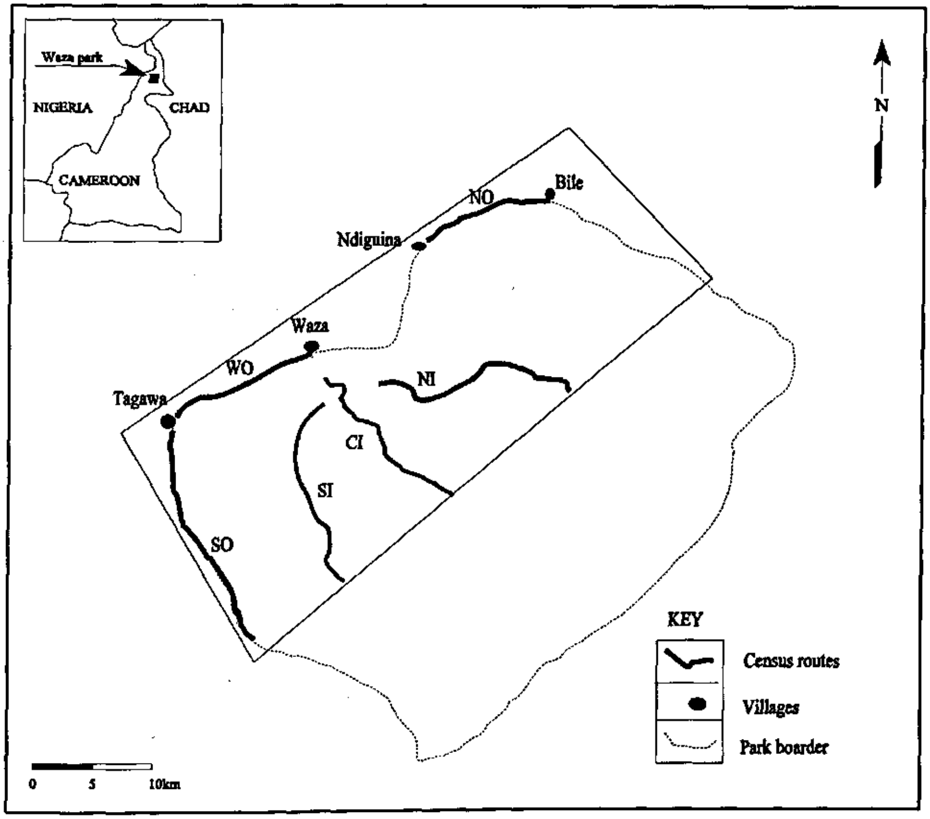


Figure 3.1
Map of the Waza National Park showing the main study area (rectangle), guineafowl census routes and villages. NO = route to the north, outside the park, WO = route to the west, outside the park, SO = route to the south, outside the park *NI* = route to the north, inside the park, CI = route passing through the centre of the park SI = route to the south, inside the park.
Each routes was later sub-divided into 2 km transects for statistical analysis.

season from November to April. Rainfall varies from 500 to 800 mm per year. The vegetation of this region has been described by Wit (1975) and Gaston (1991) as a Sudan-Sahelian grassland with two distinct vegetation types, a wooded savanna to the west and a grassland savanna to the east. There are no rivers in this study area, but some natural and artificial water holes provide water for animals for most of the year.

The most common grasses and herbs in the whole region are of the family Andropogoneae, Cyperaceae, Araceae and Malvaceae. There are eight types as shown in Figure 3.2.

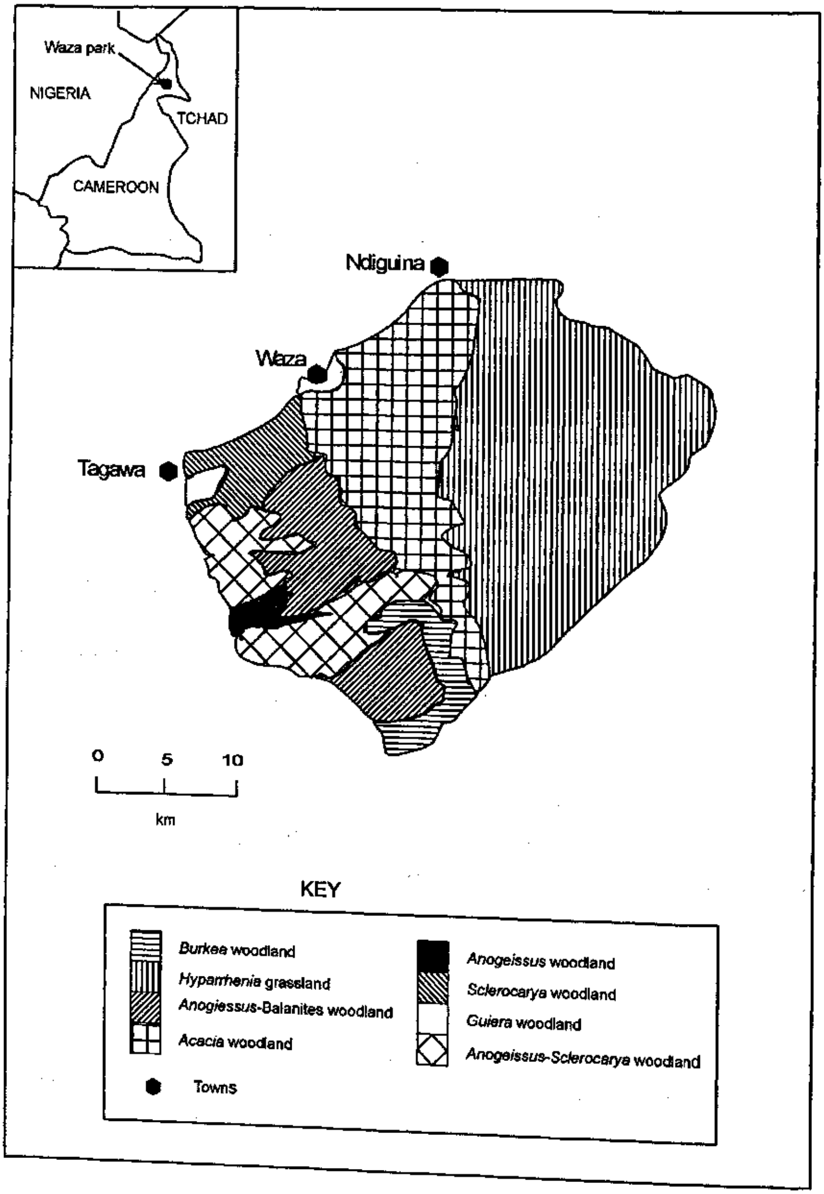


Figure 3.2
Map of the Waza National Park showing the 8 major vegetation types (adapted from Gaston 1991).

These are:

1. *Burkea* woodland, where the dominant trees are *Burkea africana, Lophira lanceolata,* and *Pericopsis laxiflora.* Grasses include *Loudetia simplex, Loudetia togoensis, Schizachyrrum sanguineum, Andropogon gayanus,* and *Hyparrhenia rufa.*
2. *Hyparrhenia* grassland, which is found mainly to the east of the park where flooding occurs for parts of the year. Trees are very rare but grasses include *Hyparrhenia rufa* and *Echinochloa stagnina.*
3. *Anogeissus-Balanites* woodland, where the major trees are *Anogeissus leiocarpus, Balanites aegyptiaca,* and *Lania humilis.* Grasses include *Echinochloa obtusiflora, Panicum leatum, Setaria* sp. and *Pennisetum ramosum*
4. *Acacia* woodland, where the dominant trees are *Acacia* spp., and *Diehrostachys glomerata.* The grasses include *Sorghum laceolatum, Pennisetum ramosum* and *Echinochloa colonum.*
5. Anogeissus woodland, where the main trees are *Anogeissus leiocarpus, Acacia* sp., *Ziziphus mauritiana,* and *Piliostigma thonningii.* The grasses include *Loudetia togoensis, Andropogon pseudapricus,* and *Panicum anabaptistum*
6. *Sclerocarya* woodland, where the dominant trees are *Sclerocarya birrea, Ziziphus mauritiana,* and *Anogeissus leiocarpus.* Grasses include *Hyparrhenia bagirmica, Eragrostis tremula* and *Zornia glochidiata.*
7. *Guiera* woodland, where trees include *Guiera senegalensis, Ziziphus mauritiana, Sclerocarya birrea,* and *Anogeissus leiocarpus,* Grasses include *Schoenefeldia gracilis, Hyparrhenia bagirmica, Eragrostis tremula,* and *Zornia glochidiata.*
8. *Anogeissus-Sclerocarya* woodland vegetation type, where the main trees are *Anogeissus leiocarpus, Sclerocarya birrea, Commiphora peduculata* and *Guiera senegalensis.* The dominant grasses are *Diheteropogon hagerupii, Hyparrhenia bagirmica, Eragrostis tremula,* and *Brachiaria xantholeuca.*

3.2.2 Bird population density and trend

Many census techniques are used for bird censuses depending on the species, aim and the ecological conditions in the survey region. Detailed discussions on various wildlife census techniques can be found in Seber (1982) or Caughley (1977) and for birds Bibby, Burgess & Hill (1992). Each census technique has its merits and demerits but assumptions common to most of these techniques include:

1. All birds exactly on the census route are counted.
2. Birds are randomly distributed.
3. Each bird is counted only once.
4. Birds are recorded before they move.
5. Distances are measured accurately.
6. Individuals are detected independently.
7. Bias from observers, season or weather is understood.

Considering these assumptions, the double band transect method that has been used extensively for bird population studies (see Järvinen & Väisänen, 1975; Bibby *et al.*, 1992), was used to estimate monthly population density of guineafowl in the dry season during 1991-1995. To correct for changes in delectability of guineafowl away from the census route, data for a population density estimate for 1991 using the modified Kings' method of Höglund, Nelsson & Stålfelt (1967) was used to find the best fit for a curve on the probability of sighting birds away from the line of march, as described in Caughley (1977). This data was re-ordered for the double band method and included in this study.

If the probability of detecting a bird at a distance x metres follows a linear model, the shape of the graph of the probability of detecting the bird with distance from the line of march will be of the form y= 1-kx, where k is an unknown constant to be estimated from census figures.

If L= transect length (km),
w = centre to inner band (km),
N = total number of birds within the two bands
N_1 = the number of birds within the inner band w,
p = proportion of birds within w or

$$\frac{N_1}{N}$$

and D= density per km^2.
It can be shown that p=kw(2-kw). Hence

$$k=\frac{1-\sqrt{1-p}}{w}$$

Counting guineafowl is easy during the dry season in the Waza region because of the contrast of its dark plumage to the dry (brown) landscape

The density per square kilometre (D) can thus be given by

$$D=\frac{Nk}{L}$$

Bird census data can also be influenced by one or more of the following: observer, census method, effort, habitat, bird species, bird density, season, weather, bird activity, and time of day (Bibby *et al.* ,1992). Preliminary observation showed that guineafowl were very mobile from around 05.30 until 11.00 and 16.00 until 18.00, spending the hot afternoons under cover. A census of this species around mid-day will thus result in an underestimation of population density. A trial census in February 1991 between 12.00 and 14.30 on one of the transects that had the highest guineafowl population density then gave a result that was only about 16% (53 birds/km^2) of the density obtained between 06.00 to 10.00 and 16.00 to 18.00 (331 birds/km^2). All censuses were thus carry out between 16.00 and 18.00.

Forty-four 2 km long transects along six census routes (Fig. 3.1) were chosen for population census during the study. A census was carried out each month between December 1992 and April 1993 and thereafter, once every two months. The census routes were distributed as follows, NO with six transects to the north and out of the park, WO with six transects to the west and out of the park, SO with eight transects to the south and out of the park, NI with eight transects inside the park to the north, CI with eight transects inside and passing through the centre of the park and SI with eight transects inside the park to the south. For the census proper, 2 observers watched from the back of a 4-wheel drive pick-up truck driven at a speed of about 20 km per hour. When birds were sighted, the driver was alerted by a knock on the roof of the truck. He slowed down while approaching the group, stopping at a distance that was far enough not to scare the birds but close enough for effective counting to be done. For each bird or group seen, the perpendicular distance from the road to the bird or birds and the group size was estimated with a range finder. If birds were disturbed before distances could be estimated; the perpendicular distance was measured from their position before the disturbance. The distance of the bird or group from the start of the route (used for subdivision into 2 km long transects) was read from the car's odometer.

3.2.3 Habitat type and bird density

Habitat parameter data were collected during a separate drive on each census route. The vehicle was stopped after every 400 m on the car odometer and the following information was collected on both sides of the route:

- dominant plant species.
- external ground cover for trees and grasses (% of a 10 by 100 metre quadrant covered by tree canopy or grasses) and internal ground cover (% of a 10 by 100 metre quadrant shaded by tree canopy or grasses).
- average height of grasses.
- number of trees that could be used for roosting.
- number of sites that could serve as resting place during the hot afternoons.
- soil type.
- proximity to a source of drinking water.

A multiple regression analysis with forward inclusion and backward elimination was used to investigate the role these habitat parameters play in the distribution of guineafowl in the study area. Cross-tabulation and paired samples t-tests were used to investigate the differences in distribution of guineafowl amongst habitat at low and high population density.

3.2.4 *Effect of human pressure (edge effect)*

It was hypothesised that human settlement and activity around the National Park had no influence on the guineafowl populations densities. The following data were collected and analysed to verify this. The transects were grouped into three. Group 1 had eight (2 km) transects with intense human activity (burning, grazing, wood cutting and farming) along the transects. Group 2 had 12 transects with moderate human activity (like group 1 but no farming). Group 3 was made up of 24 transects all located inside the Park where human activities were mainly limited to tourism and park management. The differences among these three groups were computed using Kruskal-Wallis one way ANOVA. All results are given ± 95% confidence limits (95% CL.).

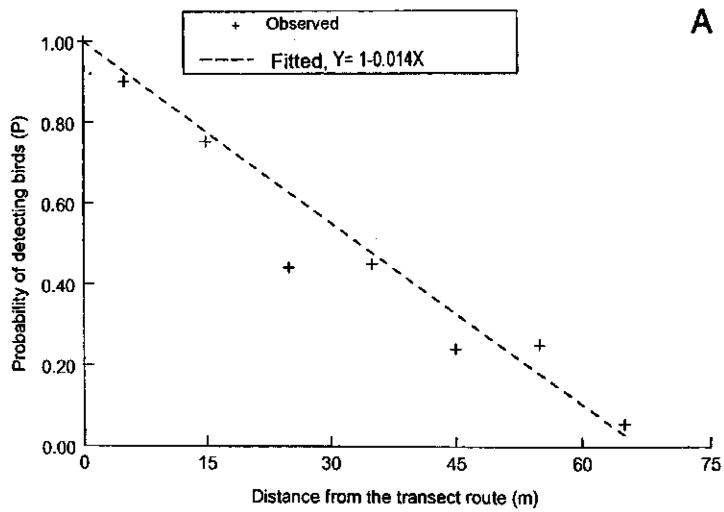
3.3 Results

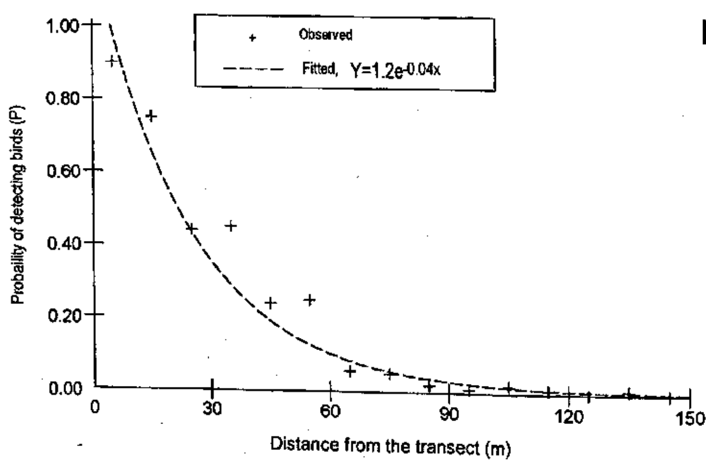
3.3.1 *Probability of sighting birds during census*

The probability of detecting guineafowl followed a linear decreasing model with transect width less than 140m or 70m on each side of the census path ($Y = 1-0.014X$, $R = 0.98$; Figure 3.3a). However, when the width of the transect was more than 140m the delectability decreased exponentially ($Y = 1.21e^{-0.04X}$, $R = 0.97$; Figure 3.3b). However, for the exponential model, the probability of detecting birds at close range was greater than one. The linear model was thus chosen for this study.

3.3.2 *Density and density variations*

In February 1991, the average population density (± 95% c.l.) for the study area was 130.0 ± 90.8 birds/km^2. It increased to a maximum of 215.6 ± 108.0 birds/km^2 in March 1993, then dropped to a low of 37.6 ± 18.5 birds/km^2 in March 1994 and started to increase again in 1995 (Table 3.1). From these density figures it can be estimated that there were 15,040 ± 7,400 birds in the study area at low density and 86,240 ± 43,200 birds at high density. Within transects, there was also a variation in density, with the highest monthly densities during the study being generally recorded on transects located inside the Park.





Figures 3.3a and 3.3b
Changes in the probability of detecting guineafowls with distance from the census route, 3a, when the census band width is ≤140 meters and 3b when it is >140 meters.

Table 3.1
Average guineafowl population density on six census routes, showing the variations of population density among routes, month and year

Route*	Guineafowl population density (birds/km²)													
	Febr. 1991	Oct. 1992	Dec. 1992	Jan. 1993	Febr. 1993	March 1993	April 1993	Jan. 1994	March 1994	Dec. 1994	Febr. 1995	April 1995	Dec. 1995	Average
NO	5.83	6.29	2.63	40.00	33.24	32.86	24.17	28.57	13.57	44.72	29.31	22.12	12.30	22,74
WO	117.33	196.00	302.22	150.42	230.88	282.50	258.47	20.83	21.67	24.10	25.20	23.33	73.40	132.80
SO	142.15	148.71	165.80	110.08	88.33	105.14	24.72	14.05	26.63	20.30	16.90	16.21	45.10	71.09
NI	10.41	12.86	5.04	118.00	163.13	248.00	135.99	45.83	15.12	61.40	52.55	41.33	47.31	73.61
CI	159.22	156.90	84.29	186.77	374.41	453.02	95.32	133.54	53.88	129.60	133.20	105.47	126.82	168.65
SI	345.22	322.77	459.23	218.83	75.13	172.37	116.91	91.71	69.52	114.70	109.70	103.22	155.80	181.16
Mean	130.03	140.59	169.87	137.35	160.85	215.64	109.26	55.76	37.56	65.80	61.14	51.95	76.79	108.66
95% conficence	90.76	87.01	132.20	46.12	92.05	108.02	63.36	34.48	18.52	33.84	35.61	30.28	39.73	62.46

* Each route was sub-divided into 2 km long transects. NO = route to the north, outside the park, WO = route to the west, outside the park. SO = route to the south, outside the park, NI = route to the north, inside the park, CI = route passing through the centre of the park and SI = route to the south, inside the park.

Table 3.2
Variations in the distribution of guineafowl among habitat at high and low population density and the dominant plant in the habitat.

	% of birds in habitat	
Dominant tree species*	Low density (1994)	High density (1993)
Acacia sp.	58.2	52.5
Anogeissus leiocarpus	4.2	6.0
Balanites aegyptiaca	2.1	4.0
Combretum sp.	15.7	10.0
Guiera senegalensis	4.4	12.5
Lannea humilis	1.6	2.5
Sclerocarya birrea	2.6	5.0
Others	4.2	3.3
No trees	7.0	4.2
Dominant grass species*		
Andropogon sp.	2.6	5.0
Diheteropogon hagerupii	13.2	17.5
Echinochloa sp.	6.8	5.5
Hygrophilia sp.	3.0	12.5
Pennisetum sp.	1.8	4.5
Schoenefeldia gracilis	2.6	2.5
Sorghum sp.	40.0	23.0
Others	2.4	4.2
Bare ground	27.6	25.3

* Dominant trees were estimated as the most numerous trees and dominant grass as the species with the highest ground cover on 1 10 by 10 quadrate spaced 400 metres apart along the census transect.

3.3.3 *Habitat distribution*

Apart from the dominant plant species in the habitat and human activity, no habitat parameters chosen for investigation or any combination of them seems to have any significant influence on guineafowl habitat distribution (all R2 < 0.2, multiple ANOVA). There was a significant difference in guineafowl habitat distribution at low and high density, (paired samples t-test, $\chi^2 = 3.44$, t-value < 0.01, df=8 for dominant tree species and $\chi^2 = 5.58$, t-value < 0.01, df=8 for dominant grass species). The result of the cross-tabulation of guineafowl population density on dominant plant species in the habitat is shown in Table 3.2. *Acacia* trees played an important role in the guineafowl habitat distribution both at low and high guineafowl density. Up to 58.2% of the birds were found in acacia dominant habitat at low density, and 53.0% were also found there at high density. Grasses also influenced guineafowl distribution; *Sorghum* sp. was used by 40.0% of the birds at low guineafowl density and by 23.0% of them at high density. Habitat where *Hygrophilia* sp. was dominant became a relatively important habitat for the birds at high density, with 12.5% of them using it as compared to only 3.0% at low density. At both low and high densities, a high percentage of the birds were found on bare ground (27.6% at low density and 25.3% at high density).

3.3.4 *Human pressure*

There was a marked difference in guineafowl population density amongst the three groups of transects at both low and high population density levels. At both population density levels, the transects in group 1 (with intense human activity) had the lowest densities, followed by those in group 2 (moderate human activity) and group 1 (human activity mainly tourism),had the highest densities throughout (Table 3.3). The differences in population density among the three groups was statistically significant (χ^2 = 10.57, $p < 0.05$ at high density and 14.12, $p < 0.01$ at low density).

Table 3.3 Differences in guineafowl population density among three transects with different level of human activities

*Transect group**	Low population density leven	
	guineafowl density	95% confidence limits
1	14.4 ± 7.21	38.6 ± 22.31
2	36.1 ± 12.30	227.0 ± 49.51
3	61.2 ± 10.41	339.3 ± 164.44

* Group 1 were transects with intense human activity (farming, grazing, wood cutting), group 2 were transects with moderate human activity, same as group 1 but no farming. Group 3 were transects located inside the National Park where human activity was limited to tourism.

3.4 Discussion

The probability of detecting birds away from the census route can take one of the following general shapes: linear (as in this study), exponential, or half normal (Bibby *et al.*, 1992). In all cases, it is assumed that all birds directly on the transect line are always detected (probability = 1). It has been shown that in practice, the linear and exponential models can give very similar results (Bibby *et al.*, 1992). It is however necessary to correct for bias due to variation in delectability during bird census. None of the transects in this study had a total width of more than 120 m which made the calculations based on a linear model valid. The linear model will not be valid when the width of the transect band width is more than 140m; it would be better to use the exponential model in that case.

The high percentage of guineafowl observed on bare ground might be because it would be easier for them to feed on fallen seeds and crawling insects in such habitat. Most seeds (especially those of annuals) in the study area ripen by the end of the rainy season and fall off during the early dry season. It is equally easier for the birds to see approaching predators in open habitat than in habitat with dense vegetation cover. The possibilities that more birds were missed in tall grasses than in open habitat are low because of the open nature of the habitat in the study area during the dry season, the high contrast in colour between the bird (dark grey with white spots) and the colour of the dry season vegetation (brown) and the gregarious nature of the species.

Recent studies (King & Savidge, 1995; Knick & Rotenberry, 1995) have also demonstrated the importance of local vegetation cover and structure on bird population density. Apparently habitat with dominance of *Acacia* trees and *sorghum* grass plays an important role in the distribution of the guineafowl in the study area both at high and low population density levels. The possibility is that since in the Waza region *Acacia* and *Sorghum* generally grow only on soil that is partially flooded during the rainy season, such habitat will still have more nutritious food during the dry season when the other habitat types have become dry and poor. The importance of the acacia dominated habitat to the guineafowl still needs further investigation, since the bird has never been reported to feed on any part of this tree. The shift in the habitat distribution of guineafowl with changes in population density observed here may be an indication that some habitats in the study area have different (so called) 'zero-density suitability' for the guineafowl.

The differences in the level of occupation of habitat with density observed in this study also seem to suggest that the guineafowl in this region follow the despotic distribution (first described by Fretwell & Lucas, 1970) in their habitat selection. This means that at low density, only good habitats are occupied but, as density increases poorer habitats will be occupied. This is an important implication for the management of this bird. This is because, in a despotic distribution, individuals in good habitat patches contribute a disproportionately large amount to the total population's fecundity (Bernstein, Kreb & Kacelnik, 1991). The implication here will be that a loss of good habitat will have a very drastic effect on the population growth. It would then be possible that the low population density observed on transects with high human activity might be due more to habitat destruction (from burning, grazing, wood cutting and farming) than to poaching. However, additional data may still be needed to completely understand the habitat preferences of the helmeted guineafowl in the Waza region. This is because what may appear to be an important habitat component in a few year's study may not even be a significant component again in a long-term study (Ohmart & Anderson, 1986).

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Chapter 4

Diet of the Helmeted Guineafowl (*Numida meleagris galeata* Pallas) in the Waza Region of North Cameroon

Summary

Through laboratory and field experiments, we investigated the effect of food availability and food nutritive value on food selection by helmeted guineafowl (*Numida meleagris galeata* Pallas) during the dry season in the Waza region of North Cameroon. Field study and crop analysis shows that a wide variety of food types are eaten by guineafowl during the dry season. Analysis of 101 crops from wild birds reveals a statistically significant positive correlation between the sodium and water content of food items and the quantity found in the crops. Rhizomes of *Stylochiton lancifolius* and termites form the bulk of the diet of this species during the dry season. It is concluded that the selection of water-rich food may be an adaptation to the dry environment.

4.1 Introduction

The helmeted guineafowl (*Numida meleagris galeata* Pallas, 1767) is a characteristic species of the Waza region of North Cameroon in general and the Waza National Park in particular. However, their populations drastically decreased from 1990 to 1995 (Chapter 3). Factors which were responsible for this decline included natural causes (mostly climatic changes) and human interference (mainly habitat destruction and poaching).

Poaching occurs mostly during the dry season, when both food and water for wildlife are scarce, and the situation is even worse in drought years. In the present context, it is important to know how guineafowl survive this critical period. One possibility is that during the dry season, guineafowl are less

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selective in their feeding with respect to nutrient content, but more selective with respect to water content. This study was aimed at finding out which food is eaten by this bird during the critical dry period.

Guineafowl can vary their diet with season and location (Skead, 1962: Ayeni, 1980, 1983). Studies of the food of *N.m. meleagris* and *N.m. coronata* in both natural and agricultural land include those of Chapin (1932) in Congo, Skead (1962), Grafton (1970), Mentis, Poggenpoel & Maguire (1975) in South Africa, Benson (1963), Angus and Wilson (1964) in former Rhodesia and Swank (1977) in Kenya. To our knowledge, the only study on the diet of the subspecies *N.m. galeata* is that of Ayeni (1980) in the Kainji Lake area of Nigeria.

The following questions were asked:
1. What types of food do guineafowl select during the dry season?
2. Will crop contents analysis alone suffice to determine what birds eat or are field observations and a correction factor necessary to complement this?
3. What are the mineral, nutrient and water content of the guineafowls' diet during the dry season? Will this influence the choice of food by the bird?

4.2 Methods

4.2.1 The study area

The study area covers about 10,000 hectares, mainly the south-western part of the Waza National Park (Fig. 4.1). The average altitude is about 300 metres, and the topography is generally flat, sloping gently towards the East. Annual maximum temperature is around 40°C and the minimum is around 18°C. The hottest month is April (average temperature 32.8°C) and the coldest is January (average temperature 26.1°C). There are two main seasons, a rainy season from May to October and a dry season from November to April. Rainfall varies from 500 to 800 mm per year. The vegetation of whole Waza region has been described by Wit (1975) and Gaston (1991) as a Sudan-Sahelian grassland with two distinct vegetation types, a wooded savannah to the West and a grassland savannah to the East. There are no rivers in this study area, but some natural and artificial water-holes provide water for animals for most of the year.

The most common graminoids and forbs in the region as a whole belong to the Cyperaceae, Araceae and Malvaceae families. The vegetation of the whole region was divided into 8 main vegetation formations by Gaston (1991) (Fig. 4.1). The 6 vegetation formations covering a major portion of the main study area are shown in the rectangle in Fig. 4.1.

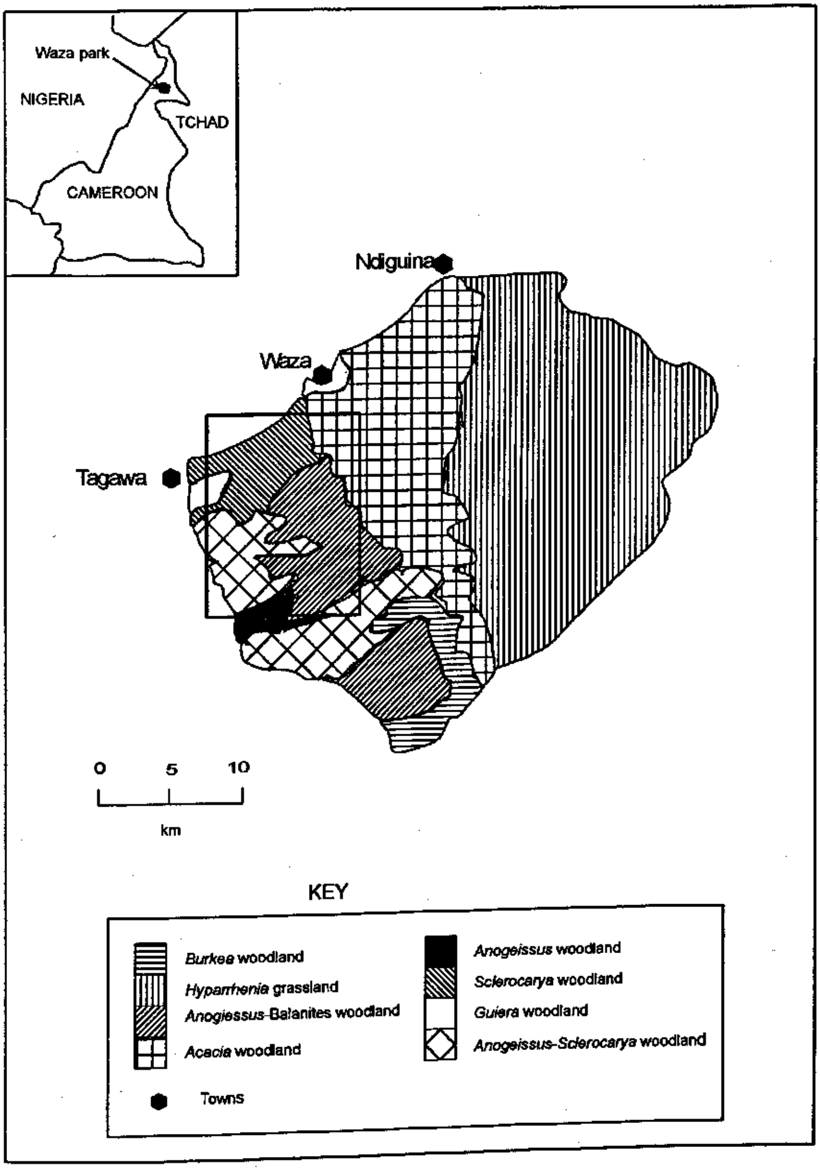

Figure 4.1
Vegetation map of the Waza national park. The main study area where the guineafowl diet was studied falls inside the rectangle (adapted from Gaston, 1991).

4.2.2 *Crop contents*

To find out what guineafowl eat during the dry season seventy-three guineafowl were collected from licensed hunters in the South of Waza National Park for crop content analysis. All the shooting took place between the months of February and March 1994. Shooting was usually carried out in the evening (from 2 to 3 hours before sunset and dusk). Dead birds were sexed by examining the cloaca, given a number tag, put in a plastic bag and stored in a big cooler to inhibit decomposition. After each shooting session, the birds were weighed on an electronic balance of precision ± 0.2 g, dissected, and the crops were removed, weighed, and stored in 65% alcohol for later analysis.

Additional data were collected from 28 crops of guineafowl taken from poachers in 1993. The crop contents were sorted into different order of insects, species of plants (leaves grains and roots), pebbles and unidentified items under a microscope at 10X magnification. Unidentified seeds were germinated in trays containing sterile soil. A Spearman rank correlation test was used to describe the relationship between the number of pebbles in crop and the full crop weight.

4.2.3 *Food correction-factor*

The feeding habit of birds can be investigated by crop contents analysis. However, because of differences in digestibility, the crop contents may not give a true picture of what was consumed. It might thus be necessary to use a correction-factor to make up for the differences. If a bird that consumed a certain quantity (*A*) of a food items is killed after a given time period, an unknown quantity of food (α) would have been digested. If quantity of food that is found in the crop = *a* then the quantity of food consumed (*A*) may be calculated from the following formula:

$$A = a + \alpha \tag{4.1}$$

or,

$$\frac{A}{a} = 1 + \frac{\alpha}{a} \tag{4.2}$$

where A/α is the correction-factor for a food item. If the birds are of different age groups resulting in different correction-factors, the average correction can be calculated by taking the harmonic means for the different age groups, since correction-factors are ratios (equation 4.2).

To find out if this food correction-factor is necessary for guineafowl, 15 semi-wild guineafowl (8 adults and 7 sub-adults) were kept in two cages (one for adults and one for sub-adults), and fed with meals composed of seeds, rhizomes, leaves and insects found in the diet analysis. Each food item was separately weighed on an electronic balance of precision ± 0.2 g; they were then mixed and given to the birds three times a day (morning, afternoon and evening) for a seven day habituation period. At the end of the seventh day, the cage was thoroughly cleaned. On the eighth day, the same feed composition was given at 6.00 and the birds allowed to feed until 10.00 after which all food was removed from the cage sorted into identical food type, counted and weighed. At 18.00 the birds were dissected and the crops removed and weighed. The crop contents was separated into the different food items which were counted and weighed. The amount of each food item eaten was calculated by subtracting the weight given from what remained. The correction-factor for each food item was calculated using equation 2.

4.2.4 Food selection from field observation

Birds were observed while feeding in all six vegetation types to verify whether analysis of crop contents provided a good estimate of the guineafowls' diet,. Observations were carried out for 2 hours a day (from 15.00 to 16.00), 4 times a week for 12 dry season weeks. When a group was encountered, feeding birds were identified by scanning through the group. Food type taken were either identified in the field or collected for identification.

4.2.5 Influence of mineral and water content on food selection

The crop contents were weighed, oven dried at 50 to 60°C until constant weight and the dry weight recorded. Percentage of water content was calculated from the difference of dry and fresh weight of the crop contents. The water content of some food items that were only found in small amount in the crops and those seen to be fed on in the field but not found in the crops were estimated from samples collected in the field. Samples of plant food identified were also collected from the field and sent with those from the crops to the Biochemical Laboratory of the University of Wageningen for mineral and nutrient content analysis. A Spearman rank correlation test was used to evaluate the relationship between the water content of food items and the quantity found in the crops. The relationship between the mineral and nutrient contents of each food item and the quantity consumed by birds was also tested using correlation statistics.

4.3 Results

4.3.1 Crop contents

The average weight of crop contents ± 95% confidence limit was 25.6 ± 2.0 g, while that of empty crops was 6.8 ± 0.06 g. Water occupied an average of 56.5 ± 3.5% of the fresh weight of crop contents. Plant seeds and roots formed 64.8 ± 6.3% of the dry weight of the crop contents, insects 26.0 ± 3.3%, pebbles 0.1 ± 0.6% and unidentified crumbs 9.1 ± 2.4%. Seeds were found in all the 101 crops (100%), while insects were found in 60 (58.9%) of the crops. Pebbles were found only in 6 crops (5.9%).

Rhizomes of *Stylochiton lancifolius* occurred in 99.0% of the crops with a relative dry weight (weight expressed as a percentage of the weight of all food in the crops) of 23.0% for all the 101 crops (Table 4.1). It was closely followed by seeds of *Hibiscus asper* with 63.4% frequency and 21.8% relative dry weight, *Vegna* sp. and *Monecma ciliata* with frequencies of 53.5 and 44.6% and relative dry weights of 2.2 and 4.1%. Frequencies of the other plant items ranged from 1% for *Cassia obtucifolia* and *Cuccumulus* sp. to 39.6% for *Cyperus* sp. Some of the plant food with high percentage frequency of occurrence in crops had low relative dry weight. For example, seeds of *Vigna* sp. with a relative frequency of 53.5% had a relative dry weight of only 2.2%. Leaves were only found in a few crops, and when found, were usually difficult to identify because they were generally in fragments.

Numerically, the order Isoptera was the most important insect order, with 5725 in 40 crops. It was closely followed Hymenoptera (23 crops) and Heteroptera (28 crops) with totals of 483 and 397 insects respectively. The orders Coleoptera (15 crops) and Orthoptera (2 crops) only had 68 and 3 insects respectively.

Pebbles were only found in 6 crops and there was a very significant positive correlation between the number of pebbles in the crop and the weight of the full crop ($p<0.05$).

4.3.2 Food correction-factor

Apart from seeds, the correction-factors for sub-adult birds were different from those of adults for most of the food items (Table 4.2). Adult birds digested insects faster than sub-adults. The overall correction-factors were 1.2 ± 0.14 for seeds, 39.08 ± 10.68 for leaves, 1.17 ± 5.07 for rhizomes and 1.41 ± 10.63 for insects.

Table 4.1
Food items and their relative dry weights from the analysis of 101 wild helmeted guineafowl crops

Food	Number observed in 101 crops	Frequency (%)	Dry weight for all crops (g)	% (corrected) of total dry weight
Plants				
Gramineae *Brachiaria* sp.	16	15.8	403.0	3.7
Loudetia togoensis (Pig.) C.E. Hubb.	6	5.9	45.6	0.4
Sorghum arundinaceum (Desv.) Stapf.	38	37.6	1664.4	15.2
Oryza barthii A. Chev.	29	28.7	698.9	6.4
Combretaceae *Anogeissus leiocarpus* Guill. & Perr.	4	4.0	10.8	0.1
Anonaceae *Anona senegalensis* Pers.	6	5.9	39.6	0.4
Cesalpiniaceae *Cassia obtucifolia* L.	1	1.0	0.3	<0.1
Fabaceae *Commelina forskalaei* Vahl.	38	37.6	604.2	5.5
Vigna sp.	54	53.5	237.6	2.2
Cucurbitaceae *Cucumulus* sp.	1	1.0	0.3	<0.1
Malvaceae *Hibiscus asper* Hook	64	63.4	2380.8	21.8
Acanthaceae *Hygrophila africana* T. Anders	2	2.0	6.2	0.1
Monecma ciliata (Jacq.) Milne-Redhead	45	44.6	445.5	4.1
Onagraceae *Ludwigia leptocarpa* (Nutt.) Hara	18	17.8	174.6	1.6
Anacardiaceae *Sclerocaria birrea* (A. Rich.) Hochst.	4	4.0	6.4	0.1
Bignonaceae *Stereospermum kunthianum* Cham.	8	7.9	8.8	0.1
Nyctaginaceae *Boehaavia erecta* L.	4	4.0	36.4	0.3
Rhamnaceae *Ziziphus* sp.	3	3.0	1.5	<0.1
Bulbs and roots				
Cyperaceae *Cyperus esculentus* Linn.	30	29.7	936.0	8.6
Cyperus sp	40	39.6	664.0	6.1
Araceae *Stylochiton lancifolius* Lepr.	100	99.0	2520.0	23.0
Insects				
Coleoptera	16	15.8	1.0	1.8*
Heteroptera	31	30.7	7.1	13.0*
Hymenoptera	27	26.7	13.2	24.5*
Isoptera	40	39.6	31.6	57.8*
Orthoptera	2	2.0	1.6	2.9*
Pebbles	6	5.9	1.8	8.2*

* Percentage relative to total dry weight of insects only.

Table 4.2
Correction factors for seeds, plant leaves and insects calculated from the analysis of the crops of semi-wild helmeted guineafowl crops

Food item	% dry weight eaten		% (dry weight) found in crops		correction factor		overall correction factor (harmonic mean) ± 95% conficence limits
	sub-adults	adults	sub-adults	adults	sub-adults	adults	
Seeds	86.83	78.1	98.27	99.07	1.13	1.27	1.2 ± 0.14
Leaves	11.00	18.11	0.32	0.40	34.38	45.28	39.08 ± 10.68
Rhizomes	1.28	0.13	0.22	0.20	5.82	0.65	1.17 ± 5.07
Insects	0.89	3.65	1.19	0.33	0.75	11.60	1.41 ± 10.63

4.3.3 Food selection from field observation

All insect orders found in the crop analysis were also observed to have been fed on in the field. Ten plant seeds found in the crop analysis were not seen to be eaten in the field while 1 rhizome and 1 leave eaten in the field were not found in the crop analysis. Table 4.3 shows the differences in guineafowl diet from field observations and crop content analysis.

Birds were observed to feed on the rhizomes of *Stylochiton lancifolius* and *Cyperus* spp. as often as they found them. Birds were digging actively for these rhizomes as deep as 50 cm, especially in the southern sandy part of the park. Rhizomes of Cyperaceae and wild onions (*Albuca nigritana*) were frequently eaten in areas where there was no surface water. Leaves and flowers of *Leptadenia hastata* were also consumed in all areas. Analysis showed that leaves of *L. hastata* contained 78.7 ± 3.2% water, *A. nigritana* 92.2 ± 4.1%, and *S. lancifolius* 86.1 ± 6.3% water, whiles different species of *Cyperus* had water content ranging from 68.2 to 89.6%.

4.3.4 Influence of mineral and water content on food selection

A very high water content (up to 92.20% for *A. nigritana*) was found in some selected food items. There was a significant correlation between the water content of selected food items and their percentage occurrence in the crops ($r = 0.82$, $df = 25$, $P < 0.05$). Sodium was found to be the only mineral with a significant influence on food choice ($r = 0.78$, $df = 7$, $P < 0.05$). Other minerals like nitrogen, phosphorus calcium, magnesium, and nutrients like starch and fat had no significant influence on choice. Table 4.4 shows the mineral content of the most common plants eaten by guineafowl.

Table 4.3
Differences in guineafowl diet from field observations and crop content analysis

Food	Found in crop*	Consumed in the field*
Plants		
Gramineae *Brachiaria* sp.	Y	Y
Loudetia togoensis (Pig.) C.E. Hubb.	Y	Y
Sorghum arundinaceum (Desv.) Stapf.	Y	Y
Oryza barthii A. Chev.	Y	Y
Combretaceae *Anogeissus leiocarpus* Guill. & Perr.	Y	N
Anonaceae *Anona senegalensis* Pers.	Y	N
Cesalpiniaceae *Cassia obtucifolia* L.	Y	N
Fabaceae *Commelina forskalaei* Vahl.	Y	Y
Vigna sp.	Y	Y
Cucurbitaceae *Cucumulus* sp.	Y	N
Malvaceae *Hibiscus asper* Hook	Y	Y
Acanthaceae *Hygrophila africana* T. Anders	Y	Y
Monecma ciliata (Jacq.) Milne-Redhead	Y	N
Onagraceae *Ludwigia leptocarpa* (Nutt.) Hara	Y	N
Anacardiaceae *Sclerocaria birrea* (A. Rich.) Hochst.	Y	N
Bignonaceae *Stereospermum kunthianum* Cham.	Y	N
Nyctaginaceae *Boehaavia erecta* L.	Y	N
Rhamnaceae *Ziziphus* sp.	Y	N
Bulbs and roots		
Cyperaceae *Cyperus esculentus* Linn.	Y	Y
Cyperus sp	Y	Y
Araceae *Stylochiton lancifolius* Lepr.	Y	Y
Albuca nigritana	N	Y
Asclepiadaceae *Leptadenia hastata*	N	Y
Insects		
Coleoptera	Y	Y
Heteroptera	Y	Y
Hymenoptera	Y	Y
Isoptera	Y	Y
Orthoptera	Y	Y

* Y = yes, N = no.

Table 4.4 Weights per kilogram of food item for some nutrient and the percentage of some mineral found in the principal food of wild helmeted guineafowl

mineral content / guineafowl food	Nitrogen (%)	Phosph. (%)	Sodium (%)	Potas. (%)	Calcium (%)	Magn. (%)	Starch (g/kg)	Fat (g/kg)
Poacea	1.93	0.22	0.05	0.31	0	0.11	-	-
Oryza longistaminata	1.67	0.33	0.09	0.39	0.07	0.14	551.60	19.50
Cyperus sp.	1.09	0.19	0.14	0.50	0.10	0.12	112.90	218.90
Sclerocaria birrea	0.44	0.14	0.21	1.02	0.02	0.08	-	-
Brachiaria sp.	1.58	0.31	0.13	0.5	0.03	0.14	-	-
Hibiscus asper	4.16	0.82	0.07	1.28	0.27	0.40	10.30	152.50
Cyperus esculentus	0.84	0.22	0.07	0.64	0.02	0.11	269.60	230.40
Commelina forskalaei	2.26	0.22	0.30	0.81	0.72	0.20	528.00	7.30
Albuca nigritana	2.49	0.08	0.56	1.36	1.02	0.22	-	-
Liliacea	1.62	0.16	0.27	1.74	0.85	0.19	364.15	5.70
Garamineae	1.67	0.41	0.09	0.47	0.02	0.02	419.90	41.10
Echinochloa stagnina	3.12	0.46	0.45	1.97	0.57	0.38	93.60	22.10
Datyloctenium aegyptium	1.42	0.36	0.07	0.31	0.64	0.18	482.00	19.30
Cassia obtusifolia	3.90	0.76	0.00	1.37	0.74	0.35	1.50	69.50
Stylochiton lancifolius	1.53	0.18	0.50	1.50	0.47	0.18	287.80	16.20

4.4 Discussion

Food supply to the guineafowl in the Waza National Park is lowest during the dry season (Njiforti, unpublished data). This is due to a number of factors which include; the annual burning that takes place between the months of December and February, the drying out of most plants and the decrease in insect number. Late burning may be the most important cause of this decrease in food supply not only to guineafowl but also to most of the animals in the park. Early burning may, however, be useful to this bird, since its moderately hot flames will only burn part of the vegetation, and expose seeds lying on the ground. Bodenkamp and Edelaar (1993) found no significant difference in seed abundance between early burned and unburned areas in the Waza Park. Early burning will thus increase food availability to the birds. Ayeni (1983) had recommended patchy burning as a management tool for the guineafowl habitat.

The guineafowl is an omnivorous bird, feeding on seeds and insects

During the dry season, the helmeted guineafowl feeds mostly in the early mornings and late afternoons because of the high temperatures (Njiforti, unpublished data) leading to a decrease in food intake by some birds. Skead (1962) reported that 9 out of 44 birds shot at sunset for crop contents analysis had empty crops. This might have been due rather to the birds feeding early in the morning on highly digestible food and being shot before they fed in the afternoon, than to birds not having fed at all. No empty crops were found in the present study. However, the smallest crop contents weighed only 2 g. Ayeni (1983) had noted a correlation between the ingestion of hard and bulky plant material by guineafowl and the intake of pebbles, which was confirmed by this study.

Out of the 25 plant species cited by Ayeni (1983) as food of the helmeted guineafowl (*N.m. galeata*) from crop contents analysis, 20 were present in our study area in varying abundance, but only 4 were found in the diet (either from crop analysis or direct observation). Ayeni (1983) found a slightly lower percentage dry weight for insects eaten by this bird, 21.6 ± 5.1% as compared to 26.0 ± 3.3% (corrected) for this study. However, he found more insect orders than were found in this study. The fact that most of the plant species he found to be consumed by the helmeted guineafowl in his study area were also present in ours but not found in the crops, might be due to differences in habitat composition between our study area and his. These differences could not be verified from his paper. It may also be possible that factors other than the presence of a food item in an area determine whether guineafowl will feed on it or not.

The differences in digestibility between food items may mean that crop contents analysis data should be corrected before interpretation. The high 95% confidence limits for the overall correction factors for insects and rhizomes suggest that it might be necessary to correct these food items separately for adults and sub-adults. The correction-factor for leaves was higher than those for both insects, rhizomes and seeds, suggesting leaves are easier to digest. This may explain why very few leaves could be found in the analysed crops. Fresh leaves may also provide birds in very dry habitat with water, which may be one of the reasons why guineafowl can live in very dry habitat.

Some species that were observed to be eaten voraciously (for example *L. hastata*) were only found in traces in the crop analysis. This could be either due to a high digestibility, or their being in crumbs by the time they reach the crop, making identification difficult. This means that one should not interpret data on the feeding habit of this bird from crop contents analysis alone or it should be done with great caution.

Studies of *N.m. coronata* and *N.m. meleagris* showed that agricultural waste and farmland weed as well as insects make up the bulk of their food (Skead, 1962; Grafton, 1970; Mentis *et al.*, 1975; Swank, 1977). Rhizomes of Cyperaceae seems to be a favourite food of most guineafowl species, especially in the dry season. Rhizomes of Cyperaceae were found to be important food in all the studies of *N.m. coronata* and *N.m. meleagris* by the above mentioned authors, and in *N.m. galeata* by Ayeni (1980, 1983) and this study. Rhizomes of *Stylochiton lancifolius* are, however, the most important dry season food of *N.m. galeata* in the Waza region.

We do not at the moment have any biological explanation for the choice of sodium-rich food by this bird. However the high water content of most selected food items and the highly significant correlation of the water content of food and the number of birds eating it confirms our hypothesis that the birds feed on water-rich food during the dry season. This may explain why the guineafowl can exist in regions devoid of any surface water (Njiforti, unpublished data), and its wide distribution in Sub-Sahara Africa (Crowe, 1978).

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Chapter 5

The Breeding Performance of Wild Helmeted Guineafowl *(Numida meleagris galeata* Pallas) in the Waza National Park, North Cameroon

Summary

The breeding success of wild helmeted guineafowl (*Numida meleagris galeata* Pallas, 1767) was investigated for three consecutive years, from 1992 to 1994. The results show that egg laying starts in August. The breeding season usually lasted for about two months. Average clutch size for successful nests over 3 years was between 11.6 and 13.1 eggs per clutch. Nest abandonment, predation, trampling by elephants and flood were found to be the main causes of nest loss. The intensity of these factors varied with breeding stage and year. However, re-nesting compensated for most of the lost nests if the losses took place during the laying or early incubation stage. The age of the breeding hens also influence breeding success with older birds being more successful than first-time breeders. Nest survival was found to vary with breeding stage and rainfall, being highest (for all stages) in the year with the highest annual rainfall (1994) and lowest in the year with the lowest annual rainfall (1993). The overall breeding success ± 95% confidence limit was 29.0 ± 0.03% in 1992, 15.6 ± 0.03% in 1993 and 40.2 ± 0.03% in 1994. The breeding season each year started about a month after insect number had reach its annual peak.

5.1 Introduction

Information about density, mortality and recruitment as well as on immigration and emigration is needed for the description of the population dynamics of a group of individuals (Lack, 1954; Von Haartman, 1971; Ricklefs, 1973; Eberhardt, 1985; Clobert & Lebreton, 1991). The biological significance of

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these demographic parameters is determined by species studied, the population studied and the methodology used (Clobert & Lebreton, 1991).

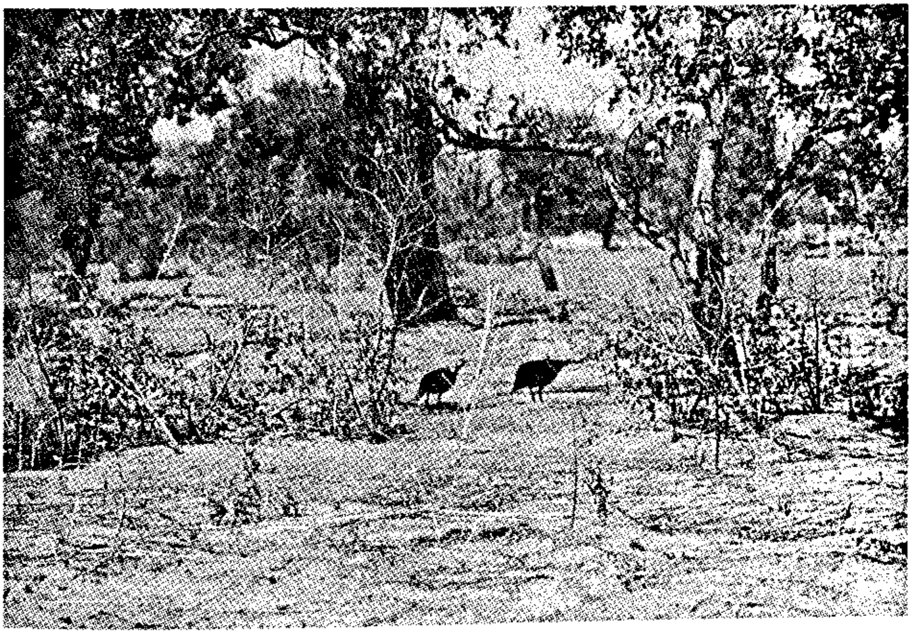
The helmeted guineafowl (*Numida meleagris galeata* Pallas, 1767) is a characteristic member of the African savanna avifauna (Chapin, 1932; Crowe, 1978). Its wide distribution is partly due to the adaptation of this bird to varying ecological conditions. These include both physiological and morphological adaptations (Crowe, 1978). In nature, the species breeds only once a year throughout its geographical distribution. Another important biological characteristic of the guineafowl is its high egg production: 15 to 20 eggs per clutch in the wild (Ayeni, 1980) and 40 to 100 eggs produced per female per year in improved stocks (MacCarthy, 1974, Chrappa *et al.*, 1978).

In birds, the breeding of females and the subsequent growth of young seem to depend on the acquisition of high-protein food (Davis, 1943; Jones & Ward, 1976; Woodall, 1994). Climatic factors are also known to influence breeding success in birds (Liversidge, 1966, 1970; Syroechkovskiy *et al.*, 1991; Telleria & Diaz, 1995). It has been suggested that rainfall influences breeding success in guineafowl through the availability of protein-rich insect food (Mentis *et al.*, 1975; Crowe, 1978). There are also reports that reproduction in guineafowl is governed by the combined effect of relative humidity, temperature and number of hours of sunshine together with rainfall (Onuora, 1983; Crowe, 1978).

Studies in Nigeria by Aire *et al.* (1979), Ayeni (1980) and Onuora (1983) have shown that breeding in wild helmeted guineafowl only occurs during the rainy season. Barbier & Leroy (1970) also reported that spermatogenesis in the guineafowl begins in April, reached its peak between May and August before decreasing to the resting stage between September and November. However, eggs with very low fertility can be laid during off season periods (Ayorinde, 1987). Factors like age of the bird (Veitsman & Pavlova, 1972; Martin, 1995), sex ratio (Veicman, 1962; Gonzalez & Klein, 1974), nutrition (Offiong & Abed, 1980; Offiong, 1983; Monaghan *et al.*, 1992) and predation (Greenwood *et al.*, 1995) might influence the breeding performance in birds too.

On the basis of these information, it was hypothesised that the breeding performance of the guineafowl in the Waza region which has an unpredictable and fluctuating annual rainfall, will vary from year to year due to variations in environmental conditions. In this context, the following research questions were asked:

1. What are the major factors influencing breeding success in wild guineafowl in the Waza region?
2. To what extent do these factors influence breeding success of individuals in this population?
3. What are the recruitment rates under these conditions?



Breeding in guineafowl starts with pairing after the first rains (May-June) in the Waza region

5.2 Methods

5.2.1 The study area

The study area covers about 100 hectares in the western part of the Waza National Park in Northern Cameroon. The terrain is gently undulating, with an average altitude of about 307 metres. Annual maximum temperature is around 40°C and the minimum is around 18°C. The hottest month is April (average temperature 32.8°C) and the coldest is January (average temperature 26.1°C). There are two main seasons, a rainy season from May to October and a dry season from November to April. Rainfall varies from 500 to 800 mm per year. The vegetation of this region was described by Wit (1975) and more recently by Gaston (1991) and is of a Sudan-Sahelian type.

5.2.2 Data collection

Start of the breeding season and clutch size

During the 1992, 1993 and 1994 guineafowl breeding seasons, a research team of 4 people went out to search for nests. The searchers were spaced 100 metres apart, and moved in the same direction looking out for nests and using a compass to keep course. A stick of about 1 to 1.5 metres long was used to separate tall bushes. Each search session (only one per day) lasted for 4 hours during the morning period. There was a 10 minute break each hour because previous experience showed that after a long search, some members of the search team lost concentration, increasing chances of missing nests.

Data collected included those from females tagged earlier for home range studies (6 radio-tagged and 77 ring-tagged) and those from untagged birds. The tagged birds permitted observations on re-nesting and the comparison between nest success of first and of experienced breeders. When nests were found, the characteristics of the nest sites; height and type of vegetation under which nest was found, height and nature of surrounding vegetation were noted. The identity of the bird, if tagged, was determined from the ring colour or from the radio frequency with a Biotrack Mariner 57 receiver. The number of eggs (if any) was noted and the geographical location was determined using a Magellan Geographical Positioning System (GPS), to facilitate future localisation. After being found, the nests were then re-visited once a week until hatching or until it was clear that it had been abandoned or preyed upon.

Since frequent nest visits may disturb breeding birds (Mayfield, 1975; Johnson, 1979), a one-week visiting interval during the laying stage and once a day during the late incubation stage was assumed to be sufficiently long to avoid interference with nesting hens. Subsequent data on nests were collected at a distance of about 5 to 10 metres from the nest, in order to minimise the chances of human interference with the breeding. Changes in the clutch size was recorded on each visit until hatching or loss of the nest.

Calculation of breeding index

A breeding index (I) for each year was calculated by assuming that the number of nests found by our search team (which was made up of the same people for all the years) was an index of the breeding intensity (or nest density) for that year. It was also assumed that the probability of finding a nest was the same for all nests and for all searchers. If N is the number of nests found in a month by a number of people, X, searching for a number of days, Z, the breeding index, I, for that month was calculated using the following formula:

$$I=\frac{N}{XZ}$$

'Search effort' was the product of the number of searchers and the number of search days. The breeding index was thus expressed as the number of nests found per search effort. One person searching the study area for 4 hours (=1 day) was said to have exerted one unit of search effort. Nests without eggs were not used in the calculations. The breeding index for each year was then calculated as the arithmetic mean of the breeding index for the breeding months for that year.

Calculation of nest survival

To overcome bias that usually results from the calculation of nesting success as a simple percentage of hatching from a sample of nests found independent from the time period that the nest is under study, Mayfield (1961, 1975) proposed an alternative method that takes into account nests found or lost at different stages of incubation. He measured the nesting success as a daily survival rate, which he defined as the probability, P, that a nest will survive from one day to the next. This was calculated from the formula:

$$P=\frac{F}{F+L}$$

where F is the total number of 'nest days' (the sum of all daily totals of nest present during the observation period), and L is the number of nests lost. If a nest was lost in-between two field visits, he assumed that the nest was lost halfway between the visits. If t1, t2 and t3 are the total number of days of laying, incubation and nestling respectively and P_l, P_i and P_n are the probabilities of nest surviving from one day to the next during the laying, incubation and nestling stages respectively. The nest survival for the whole laying period will be given by P_l^{t1}, nest survival for the whole incubation period by P_i^{t2}, and nest survival for the whole nestling period by P_n^{t3}. The survival from the start of laying until fledging, P_{total}, (=recruitment), will be given by the product of the survival during the laying, incubation and nestling stages, ($=P_l^{t1} \times P_i^{t2} \times P_n^{t3}$).

Daily survival rate as well as survival during the laying incubation and nestling stages were calculated using Mayfield's formula. The standard errors for the results were calculated using the formula derived by Johnson (1979) and is:

$$S.E.=\sqrt{\frac{L(F-L)}{F^3}}$$

The 95% confidence limit was calculated as 1.96 x S.E. Hatching success was calculated as the percentage of eggs present before hatching that effectively hatched into young. A Spearman rank correlation was used to compare differences in clutch size between first and experienced breeders. A multiple regression test was used to compute the relationship between clutch size, nest loss and breeding success.

Causes of nest loss
Causes of nest loss were determined by direct observation of lost nests. For preyed nest, the predators were identified by direct observation of foot-prints around the nest. Earlier observations showed that the manner in which egg shells were scattered around preyed nests was typical for each predator species and this feature was also used to identify some nest predators.

Influence of food availability
To verify how food available to the guineafowl varied during the study period and how this could have influenced breeding, insect and seed abundance were estimated monthly. Crawling insect abundance was estimated by using 100 aluminium cup traps buried in the ground with the open end exactly at ground level. The cups were arranged in rows of 5 per site. Each row was separated by 500 m from the next. A total of 6 randomly selected sites were chosen for this investigation. Four sites were chosen in the National Park, and two outside. The traps were set around 05.30 and collected around 18.00 The number of insects in each trap was noted.

Seed abundance was estimated in the same sites as those for the insect abundance estimate. The topmost 2 to 5 cm of soil (accessible to the birds) were collected in one square metre quadrats placed at 100 metres apart and 10 per site. These soil samples were brought to the field station, each thoroughly mixed, and 100 g sub-samples were taken for investigation under a microscope at 10X magnification. All the seeds in each soil sample were counted.

Influence of rainfall
Rainfall data was collected from the National Meteorological Station in Waza for the three years of the research. A simple regression of the annual breeding success on the total annual rainfall figures was carried out.

5.3 Results

5.3.1 Start of breeding and clutch size

In all three years pairing started by early March, just after the first rains. Egg laying started by early August each year. The breeding season for all three years lasted for about two months, with maximum egg production between mid-August and early-September. The form and shape of guineafowl nest have been described by Ayeni (1980). Up to 67 (76%, N=88) nests were located under shrubs of 1 to 3 metres tall. Of the remaining 13,7 (8%) were found under isolated tufts of grass of height 1 to 3 metres and 6 (7%) in the open. Up to 71 (81%) of the nests sites had very open surrounding (average grass height <2 m). No nest was found in very thick bushes or under big trees.

Table 5.1
Mean clutch size for first-time and experienced breeding guineafowl hens

	Year	Mean clutch size ± 95% confidence limits		Overall mean ± 95% confidence limits
		First time breeders	Older breeders	
All netst	1992	7.3 ± 4.7	11.5 ± 3.9	9.4 ± 4.3
	1993	5.4 ± 3.7	10.4 ± 3.1	7.4 ± 3.1
	1994	8.3 ± 5.9	12.1 ± 4.1	10.2 ± 5.0
Succes-ful nests	1992	9.0 ± 3.0	15.8 ± 1.0	12.4 ± 2.0
	1993	0.0	11.6 ± 3.6	11.6 ± 3.6
	1994	9.8 ± 2.7	16.4 ± 2.1	13.1 ± 1.0

The clutch size varied from 1 to 22 eggs per clutch. Mean clutch size for all three years for all nests found (± 95% confidence limits) was between 7.9 ± 3.1 and 10.2 ± 5.0 eggs per clutch. Successful nests generally had higher clutch size than unsuccessful ones for all three years ($P<0.05$, N=88). The mean clutch size of a successful nest for the 3 years was between 11.6 ± 3.6 and 13.1 ± 2.4 eggs per clutch. Table 5.1 summarises the mean clutch sizes for all three years. The breeding index (I) was higher for 1994 (2.22 nest per search effort) than for 1992 (1.19) and 1993 (1.16).

5.3.2 Causes of nest loss

The magnitude of each factor responsible for nest loss varied with year and breeding stage (Table 5.2). Four main factors were identified which accounted for the total of the losses during the laying stage for the 3 years, nest abandonment 39% (n=16), predation 24.4% (n=10), flooding 19.5% (n=8) and trampling by elephants 17.1% (n=7).

Table 5.2
Variations and magnitude of factors causing guineafowl nest loss

Year	Number of nests lost	Factor responsible for nest loss*			
		Predation	Abandoned	Flood	Trampling
Laying stage					
1992	12	1 (8.3)	5 (41.7)	0 (0.0)	6 (50.0)
1993	13	5 (38.5)	7 (53.8)	0 (0.0)	1 (7.7)
1994	16	4 (25.0)	4 (25.0)	8 (50.0)	0 (0.0)
Total	41	10 (24.4)	16 (39.0)	8 (19.5)	7 (17.1)
Incubation stage					
1992	7	6 (85.7)	0 (0.0)	0 (0.0)	1 (14.3)
1993	9	8 (88.9)	1 (11.1)	0 (0.0)	0 (0.0)
1994	5	5 (100)	0 (0.0)	0 (0.0)	0 (0.0)
Total	21	19 (90.4)	1 (4.8)	0 (0.0)	1 (4.8)

* Numbers in brackets represent percentages of total lost due to factors for each stage

During incubation, predation was the dominant factor responsible for nest loss, accounting for up to 90.4% (n=19) of losses at this stage for all three years, and 100% (n=5) in 1994. Other factors of nest loss at this stage (observed only in 1992 and 1994) were nest abandonment and trampling by elephants accounting for 4.8% (n=1) of nest loss each. No nests were lost during the nestling stage during the three years of research.

Most of the nests lost through predation (76.0%, N=29) were completely destroyed, and in two cases the hen guineafowl was also eaten. The most prominent predators identified included the jackal (*Canis aureus* Linné, 1758) and banded mongoose (*Mungos mungo* Gmelin, 1788), accounting for 50% (n=14) of the nests lost to predation for the three years. The red monkey (*Erythrocebus patas* Schreber, 1775) accounted for about 20% (n=6) of the nests lost due to predation for the three breeding seasons. Other predators included varanus (*Varanus* sp.) and snakes.

5.3.3 *Re-nesting*

Out of the 62 birds that lost their nest during the study, 21 (33.9%) re-nested (Table 5.3). Of these, 5 were successful in their breeding effort which represents

19.2% of the successful breeders (N=26) for the three breeding years. In 1992, 28.6% of the re-nesters were successful while in 1994, 33.3% succeeded. No re-nesting was observed in 1993.

In 19 re-nesting cases (90.5%), the re-nesting took place when the nest was lost during the laying stage. Only 2 (9.5%) re-nested after incubation had started, but this was during the early stage of incubation. In one of the nests (which belonged to a radio-tagged bird), re-nesting was not observed when the nest was trampled upon by elephants after 8 days of incubation.

Table 5.3
Re-nesting and re-nesting success for first-time and experienced breeding guineafowl hens

Year	Re-nesters (N)	First-time breeders		Older breeders		Successful (% of N)
		re-nester	successful	re-nester	successful	
1992	7	5	1	2	1	2 (28.6)
1993	5	4	0	1	0	0 (0.0)
1994	9	6	2	3	1	3 (33.3)
Total	21	15	3	6	2	5 (19.2)

5.3.4 *Nest survival*

The daily nest survival rate varied from year to year, with daily survival during both the laying and incubation stages being lowest during the 1993 breeding season. Incubation lasted for 17 ± 2.0 days (± S.E., N=26 nests) for all three years. Nest survival during the incubation stage was lower than during the laying stage in 1992 and 1993 (Table 5.4). Nest survival during the incubation stage was lowest during the 1993 breeding season and highest during the 1994 breeding season.

The nestling stage lasted for only 1 ± 0.5 days (N=24 nests). In one nest which was intensively followed, the bird left the nest about 6 hours after hatching was completed. However, most of the birds stayed one or more nights with their flightless keets in their nest. Some birds (6) did not stay more than 2 nights in their nest after the nestling stage. Since no chicks were lost during the nestling stage in any year, this resulted in a survival of 1 for the nestling stage. Because the product of the probability of nest survival during the laying, incubation and the nestling stages gives the overall survival from the beginning of laying to the fledging of young (Mayfield, 1975), survival up to fledging of young (recruitment) was the same as survival up to the end of incubation. This recruitment (plus or minus the 95% confidence limit) was 0.290 ± 0.034 in 1992, 0.157 ± .028 in 1993 and 0.402 ± 0.027 in 1994.

Table 5.4
Guineafowl nest survival rates for the laying and incubation stages from 1992 to 1994

Year	Total number of nests under observation	Nest days	Nests lost*	Survival per nest day ± 95% confidence limits	Nest survival for the stage ± 95% confidence limits
Laying stage					
1992	27	294	12 (63)	0.961 ± 0.0231	0.571 ± 0.1648
1993	26	273	13 (59)	0.955 ± 0.0258	0.521 ± 0.1660
1994	35	378	16 (76)	0.059 ± 0.0207	0.560 ± 0.1473
Incubation stage					
1992	15	138	7 (37)	0.949 ± 0.0374	0.508 ± 0.2067
1993	13	102	9 (41)	0.012 ± 0.0561	0.301 ± 0.1693
1994	19	198	5 (24)	0.975 ± 0.0223	0.717 ± 0.1863
Nestling stage					
1992	8	12	0	1.0	1.0
1993	4	6	0	1.0	1.0
1994	14	21	0	1.0	1.0
Whole breeding season (recruitment)					
1992					0.290 ± 0.0341
1993					0.156 ± 0.0281
1994					0.402 ± 0.0274

* Numbers in brackets represent the percentage of egg lost compared to the total lost for the whole breeding season (laying plus incubation stages) for each year.

The hatching rate (the probability that eggs present at hatching time actually produce living young) for 1992 was 0.924 (N=8 nest), in other words, 92.4% of the eggs in the nest just before hatching started finally hatched into chicks. In 1993, the hatching success was 91.0% (N=4 nest) and in 1994 it was 95.0% (N=14 nest).

5.3.5 *Influence of food availability*

During all three years, there was a drop in the availability of both insects and seeds from the start of the first rains in March until June (Fig. 5.1). After this period, insects rapidly increased to their maximum number in July. Breeding each year started about a month (August) after the insect number have reached its peak. Seed density continue to decrease in number until August, after which it rapidly increase to a maximum by October when most eggs were already hatched.

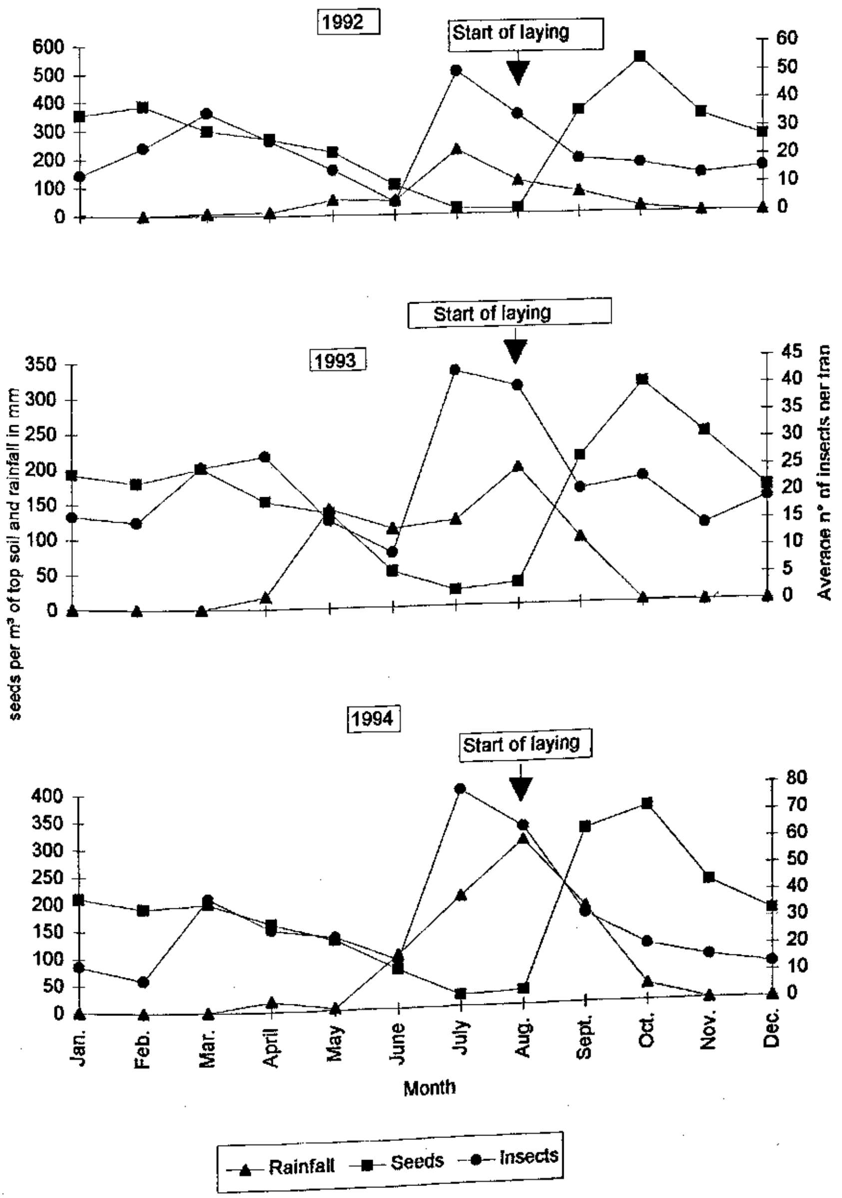


Figure 5.1
Monthly variation of insect and seed density in the study area (1992-1994) in relationship to the start of egg laying by guineafowl.

5.4.6 Influence of rainfall

The rainy season started later in 1994 (April) than in 1992 and 1993 (March), but 1994 received 841 mm of rainfall compared to 689 mm and 609 mm for 1992 and 1993 respectively. This rainfall figure was the highest recorded in the region over the last 10 years. There was a very significant positive correlation between the annual rainfall and the breeding success, which is equivalent to recruitment ($R=0.98$, $R^2=96\%$, $P<0.05$). A fitted regression of breeding success on rainfall was of the form $Y= -0.45+0.001X$, with t-values of -2.99 for the constant (-0.45) and 4.92 for the coefficient of X (0.001).

5.4 Discussion

This study has shown that there is a statistically significant positive correlation between annual rainfall in the Waza region and breeding success in the helmeted guineafowl. Consequently, pairing starts in the Waza region between the months of March and April each year, which coincide with the start of the rainy season. Ayeni (1980) also reported that pairing started with the start of the rainy season between May and June in Nigeria in this species. Benson (1963) suggested that the marked peak breeding during the rainy season in the guineafowl might be linked to the abundance of insect food during this period. Fergin (1964) had suggested from studies of *N. meleagris* in Uganda that rainfall may directly or indirectly control breeding activities in this species. Crowe & Siegfried (1978) also found a high statistically significant correlation between the number of rainy days and the shooting index (index of guineafowl population density). Other studies have also shown that rainfall might influence breeding success in birds (Martin, 1995)

In the Waza region, eggs laying started in August for all three research years and continued until October. Maximum egg production coincided with the peak of the rainy season in August. The start of egg laying in this study (August) is later than was reported in neighbouring Nigeria (June) for the same species by Ayeni (1980). Crowe (1978) had also observed that rainfall might only be controlling the guineafowl population in South Africa indirectly through the availability of protein-rich arthropods.

The annual mean clutch size in Waza (between 7.9 to 10.2 eggs per clutch for all nests found and 11.6 to 13.1 eggs per clutch for successful nests) is low when compared to 15 to 20 eggs per clutch reported for this species in neighbouring Nigeria by Ayeni (1983). The clutch size, however, falls within the range of 6 to 19 eggs per clutch reported by Clancey (1967) and McLachlan &

Liversidge (1972). There has also been reports of an average clutch size of 80 to 100 eggs in the wild (Wyeld, 1977, cited in Ayorinde, 1987).

Re-nesting plays an important role in the guineafowl's breeding strategy in the Waza area. In general, quantitative information about re-nesting is scarce (Beintema & Müskens, 1987). Up to 100% re-nesting appears to be possible if nests were lost within the first week of breeding in some European meadow birds but it was noted that later in the breeding season, re-nesting became difficult (Beintema & Müskens, 1987). Re-nesting was also only observed in this study during the laying and early incubation stages. The absence of re-nesting when nest are lost in the late stage of incubation or just after hatching had also been reported in the Red Grouse (*Lagopus lagopus scotiscus* Lath) by Watson (1970) who suggested that re-nesting was controlled by a 'psychological-endocrine' mechanism which became irreversible after hatching had taken place.

The observed incubation period of between 15 to 19 days is close to that of the Crowned guineafowl (24 to 25 days) in South Africa (Farkas, 1965). Ayeni (1980) found that incubation took up to 27 days in *N.m. galeata* in Nigeria. The incubation stage in his study will probably have included part of the laying stage that is considered as a different stage in Mayfield's method, the merits are of which discussed in Johnson (1979). However the duration of incubation can vary from year to year within the same species, (Jenkins *et al.*, 1967; Jenkins & Watson, 1967) and also with clutch size (Jenkins *et al.*, 1963). So the longer incubation period reported in Nigeria might been due to any of those conditions.

The hatching rates for the three years of this study (92% in 1992, 91% in 1993 and 95% in 1994) are high when compared to those reported in Nigeria (between 28 and 34%) by Ayeni (1980). His results, however, were from laboratory raised and from locally acquired semi-wild birds which might explain the low hatching rate since an uneven sex ratio, competitions amongst males and overcrowding in the laboratory might lead to some hens not copulating before laying eggs, with a resultant increase in infertile eggs. Ayeni (1980) also suggested that nutritional deficiency could be one of the causes of the low hatching rate in the guineafowl he studied.

Low guineafowl population and poor breeding were reported by Skead (1962) and Mentis *et al.* (1975) during years with relatively low rainfall. Also, Mentis *et al.* (1975) and Crowe (1978) suggested that poor breeding success might be more a result of the influence of rainfall on the availability of high-protein insect food for the breeding birds rather than rainfall proper. It might also be possible that heavy rains reduced the proportion of nests lost to predators indirectly through concealing nests by good vegetation cover. This was substantiated by the observation that the absence of good cover during the 1993 breeding season (the year with the highest number of nests lost to predation) led to some nests being located on bare ground and therefore becoming more vulnerable. Although no nest loss was attributed to egg collection by people, it is widely believed by the park officials that hundreds of eggs are lost each year through this. Park records show that a large number of egg poachers had been arrested in the past.

First-time breeders produced fewer eggs and consequently fewer young than experienced breeders, which is consistent with most recent bird studies discussed by Martin (1995). However, Parcs (1963) and Szabo & Bankay (1974) observed that egg production in guineafowl hens could drop by as much as 20 to 30 percent after the first laying season, which is not consistent with the results in this thesis. This difference can not presently be explained.

The peak of insect availability (July) occurs just before the start of egg laying in August. Seeds density was lowest during this period because most seeds had germinated. It is possible that seed food availability does not play an important role in the breeding of this guineafowl population since seeds were generally low in density during the breeding period, as can be seen in Fig. 1. However, seeds becoming abundant after the birds have hatched may provide an additional source of food, especially as insect numbers start dropping after hatching is ended. Insect food availability, on the other hand, must play an important role in the breeding of this guineafowl population since the start of the breeding season always coincides with the period following high insect abundance.

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Chapter 6

Estimation of Annual Surival Rate of Wild Helmeted Guineafowl (*Numida meleagris galeata*) in North Cameroon by the Mark-resighting Method

Summary

The annual survival rate of wild helmeted guineafowl (*Numida meleagris galeata* Pallas) was investigated from 1992 to 1995 in the Waza region of North Cameroon using the mark-resighting method. The differences in survival rate between adult females, adult males and unsexed young birds was computed using Student's t-test. The relationship between the annual survival rates in the three groups and the rainfall figure within a given year and a year earlier was investigated using correlation statistics.

1. The mean annual survival rate for adult females was 0.64, that for adult males was 0.65, and that for unsexed young birds was 0.62, giving an overall mean annual survival rate of 0.64 ± 0.02 (SD). There was no significant difference between the annual survival rates in these three groups over the three years of investigation. However, the annual survival rates varied with sex, age and year.
2. The annual survival rate of birds that were unsexed young by the time of tagging was the lowest amongst the three groups during the first year, but after tagging it become equal to that of adults.
3. Correlation statistics showed that there was no relationship between the annual survival rate in each groups and the rainfall figure for that year or the previous year.
4. These data implies that fluctuation in the Waza guineafowl population can only be explained by variations in the annual breeding success and the survival of young birds during their first year of life.

H.L. Njiforti, submitted to *Bird Conservation International*.

6.1 Introduction

Estimate of annual survival rate can be considered as one of the most important components of demographic modelling because long term monitoring of changes in annual survival rates can give an insight into how the population fluctuates with time. This paper is aimed at estimating the annual survival rate of wild helmeted guineafowl (*Numida meleagris galeata* Pallas) as a step in developing a demographic model for the species.

Three methods commonly used in calculating annual mortality in birds are:

A. The indirect method. This method uses data from population census and birth rate estimates to deduce annual mortality rates (see Ogilvie & St. Joseph 1976, Owen 1980).
B. The ring recovery method. This method relies on the recovery of rings from dead ringed birds. It was used as early as the 1940s (see Kortlandt 1942), Lack (1954), Haldane (1955) and is still being used by ornithologist for example Brownie *et al.* (1985) and Ebbinge *et al.* 1991
C. The multiple resighting of marked individuals. This method involves marking individuals and recording their sightings over a time period. This method has been used in many intensive bird studies (see Owen 1982,1984, Ebbinge *et al.* 1991, Bibby *et al.* 1992).

In the indirect method, A, the annual mortality rate is estimated by first estimating the total population size using any census method. The proportion of first-year birds in a sample of the population is then estimated. This is multiplied by the total population size to give an estimate of the total number of first-year birds in the whole population. The number of survivors during the previous season or year can then be deduced by subtracting this number from the previous years' population figure. The assumptions are that population censuses and sampling for estimation of first-year birds are statistically robust are important. Criticisms for this method include the inability to account for age specific mortality and the biases that may result from the population estimates and sampling for first-year birds.

The ring-recovery method, B, relies on rings recovered from hunters or from dead birds found in the field. The major disadvantage of this method is that when recovery rates are too low, (as they usually are: see Brownie *et al.*, 1978, 1985) a constant survival rate is assumed. To overcome this, a very large number of birds must be ringed, but even then the low recovery rates might lead to exaggerated over-estimation of survival rate (see Ebbinge *et al.* for their results on geese).

Tagging guineafowl can generate a lot of ecological data, but leg rings can be difficult to recognise during the wet season

The multiple resighting method, C, relies on the re-sighting of birds marked and followed throughout their life for the estimation of the annual survival rate. One of the major criticisms to this method was that all marked survivors may not have the same probabilities of being seen, which can be particularly true for migratory species since the birds may not necessarily return to a study site. This leads to a positive bias in the mortality estimate. Ebbinge *et al.* (1991) devised a formula to correct this bias, and in a comparative analysis of mortality data for barnacle geese (*Branta leucopsis*), using the above three methods, concluded that the multiple resighting method gave a more accurate result.

For this reason, the multiple resighting method, C, was chosen for this study. Since this method is essentially a capture-recapture method, (Ebbinge *et al.*, 1991), it has the same basic assumptions as described in Seber (1982).

That is:

a. There is neither migration nor immigration during the study.
b. Marked birds are representative of the whole study population and marking does not affect the survival and behaviour of the birds.
c. Every marked bird has the same probability of being spotted, identified and reported.

d. No mistakes are made by observers in identifying and recording identity.
e. Marked birds do not lose their marks.
f. Each marked individual has the same probability of survival from one year to the next (independent of the marking).
g. The fate of marked individuals is independent of the fate of other marked individuals.

Looking at assumption (a), one would quickly say that only populations on islands or in enclosures can be studied using this method. Although the guineafowl in this study could not completely satisfy assumption (a), the following arguments lead to the use of this method:
1. The guineafowl is a terrestrial species with a maximum migration distance of about 5 km, (Skead, 1962; Ayeni, 1983).
2. guineafowl in the present study area rarely emigrate more than 3 km distance, (Chapter 7).
3. This method gave a better result in Barnacle Geese, even though it is migratory, than other methods (see Ebbinge *et al.*, 1991).

To satisfy assumption (b), birds were marked from 8 different locations in the study are. This also reduced disturbance of the population which could have influenced the mortality result (Seber, 1982). To validate assumptions (c) and (d), colour combinations and numbers that could cause confusion in identification (red B and red 8) were not put in the same group. The same observers were used for practically all the study years to minimise biases related to assumption (d). To minimise ring loss, (assumption e), a hot soldering iron (portable gas) was used to seal off the end of the rings. Assumption (f) is only valid if a bird is not spotted at least once a year during the study; even if a couple of birds are missed, the error in the mortality estimate can be very low, (Ebbinge *et al.*, 1991). The limited migration of this bird (Ayeni, 1983; Chapter 7) and its gregarious nature lead to the conclusion the that conditions for assumption (f) was met.

6.2 Method

6.2.1 Calculation of survival rate

Ebbinge *et al.* (1991) devised a formula for estimating annual survival rates from mark-resighted birds. They divided their marked birds into four categories depending on the number of times the birds were seen after being marked.

If n was the number of marked birds reported during a particular year (t), these categories were:

a_{00}: individuals alive in year ($t+1$), but neither reported in ($t+1$), nor in any subsequent year ($t+x$)
a_{10}: individuals reported in ($t+1$), but not in any subsequent year ($t+x$)
a_{01}: individuals not reported in year ($t+1$), but at least once later on ($t+x$)
a_{11}: individuals both reported in year ($t+1$) and at least once later on ($t+x$).

Where the first subscripts represent: reported (1) or not reported (0) in year ($t+1$), the second one indicates whether reported (1) or not reported (0) in year ($t+x$), with $2 \leq x \leq X$ (X= number of years of observation).
They showed that a_{00} could be deduced from the formula,

$$\hat{a}_{00}=\frac{a_{10}\times a_{01}}{a_{11}}$$

where $\hat{a}_{00}$ was used instead of a_{00} because the equality of the proportion was only true in expectation.

The number of birds surviving from t to ($t+1$), a_{++}, was then given by

$$\hat{a}^1{}_{++}=\hat{a}_{00}+a_{10}+a_{01}+a_{11}$$

and the annual survival rate ($\hat{s}$) given by:

$$\hat{s}=\frac{\hat{a}^1{}_{++}}{n}$$

Annual mortality rate can be deduced by subtracting the annual survival rate from 1.

6.2.2 *The study species*

The helmeted guineafowl is a terrestrial gregarious species that is very common in the savanna region of Africa (Crowe, 1978). Breeding in the wild is limited to once a year in the rainy season (Ayeni, 1980), and in the Waza area, this is between August and September (Chapter 5). During the breeding season, the birds form breeding pairs while unmated birds (mostly males) continue to live in groups (Ayeni, 1980, 1983). After the breeding season, groups are formed again with a great tendency for group faithfulness (pers. observation). This species can only fly over short distances and movements are limited to distances of about 5 km (Ayeni, 1983).

6.2.3 *Catching and tagging*

A good catching technique is fundamental to the success of a mark-resighting study since a considerable number of animals must be marked for the result to be representative for the species. Trials showed that a traditional guineafowl catching technique was the best for this species.

During the hottest part of the day, especially towards the end of the dry season, guineafowl in the Waza area hide in shady places to escape from the burning sun. They use cover with enough shade to protect them from the sun (pers. observation). Such hiding places were identified (indicated by the presence of bird's droppings and loose feathers) and the traditional traps were set there in the following manner: Big tree branches were laid at the sides of the resting sites in order to build a funnel-like structure with a big and a small entrance. Smaller twigs were used to re-enforce the trap walls, making it difficult for birds to escape through the side walls (see Figure 6.1). After construction, the traps were not visited for about 3 days to let the birds become use to it. After this period, a funnel shape net-trap, made (locally) out of black twine was set at the small entrance. The traps were set early in the morning, when the birds were either still roosting or feeding. The catching itself took place between 12.00 and 13.00.

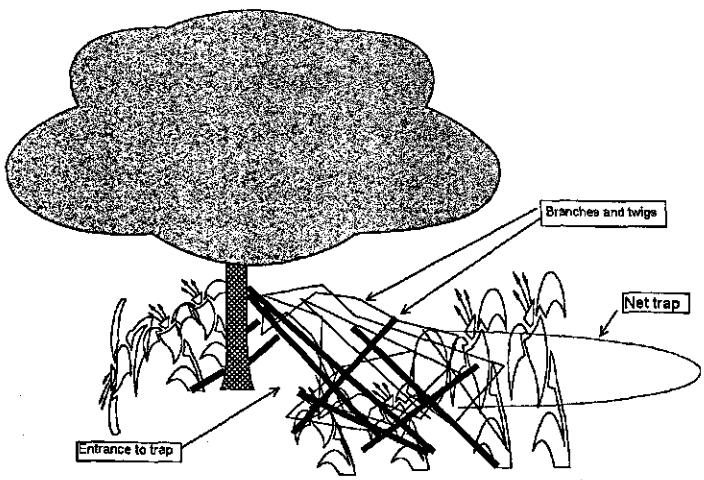

Figure 6.1
Sketch of a traditional guineafowl trap (Many dead branches and twigs are used to make the trap escape-proof

An open 4-wheel-drive pick-up truck with 3 to 4 people in the back was driven at the fastest possible speed towards the big entrance of the trap. On trying to escape through the small entrance, the birds were trapped in the net and the people at the back of the truck jumped out and blocked the big entrance. When a trap was not accessible by car, 3 to 4 people ran towards the big entrance which aimed to have same effect as using a car, but the catch was low in such cases. To minimise stress, the birds were only handled for the time it took to place rings or transmitter and to take measurements.

This was on average approximately 5 minutes per bird. The most successful trappings (up to 13 birds in one trap) took place between the months of April and early May (the hottest months) each year.

A total of 170 birds were tagged, 12 with leg-rings plus radio-transmitters, 100 with neck plus leg-rings and 58 only with leg-rings. All birds with leg-rings were given three colour-ring combinations, while those with neck-rings had a combination of letters of the alphabet (A to Z), number (0 to 9) and colours. The type of radio-transmitters used (from Biotrack UK) were what are sometimes called necklace transmitters. These are suitable for birds of up to 400 grams and have a flexible whip antenna attached to the body of the radio. The radio-transmitter hangs on the bird's neck like a necklace, hence the name. About 2 fingers of space was left between the transmitter's cord and the bird's neck to allow the bird to swallow large pieces of food.

The neck and leg-ring material were of a hard, brightly double coloured (black interior) plastic that could make a ring form when twisted round a piece of wood and immersed in boiling water for some minutes. After tagging, birds were identified in the field using a Mariner 57 radio receiver (from Biotrack UK) for those with radio-transmitters, and a pair of binoculars (10x50).

Tagged adult birds were classed according to their sexes by carefully examining the cloacae (Ayeni, 1980). Since it was impossible to sex all the young birds during the tagging, they were all classed as unsexed. A t-test for paired data was used to investigate the differences in mortality between the three groups. The relationship between mortality in each group and the rainfall figure for the year and one year earlier was investigated using Person's (two-tailed) correlation statistics.

6.3 Results

6.3.1 Ring loss

After the first 10 tagging with leg-rings, it was noticed that birds could pull off a ring by continuously picking and pulling at it during the first days following tagging. Four birds succeeded in pulling off their rings within this period. This was why the ends of the rings (both leg and neck-rings) were sealed off with hot soldering iron. These first ten birds were excluded from further analysis.

By December 1993, 6 birds had lost at least one of their leg-rings, by December 1994 the number increased to 8 and by December 1995 it became 11. Expressed as a percentage of the birds sighted in previous years, this gave a loss of 3.53%, 1.52% and 3.53% respectively, giving an average annual rate of ring loss of 2.86%, which is high when compared to most tagging experiments. No birds were found to have lost their neck-rings during the whole study period (this was verified from the leg-rings that were given to birds with neck-rings).

6.3.2 Mortality

The mean annual survival rate for adult females was 0.64, that for adult males was 0.65 and that for unsexed young birds was 0.62 (Table 6.1). This gave an overall mean annual survival rate of 0.64 $\pm$ 0.02 (SD). Despite annual differences in mortality, there were no statistically significant differences between the survival rates of the three groups (Multiple ANOVA). The unsexed young birds had lower survival (or higher mortality) figures compared to the adult males and females between 1992 and 1993, but the survival figures became equal from 1993/1994 onward. There was no significant difference in mortality between birds marked with leg rings and those marked with neck-rings (Wilcoxon's signed rank test, two-tailed, $p=0.82$), and all the data were lumped. There was also no significant difference in the mortality of birds with radio tags and those with neck or leg rings (two-tailed, $p=0.91$). There was no correlation between the annual survival rate and the annual rainfall figure or the rainfall figure for the previous year.

Table 6.1
Annual survival rate for adult females, adult males and unsexed young guineafowl

	N	a_{11}	a_{10}	a_{01}	a_{00}	SR	SE
Adult males							
1992	73				0.57	0.65	0.02
1993	58	37	7	3	0.74	0.63	0.01
1994	37	27	5	4	0.32	0.66	0.01
1995		19	3	2			
					Mean	0.65	
Adult females							
1992	61						
1993	50	30	5	4	0.67	0.65	0.01
1994	34	22	6	2	0.55	0.61	0.03
1995		18	3	1	0.17	0.65	0.01
					Mean	0.64	
Unsexed (sub-adults)							
1992	36						
1993	24	11	6	3	1.64	0.60	0.04
1994	14	9	3	2	0.67	0.61	0.01
1995		7	1	1	0.14	0.65	0.02
					Mean	0.62	

SR = Survival rate; SE = standard error
N = number of tagged birds reported
a_{00}: individuals alive in year $(t+1)$, but neither reported in $(t+1)$, nor in any subsequent year $(t+x)$
a_{10}: individuals reported in $(t+1)$, but not in any subsequent year $(t+x)$
a_{01}: individuals not reported in year $(t+1)$, but at least once later on $(t+x)$
a_{11}: individuals both reported in year $(t+1)$ and at least once later on $(t+x)$.

6.4 Discussion

The traditional catching technique described here demands speed of operation and a large work-force. This is especially true if more than 10 birds are caught in one trap. With a group of 6 people, 3 birds were almost lost at the beginning of the tagging, when a trap caught 12. The last three birds in the net-trap were so weak (from struggling to escape), and were only saved by more than 30 minutes of fanning and cooling. From experience, not more than 3 birds should be left in the trap while the others are being tagged. It is preferable to put the birds in a big perforated wooden box before starting the tagging. Because of the difficulties involved in reading leg-rings, especially during the rainy season when the average vegetation height in the area can be up to 3 m, neck-rings seem to be a better marker for this bird than leg-rings. It is easier to see these even in tall vegetation because this bird has a habit of stretching out its neck at the slightest intrusion.

The advantage of collar radios (used in this study) over harness radios is that the latter may disturb the bird to a larger extent than the former. Collar radio does not irritate the bird's skin and does not restrict their mobility (Amstrup, 1979). There were no indications that the radios adversely affected the birds breeding or survival.

The similarity in mortality rate between the birds that were unsexed young at tagging and the adult males and females is mostly due to the effect of their later years since adulthood is attained within one year from hatching. It is clear from Table 6.1 that survival was lower (or mortality higher) in the unsexed young than in either adult females or males during the first year which is in agreement with studies in most species (for a review see Martin 1995). A constant annual survival rate in the three groups (adult males, adult females and unsexed young birds) over the years implies that population fluctuations observed in the Waza region (Chapter 3) can only be explained by variations in annual breeding success (about 29%, Chapter 5) and the survival of young birds during their first year of life. This implies that a annual breeding success and chick survival to one year of age are important demographic parameters for modelling the population dynamics of this bird.

The similarity in mortality between birds marked with leg rings and those marked with neck-rings in this study does not agree with Ebbinge *et al.* (1991) who suggested that neck-rings might disturb the bird or increase mortality. Cotter and Gratto (1995) also found that mortality in radio tagged Rock Ptarmigan (*Lagopus mutus*) was the same as for untagged birds except for the years when heavier radio transmitters were used.

The rate of loss of leg-rings is very high when compared to the 0.5 to 1% lost reported in most studies (see Cooke *et al.*, 1980; Owen, 1982; Ebbinge *et al.*, 1991). This further disqualifies the use of leg-rings in the studies of the guineafowl. Neck-rings seem to be the only viable alternative to leg-rings for a mark-resighting study of this species. The sealing of the neck-ring ends with the hot soldering iron must have contributed to this absence of loss. However, to be used on young birds, the species must be early maturing (like the guineafowl that attends adult size within 9 months from hatching), because the sealing means that the ring cannot expand afterwards. To use this technique on other species one must know the growth pattern and adjust the diameter of the ring to avoid injury to the bird.

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Chapter 7

Home Range Size and Dispersion in the Helmeted Guineafowl (*Numida meleagris galeata* Pallas) of the Waza National Park, Cameroon

Summary

Field investigations of the home range size and emigration pattern of wild helmeted guineafowl (*Numida meleagris galeata* Pallas) from 1992 to 1995 showed that home range size ± 95% confidence limits (95% CL) varied with the season, being 3.63 ± 1.53 km^2 for the dry seasons and 3.12 ± 1.45 km^2 for the rainy seasons. Home range size varied depending on whether it was estimated with data for adult males, adult females or young birds, with a higher home range size for young birds, closely followed by adult males. Group size ± 95% CL varied with months, being highest between the months of March and April (47.0 ± 8.1 birds/group) and lowest in August 9.0 ± 5.1 birds/group). More young birds ± 95% CL (36.77 ± 19.60%) dispersed during the study than adult males (21.07 ± 1.91%) or adult females (13.5 ± 1.77%). There was a very significant positive correlation between group size and the number of birds emigrating from the group. There was also a significant negative correlation between the weights of birds at tagging and the percentage that emigrated during the first year of study but not later. This is suggested to be linked to the high number of young birds emigrating, since they weigh relatively less than adults. The lack of correlation between body weight and number of birds emigrating a year or later after birds were tagged was thought to due to the fact that birds which were tagged while young attained adult weight within a year.

H.L. Njiforti, *African Journal of Ecology*, in press.

7.1 Introduction

The successful management of any wildlife species for exploitation or for conservation entails a good knowledge of the species to be managed. In addition, managers of species that are going to be exploited need to be sure that the harvest from their exploitation area can be effectively replaced. This replacement can be through either immigration into the area from neighbouring regions or through birth. Unfortunately, the dispersal pattern of any given species can depend on a number of factors like the behaviour of the species, the population density, food availability and local environmental factors on which information are usually lacking during the setting up of an exploitation project. Local variations in both mortality and dispersal patterns within the same species also make it inappropriate to extrapolate from data of other regions.

This study aimed to investigate the dispersal pattern and home range size of the helmeted guineafowl (*Numida meleagris galeata* Pallas) to assess the consequences of these on a guineafowl hunting project in the buffer zone of the Waza National Park. The following questions were asked in that respect:

1. What is the mean group size of guineafowl in the study area and how does this vary with season?
2. What is their home range and how does it change with season and other environmental conditions?
3. What percentage of individuals in a group emigrate each year?
4. What is the emigration distance?
5. Do the weight (an indication of physical fitness), sex and age influence dispersion?

To answer these questions, 170 guineafowl were tagged in 8 groups spaced about 5 to 8 km from each other between February 1991 and March 1993 and monitored until December 1995.

7.1.1 *Theoretical considerations*

White and Garrott (1990) reviewed all the methods for estimating home range size and evaluated the two most commonly ones which are:

1. The minimum area polygon (Mohr, 1947): this method constructs a convex polygon by connecting the outer locations of the animal. The area of the polygon resulting from this gives the home range size for the animal. This method considers all the animals' locations as 'normal' movements, and

uses this in calculating the home range. The advantages of this method are its simplicity, flexibility and ease of calculation. An important disadvantage is that the polygon includes all locations, not taking into account occasional 'excursions' out of the home range.

2. The 95% ellipse method (Jennrich-Turner, 1969): this method draws an ellipse around 95 per cent of the animal's locations. Here, only 95% of the animal's movements are considered normal. The centre of the ellipse is the most probable location for the animal (the mean x and y locations), that is, the mean location. This method has the advantage being independent of sample size. It also has the advantage of including an F-statistic for additional precision. This F-statistic estimates the centre of the ellipse in the home range based on the data, (White and Garrott, 1990). This gives a higher accuracy for the home range estimate, but also demands a greater sample size.

7.2 Material and methods

7.2.1 *Study area*

The study area covers about 35 km² in the western part of the Waza National Park in Northern Cameroon. The terrain in this area is gently undulating, with an average altitude of about 307 metres. Annual maximum temperature is around 40°C and the minimum is around 18°C. The hottest month is April (average temperature 32.8°C) and the coldest is January (average temperature 26.1°C). There are two main seasons, a rainy season from May to October and a dry season from November to April. Rainfall varies from 500 to 800mm per year. The vegetation of this region was described by Wit (1975) and recently by Gaston (1991) and is of a Sudan-Sahelian type.

7.2.2 *Catching, tagging, and tracking*

The methods of catching and tagging are described in Chapter 6. When birds were caught, their weight was measured using a 0.05g precision spring balance. The sex of each bird was determined by careful examination of the cloaca (Ayeni, 1980). Since it was impossible to determine the sex of all young birds accurately, they were combined in a class as 'young'.

Each bird was tagged with either leg-rings, leg-rings and neck-rings or leg-rings and necklace radio-transmitters from Biotrack (UK). All leg-rings had three colour combinations. A Mariner 57 (Biotrack UK) radio receiver was used to locate radio tagged birds, and a 10X50 binoculars was used for birds with neck or leg rings. The search for tagged birds was done either from the back of a 4-wheel drive pick-up truck, or on foot. For each bird located, the geographical position was determined with a GPS (Global Positioning System) in degrees, minutes and seconds. Information on the group size and time of day was also recorded. Tracking was done with at least a 24 hour time-gap in-between samples, to increase the chances of having statistically independent locations.

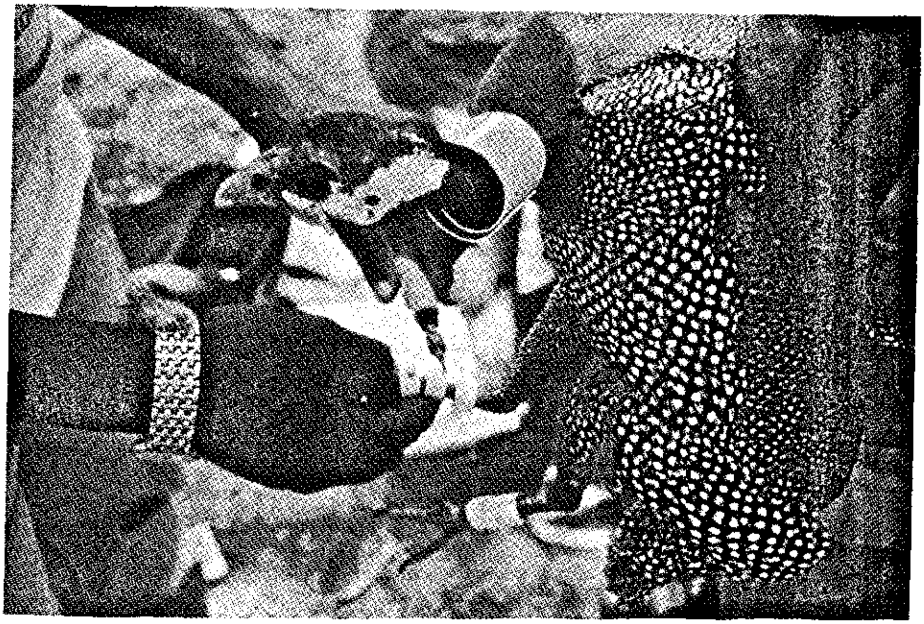
The bird locations from the GPS were later converted to metres North of the Equator and East of the Greenwich meridian and analysed for the home range size using a computer programme (McPaal, Smithsonian Institution USA) specially designed for this. This programme can estimate home range and plots both the polygon and the 95% ellipse of the calculated home range. It can also include an F-statistic in the calculation of the ellipse method.

Birds that left their parental groups were divided into two groups, those that left their parental group and joined another for some time but later returned to the group henceforth considered as having migrated, those that left to a known destination without coming back, henceforth considered as having emigrated or dispersed. The birds that emigrated were used for further analysis on the percentage of emigrants from each group. The relationship between the group size, age and weight of birds and the number of emigrants was investigated using correlation statistics. Persons two-tailed correlation was used except otherwise stated. For all values, 95% confidence limits have been reported except where stated otherwise.

7.3 Results

7.3.1 Group size

The mean monthly group size for all the study years varied with month, being highest between the months of March and April (47 ± 8.09 birds per group) and lowest in August (9 ± 5.10 birds per group). The variation in group size with month is shown in Fig. 7.1. The period when the group size was lowest coincided with the breeding season. This was due to the formation of breeding pairs. However, most breeding pairs still stayed within their home range despite being away from the group. Groups of up to 15 to 20 birds could still be seen during the breeding seasons but were mostly made up of unpaired birds (adult males, females and first-year males or females). By the time the breeding season ended in September-October each year, the group sizes started increasing again as unsuccessful (and later on successful) breeders rejoined the groups.



Necklaces as tags don't seem to increase mortality in guineafowl.
It might be the best tag for this bird in tall vegetation

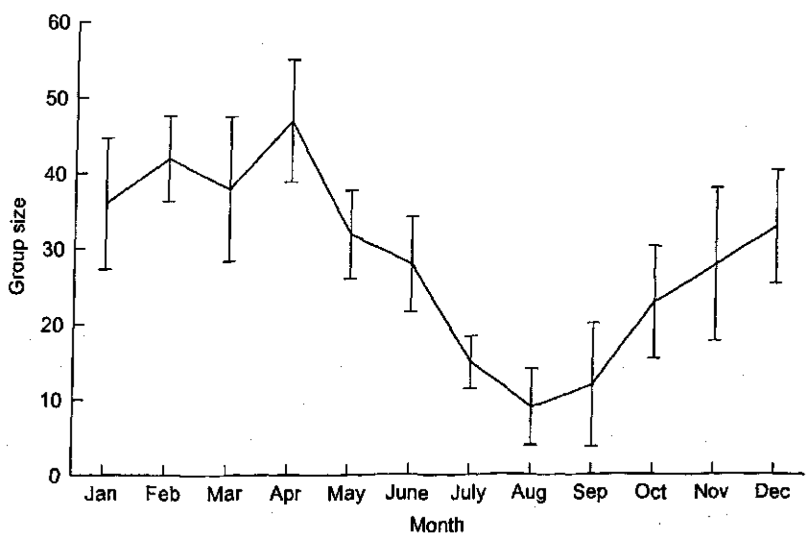


Figure 7.1
Variation in mean monthly guineafowl group size from 1992 to 1995. Vertical lines are the 95% confidence limits for the group size.

7.3.2 *Home range*

The overall mean home range was 3.63 ± 1.53 km^2 for the dry season and 3.12 ± 1.45 km^2 for the rainy season (Table 7.1). There was a statistically significant difference between the dry and the rainy season home range estimates based on the locations of adult females, adult males and young birds (Table 7.1, paired t-test, $t=6.92$, $df=2$, $p<0.05$). Home range estimates based on data of young birds gave bigger home range than those of adults' (females or males) for both dry and rainy seasons (Table 7.1).

Table 7.1 Mean home range size estimates for tagged guineafowl over a 3 years period

Age/sex	Mean home range km^2 ± 95% confidence limits	
	Dry season	Rainy season
Adult females	3.14 ± 1.21	2.77 ± 1.33
Adult males	3.76 ± 1.45	3.22 ± 1.86
Young unsexed	3.98 ± 1.92	3.36 ± 1.17
Overall mean	3.63 ± 1.53	3.12 ± 1.45

7.3.3 *Emigration*

More unsexed young birds emigrated during the study than either adult females or adult males. The mean percentage of females that emigrated ± 95% CL each year was 13.51 ± 1.77%, that for adult males was 21.07 ± 1.91% and that for young birds was 36.76 ± 19.60%, (Table 7.2). This gives an overall mean of 23.78 ± 13.42% of birds emigrating each year.

7.3.4 *Influence of group size, age and weight on emigration*

There was a very significant positive correlation between the annual mean group size and the number of birds that emigrated from the group, (Fig 7.2, $R=0.95$, $p=0.05$). When all birds were considered, there was a significant negative correlation between the weight of birds at tagging and the number that emigrated between 1992/1993 and 1993/1994, (Fig. 7.3, $R=0.88$, $p=0.05$). However, when only adult birds were considered, the correlation was not statistically significant ($p=0.14$). Between 1994/1995 season, the correlation became insignificant even when only birds tagged young were considered ($p=0.23$).

Table 7.2
Annual percentage migration of guineafowl according to age and sex

	N	Migrated	% of N
Adult females			
1992/93	61	9	14.75
1993/94	50	7	14.00
1994/95	34	4	11.75
		Mean ± 95% CL	13.51 ± 1.77
Adult males			
1992/93	73	14	19.18
1993/94	58	13	22.41
1994/95	37	8	21.62
		Mean ± 95% CL	21.07 ± 1.91
Young birds			
1992/93	36	20	55.56
1993/94	24	8	33.33
1994/95	14	3	21.43
		Mean ± 95% CL	36.77 ± 19.60

N= number of birds at the beginning of season, CL= Confidence limits

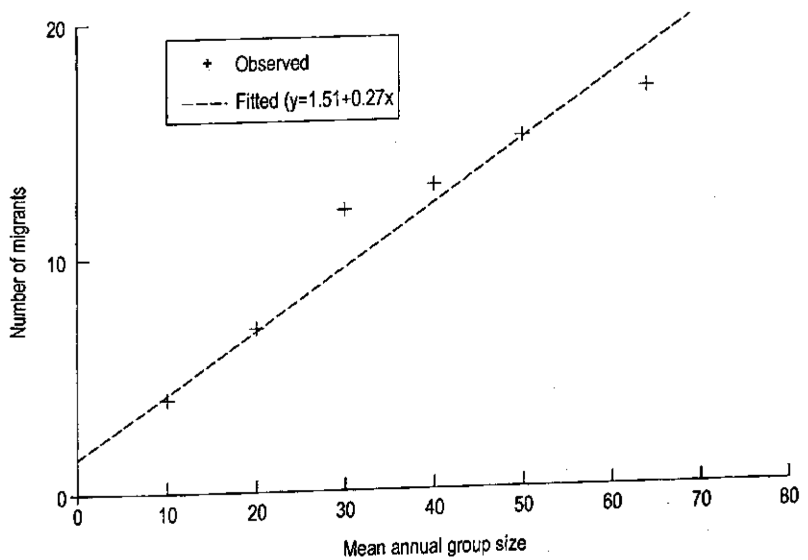


Figure 7.2
Correlation between mean annual guineafowl group size and number of birds emigrating during the year.

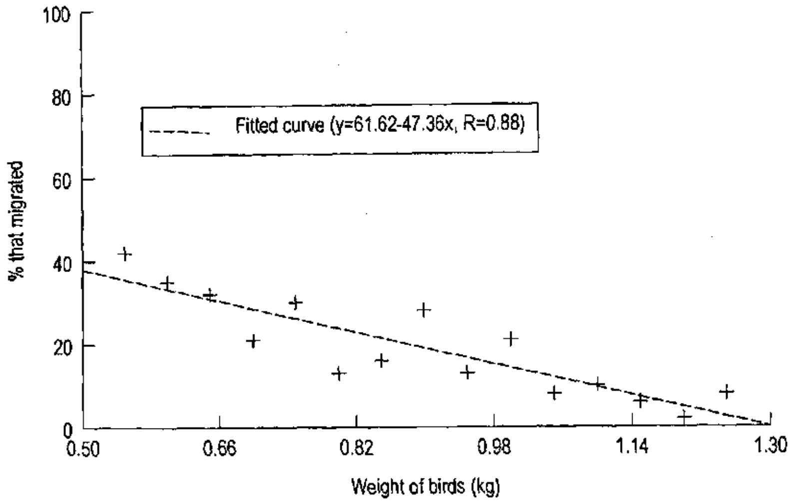


Figure 7.3
Correlation between the weight of birds at tagging and the percentage that emigrated within the first year after tagging.

7.4 Discussion

Studies on home range can be very useful for understanding the biology of a species and much attention lately has been focused on this aspect of ecology (see Worton, 1987; Harris *et al.*, 1990; and Aebischer *et al.*, 1995). The difference in dry and rainy season home range recorded here has also been reported in other social species, e.g. pheasants *Phasianus colchicus* (Whiteside & Guthery, 1983; and Gatti *et al.*, 1989),. gray partridges *Perdix perdix* (Smith *et al.*, 1982), partridges *Alectoris rufa* (Ricci, 1985). This type of variation in home range with seasons has also been reported in large mammals like the African elephants *Loxodonta africana* (Jachmann, 1983; Viljoen & Bothma, 1990).

Variations in food supply might explain the variation in guineafowl home range size between the wet and the dry season in the Waza region since food supply is high during the wet seasons and low during the dry seasons (Chapter 4). Other studies have shown that food can play a major role food in home range size, (Mackie & Nel, 1989; Lovari *et al.*, 1994; Lucherini *et al.*, 1995).

The bigger home range size in young bird as compared to adults might be a prelude to emigration. Many tagged young guineafowl emigrated during the study. The negative correlation between birds' weight and the number of birds emigrating must have been caused by the high number of young that emigrated as compared to adults since young birds generally weigh less than adults. This could explain why between 1994 and 1995, the correlation became insignificant, since all birds tagged while young were then adults. The slightly lower home range that was based on the location of females rather than that based on males locations might be linked to the lower mobility of females during egg-laying, and incubation. Males might also have to migrate in search of females during the breeding season.

It is not known if the tagging affected the emigration and home range of the birds. Scientific opinion is still divided as to whether tagging influences birds' behaviour. There are those who find no influence e.g. O'Connor *et al.* (1987) for honeyeaters (*Phylidonyris novaehollandiae*), Amstrup (1980) for grouse, Marcstroem *et al.* (1989) for pheasants. There are also numerous reports of influences ranging from change in behaviour to increase in mortality, see Sorenson (1989) for the redheads (*Aythya americana*), Hines & Zwickel (1985) for the blue grouse (*Dendragapus obscurus*), Marks & Marks (1986) for the sharp-tailed grouse (*Tympanuchus phasianellus columbianus*), and Johnson & Sibly (1989) for geese. It is however known that mortality does not differ between guineafowl tagged with radios, leg-rings or neck-rings (Chapter 6). An implication of the result obtained here is that any harvest of guineafowl in the buffer zone of the Waza National Park will be replaced mainly by immigrating young birds.

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Chapter 8

A Model for Estimating Sustained Yield in the Helmeted Guineafowl (*Numida meleagris galeata* Pallas)

8.1 Introduction

Determining the rate at which a population is changing from one year to the next is very important in wildlife management, especially if the population is to be harvested. When a population is managed for harvesting, be it for sport hunting or for commercial purposes, the goal is usually to provide a sustained yield (SY). This SY is not static for a given species but varies with different management treatments. A review of different methods for determining SY is given by Getz & Haight (1989). The use of models to determine SY is more developed for fish and marine mammals (see Eberhardt & Siniff, 1977; Caughley, 1977; Deriso, 1980; Reed, 1980) than for terrestrial mammals. However, Caughley & Sinclair (1994) reviewed the underlining principles in estimating SY for terrestrial mammals and birds and the appropriateness of using models in determining SY for birds is discussed in Lebreton & Clobert (1991). Whether the species in question is a bird or a mammal, the first step in determining SY consist of monitoring the population size and how it changes with time.

If the population size in a given year, t, is N_t and becomes N_{t+1} a year later (t+1), the rate at which this population is changing (increasing or decreasing) can be estimated from the formula:

Population rate of change =

$$\frac{N_{t+1}}{N_t} \tag{8.1}$$

This rate is also called the finite rate of increase for the population and is commonly denoted e^r, from which r, the exponential rate of increase can be estimated using the formula:

$$r = \log_e e^r \tag{8.2}$$

In population dynamics, r is usually preferred to e^r because it is centred at zero, while e^r is centred at unity. This gives greater ease of unit conversion, and different rates can be compared more easily. The exponential rate of increase, r, is equally the rate at which the population can be harvested throughout the year to keep the population size constant. In which case it is called the instantaneous rate of harvest, henceforth symbolised H. If $\bar{N}$ is the average population size between years t and t+1, the maximum number of animals that can be harvested between the two years so that N_{t+1} equals N_t will be given by $\bar{N}H$, which is also the sustained yield between the two years (Caughley, 1977).

When the population is to be harvested only during part of the year, as in most hunting regimes, SY is calculated not from H, but from the isolated rate of harvest, symbolised h, which is estimated from H using the formula:

$$h = 1-e^{-H} \tag{8.3}$$

so that SY = $\bar{N}h$ (Caughley, 1977).

If the harvesting is for more than one interval, the sustained harvesting rate for each harvest will be estimated by dividing the value of H in equation 8.3 by the number of times the harvesting will be carried out. Thus if x is the number of times hunting is to take place, the sustained harvesting rate for each hunting session will be given by the formula:

$$h_x = 1 - e^{-\frac{H}{x}} \tag{8.4}$$

Where h_x is the isolated harvesting rate for each hunting session.

The calculation of H, h and consequently SY thus requires a good knowledge of the population size for the harvesting year and a year later if equation 8.1 is to be used. However, if hunting is to take place before the next year, it will be impossible to estimate SY using equation 8.1, because N_{t+1} cannot then be estimated directly from the field. This can, however, be calculated indirectly using ecological data about that population. Ornithologists are increasingly used computer models to simulate this type of data and have thus been able to study the relationship between different hunting strategies and bird population dynamics. Computer models have been developed to estimate such population parameters for some bird species, (for a review of some important ones see Clobert & Lebreton, 1991). Each model is usually developed for specific aims and purposes. The aim of this chapter is to develop a model that uses ecological data on a guineafowl population to estimate sustainable harvesting rate and sustained yield.

8.2 Methods

8.2.1 Explanation of variables used in the model

ABS = Annual breeding success or the number of young produced in a given year expressed as a percentage of the total number of eggs laid that year. It can also be expressed as the probability of fledglings being produced from eggs laid.

λ = Annual mortality rate. This is the probability that birds alive in a given year will be death by the following year.

λ_i = Monthly mortality rate. This is the probability that birds alive in a certain month will be death a month later.

AR = Annual rainfall for a given year in mm.

Cp_t = Total number of chicks that fledge in year t. It is also equal to the productivity for the year.

H = Instantaneous rate of harvest or the rate at which a population can be harvested throughout the year to hold the rate of population increase at zero.

h = Isolated rate of harvest or the rate at which the animals alive at any time of the year can be harvested to hold the rate of population increase at zero.

N = Bird population density.

ND = Number of nest per square kilometres.

SA = Surface area in km^2.

SY = Sustained yield or the number of animals that can be harvested from the population to hold the rate of increase at zero.

8.2.2 *Assumptions in the model*

1. Natural mortality remains constant throughout the year (Chapter 6)
2. All emigration is compensated by immigration.
3. All harvesting is done after the breeding season.

8.2.3 *Estimation of population parameters*

Estimation of guineafowl population in a given year (t) and a year later (t+1)
Analysis of factors controlling the population dynamics of guineafowl in the Waza region; density and habitat requirement (Chapter 3), breeding performance (Chapter 5), mortality and their causes (Chapter 6), showed that the guineafowl population size each year depended on the breeding performance for that year which itself depended heavily on the years' annual rainfall figure.

Considering a population of guineafowl of size N_t just before the breeding season in a given year t, it is possible to estimate the population size, N_{t+1}, a year later, t+1, if the population size in year t, the annual mortality rate and the number of chicks that fledged during year t are known. If SA is the surface area of the region of interest, ND the nest density, ACS the average clutch size and ABS the annual breeding success, the number of chicks that fledged in a given year t, CP_t can be calculated using the formula:

$$CP_t = ND \times SA \times ACS \times ABS \qquad (8.5)$$

In chapter 5, multivariate statistics showed that the relationship between annual rainfall (AR) and annual breeding success (ABS) was of the form

$$ABS = AR \times 0.001 - 0.45$$

$$\text{with } R = 0.98,\ R^2 = 96\%,\ P < 0.05 \qquad (8.6)$$

A fitted curve for this regression is shown in Fig. 8.1. This means that annual rainfall can be a good indicator of the annual breeding success in the guineafowl. Nest density can be estimated using the density estimation method discussed in Chapter 3 and the search technique described in Chapter 5. The average clutch size (for all nests found) for the Waza guineafowl in three successive years was found to be around 9 eggs/nest in Chapter 5.

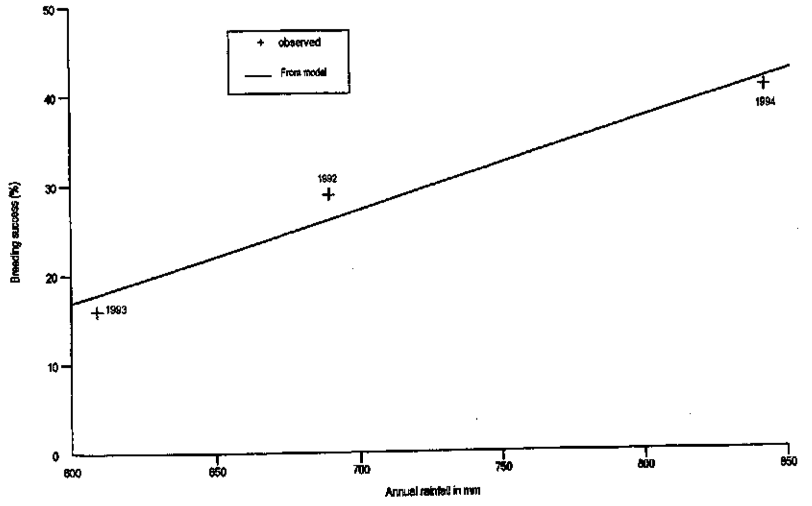


Figure 8.1
Guineafowl annual breeding success estimated from the rainfall-breeding success model for the Waza region. Crosses represent field data and the figures by the crosses represent the year in which the breeding success was estimated.

The breeding season (which is only once per year for the guineafowl) in year t will thus increase the population size from N_t to $N_t + CP_t$. As the year advances towards year t+1, this new population will be progressively reduced by mortality factors at a certain rate λ. This rate of reduction is called the annual mortality rate and is defined as the probability that birds alive in year t will still be alive in year t+1. Taking into account this mortality factor, the population size in year t+1 can be calculated from the formula:

$$N_{t+1} = N_t + CP_t - (\lambda_a N_t + \lambda_y CP_t) \tag{8.7}$$

where λ_a is the annual mortality rate for adult, $\lambda_a N_t$ the number of adults that die between years t and t+1 and λ_y, and $\lambda_y CP_t$ are the same values for young birds. Substituting equation 8.7 into equation 8.1, we have

$$e^r = \frac{N_t + CP_t - (\lambda_a N_t + \lambda_y CP_t)}{N_t} \tag{8.8}$$

from which r, H, and h can be calculated since r=H and the calculation of h is given in equation 8.3. The value of λ_a and λ_y for the guineafowl in the Waza region (from chapter 6) are 0.28 and 0.31, respectively. Using March 1994 census Fig. of 37.56 birds/km^2 (or 15024 birds in 400 km^2), equations 8.7 and 8.8 were used to simulate CP_t , H and h for different nest densities and the result was plotted on a graph of H, h=1 and h=5 harvesting instances (h=5 corresponding to the 5 month's hunting season in Cameroon).

8.2.4 Estimation of mean annual population size

To estimate the average annual population size, $\bar{N}$, a monthly mortality rate λ_i was estimated from the annual mortality rate using the formula:

$$\lambda_i = \frac{\lambda}{12}$$

(12 months of the year)

The product of this mortality rate and the population size each month gives the number of birds that die during that month. For the guineafowl, λ_i was found to be 0.028 for adults and 0.032 for young. Using the Mach 1994 guineafowl population size, the guineafowl population size for subsequent months over a one year period were estimated using the formula:

$$N_i = N_{iy} - \lambda_y N_{iy-1} + N_{ia} - \lambda N_{ia-1}$$

Where N_{ia} and N_{iy} are the population size for adults and young in a given month and N_{ia-1} and N_{iy-1} are the their population size a month earlier. The average annual population size for one year (12 months) was estimated using the formula:

$$\overline{N} = \frac{\sum_{i=1}^{12} N_i}{12}$$

from which SY at different nest densities was simulated for different harvesting rates, H, h=1 and h=5. All the SY thus generated were plotted against population size and nest density for the 3 harvesting instances. A flow diagram showing how rainfall might be controlling guineafowl population was developed based on these results.

Table 8.1
Comparison of harvest resulting from the use of different hunting rates for a nest density of 10 nest/km². Values of the different rates of harvest and sustained yield are deduced from the model used in plotting Figs 8.1 to 8.5

Average annual population size (Ñ)	Rate of harvest	Annual off take at hunting rate or sustained yield (SY)
19000	Instantaneous rate of harvest (H) = 0.420	8000
19000	Isolated rate of harvest (h) = 0.340	6600
19000	Isolated rate of harvest for 5 hunting sessions (h5) =0.080	7700
19000	Isolated rate of harvest for 12 hunting sessions (h12) =0.034	7900

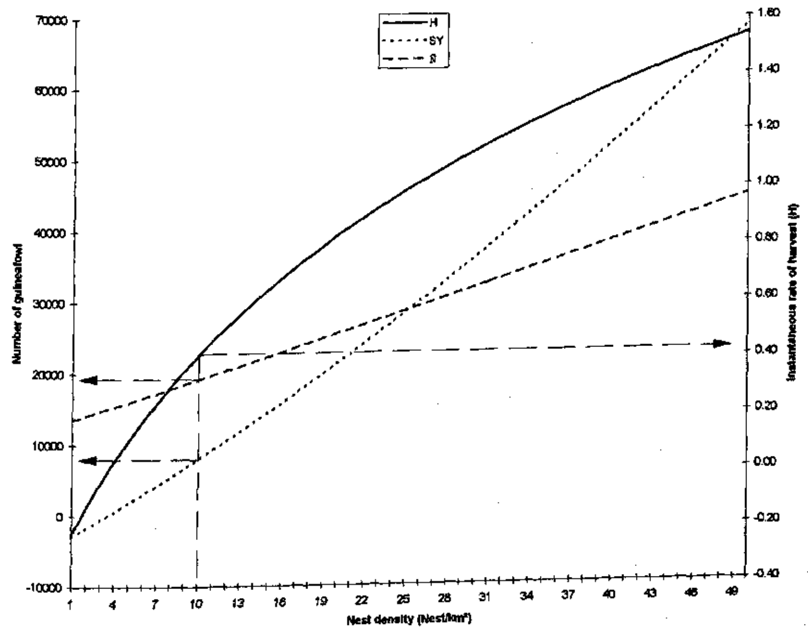


Figure 8.2
Variation of annual average population size (Ñ) (dashed line); instantaneous rate of harvest (H) (solid line); and the sustained yield (SY) (dotted line) with nest density.

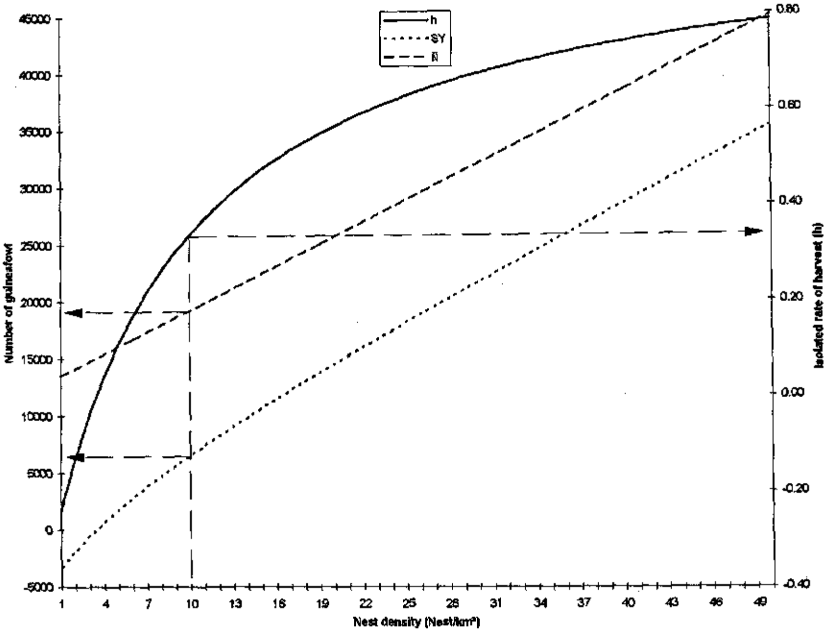


Figure 8.3
Variation of annual average population size (N̄: dashed line); isolated rate of harvest (h: solid line); and the sustained yield (SY: dotted line) with nest density.

8.3 Results

8.3.1 Changes in the values of r and sustained yield with nest density

The chick production model predicted a linear increase in the number of chicks fledged per year with increase in rainfall and nest density. Below 4 nests/km², the population was declining and SY was thus negative, meaning that no harvesting can take place below 4 nests/km². At about 10 nests/km² (the nest density figure for the 1994 breeding season), the model predicted a population size of about 23 000 birds or 57 birds/km² a year later, which is very close to the February 1995 guineafowl population census figure of 61.1 ± 35.6 birds/km² in the study area (Chapter 3).

The value of both H and h, (Figs. 8.2, 8.3, 8.4 and 8.5), increased exponentially with increase in nest density, becoming somewhat constant at high nest density. This is a normal situation since the natural log ($\log_e$) of a number increase exponentially and turns towards a constant as the number approaches infinity. Table 8.1 compares the sustained yields from different hunting rates, if an average population size of about 19000 guineafowl were to breed at a nest density of 10 nest/km^2. Taking a 10 km^2 area in the Waza region (a village hunting zone of this size is proposed in Chapter 9), Table 8.2 gives SY and H values for different nest densities and rainfall. A flow diagram showing how rainfall might be controlling guineafowl population size is given in Fig. 8.6. Low annual rainfall (< 500mm) will result in low breeding success even if nest density is high, resulting low guineafowl population the next year. The reverse is true when annual rainfall is higher than 500mm.

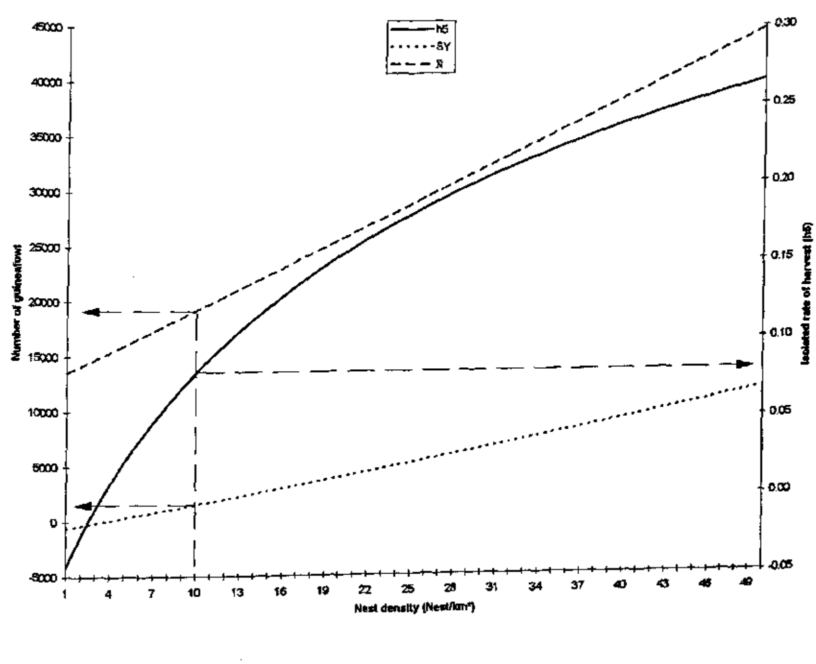


Figure 8.4
Variation of annual average population size ($\bar{N}$: dashed line); isolated rate of harvest for 5 harvesting sessions (h5: solid line); and the sustained yield with (SY: dotted line) nest density.

Table 8.2
Sustained yield estimates for a hypothetical 10 km² area in the Waza region of North Cameroon for initial population size of 4750 guineafowl/km²

		Nest density = 1 to 5 nests/km²				Nest density = 6 to 10 nests/km²				Nest density = 11 to 15 nests/km²			
Annual rainfall (mm)	Probability (%)	Annual average n° of guineafowl (Ñ)*	H	h5	SY	Annual average n° of guineafowl (Ñ)	H	h5	SY	Annual average n° of guineafowl (Ñ)	H	h5	SY
300-349	3.7	4042	0	0	0	4042	0	0	0	4042	0	0	0
350-399	4.9	4042	0	0	0	4042	0	0	0	4042	0	0	0
400-449	8.6	4042	0	0	0	4042	0	0	0	4042	0	0	0
450-499	9.9	4063	0	0	0	4172	0	0	0	4221	0	0	0
500-549	16.0	4073	0	0	0	4334	0	0	0	4373	0	0	0
550-599	14.8	4083	0	0	0	4497	0	0	0	4691	0	0	0
600-649	11.1	4123	0	0	0	4589	0	0	0	4942	0.045	0.009	222
650-699	6.2	4134	0	0	0	4821	0	0	0	5194	0.146	0.029	758
700-749	7.4	4114	0	0	0	4933	0.062	0.012	305	5495	0.223	0.044	1225
750-799	7.4	4164	0	0	0	5141	0.250	0.049	1285	5762	0.335	0.065	1930
800-849	6.2	4493	0.006	0.001	26	5232	0.274	0.053	1433	5950	0.378	0.073	2249
850-899	2.5	4559	0.026	0.005	118	5470	0.412	0.079	2253	6230	0.444	0.085	2766
900-949	1.2	4620	0.044	0.009	203	5534	0.437	0.084	2418	6486	0.507	0.096	3288
Mean ± 95% confidence limits			0.025 ± 0.022	0.005 ± 0.005			0.287 ± 0.132	0.055 ± 0.025			0.297 ± 0.123	0.057 ± 0.023	

Table 8.2 continued

Annual rainfall (mm)	Probability (%)	Annual average n° of guineafowl (Ñ)*	H	h5	SY	Annual average n° of guineafowl (Ñ)	H	h5	SY	Annual average n° of guineafowl (Ñ)	H**	h5	SY
300-349	3.7	4042	0	0	0	4042	0	0	0	4042	0	0	0
350-399	4.9	4042	0	0	0	4042	0	0	0	4042	0	0	0
400-449	8.6	4042	0	0	0	4042	0	0	0	4042	0	0	0
450-499	9.9	4225	0	0	0	4275	0	0	0	4326	0	0	0
500-549	16.0	4590	0	0	0	4742	0	0	0	4894	0.047	0.009	230
550-599	14.8	4955	0.069	0.014	341	5208	0.157	0.031	817	5462	0.238	0.047	1301
600-649	11.1	5320	0.193	0.038	1026	5675	0.301	0.058	1708	6030	0.399	0.077	2405
650-699	6.2	5685	0.304	0.059	1728	6142	0.427	0.082	2622	6598	0.537	0.102	3544
700-749	7.4	6050	0.403	0.077	2438	6608	0.539	0.102	3561	7166	0.659	0.123	4719
750-799	7.4	6416	0.494	0.094	3169	7075	0.640	0.120	4528	7734	0.766	0.142	5930
800-849	6.2	6781	0.576	0.109	3905	7541	0.731	0.136	5512	8302	0.864	0.159	7176
850-899	2.5	7146	0.653	0.122	4666	8008	0.814	0.150	6518	8870	0.953	0.174	8456
900-949	1.2	7511	0.724	0.135	5437	8474	0.892	0.163	7558	9438	1.035	0.187	9769
Mean ± 95% confidence limits			0.427 ± 0.158	0.081 ± 0.029			0.563 ± 0.117	0.105 ± 0.032			0.611 ± 0.218	0.113 ± 0.039	

*When rainfall is lower than 500mm, few or no young enter the population, which results in constant annual average population size (Ñ) since the population is mainly affected by natural mortality .

**An Instantaneous rate of harvest (H) greater than 1 signifies that the number of young guineafowl fledged were more than twice the initial population size.

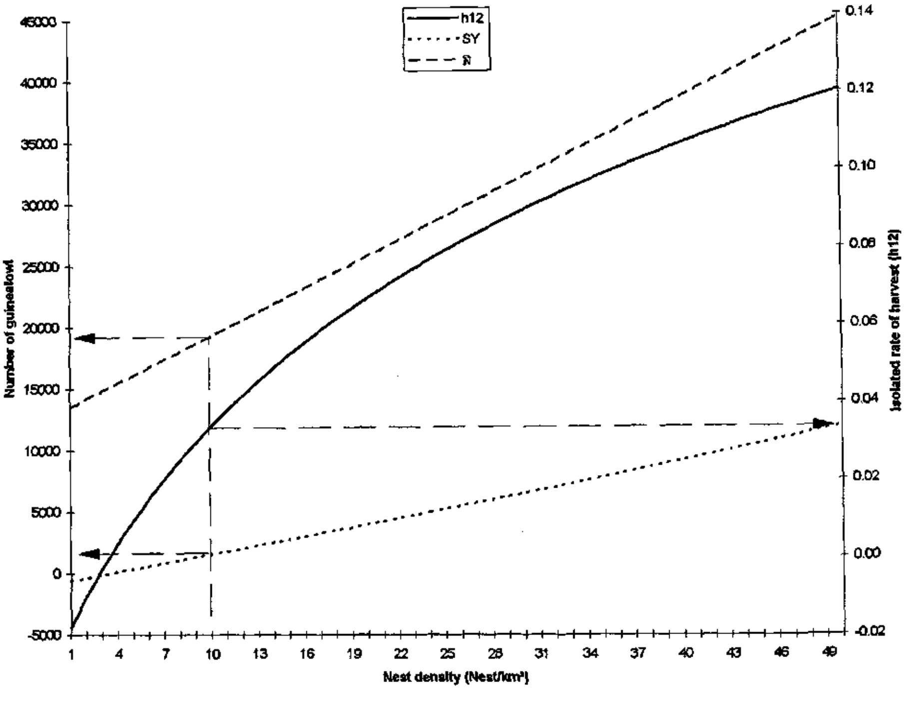


Figure 8.5
Variation of annual average population size (N̄: dashed line); isolated rate of harvest for 12 harvesting sessions or all 12 months of the year (h12: solid line); and the sustained yield with (SY: dotted line) nest density.

8.4 Discussion

The model developed here is essentially deterministic since some factors influencing the population size are assumed to be constant throughout. Such factors may vary from one month to the other in the field, and a stochastic model (model that incorporates all variables and their magnitude) would give the best result. But the complexity of modelling stochastic events makes deterministic models preferable in most population models, especially if the initial population size is large (Maynard, 1974). However, negligible fluctuations in a deterministic model could be very significant in a stochastic model (Maynard, 1974).

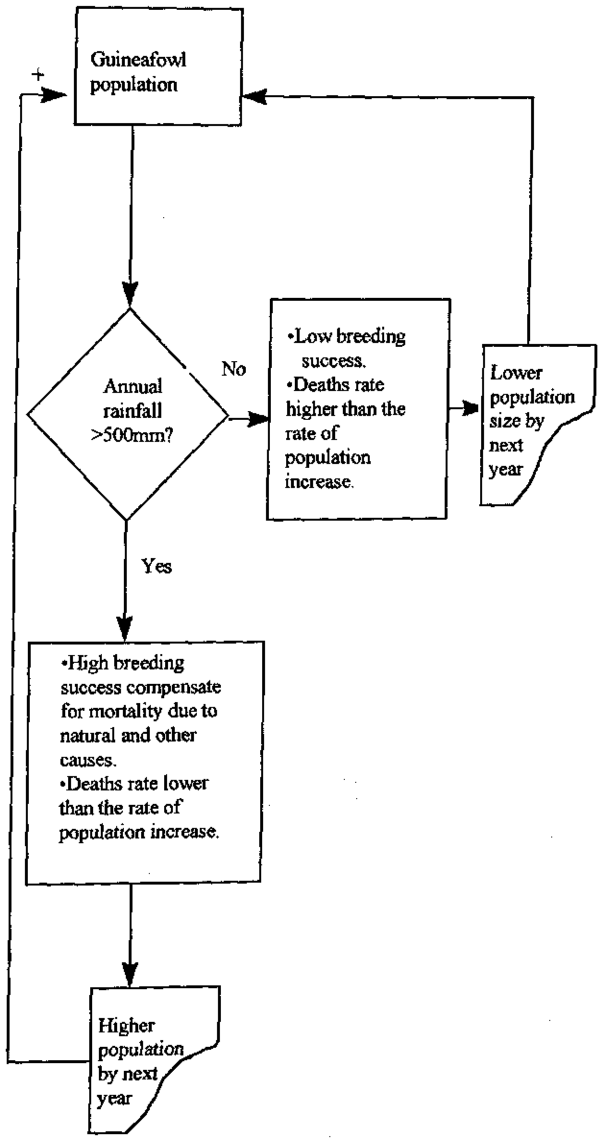
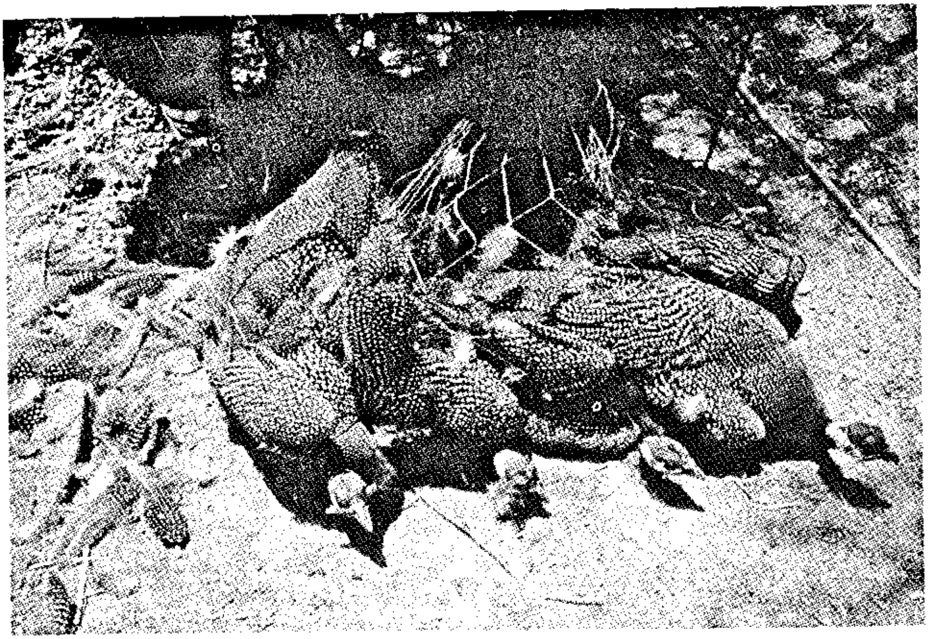


Figure 8.6
A flow diagram showing the control of guineafowl population by rainfall.



Traditional traps can be quite effective in capturing guineafowl

Although the model predicts a steady increase in the number of chicks that fledge with increase in rainfall and nest density, it must, be noted that rainfall will influence both breeding success (Chapter 5) and chick mortality (Ayeni, 1983). The closeness between the census figures for February 1995 and that from the model developed here further confirms the relationship between rainfall and breeding success with consequent influence on the population size.

The model developed here predicted that hunting at the instantaneous rate of harvest (H) will result in a higher sustained yield than at an isolated rate of harvest (h). It also predicts that hunting 12 times (or 12 months) a year (h12), will result in a sustained yield which is very close to that of hunting at the instantaneous rate of harvest (H).

The average clutch size of 9.0 eggs/nest used in the estimation of the number of chicks that fledged each year is very conservative because mean clutch size equally increases with rainfall (Chapter 5). This will lead to an underestimation of productivity for good years (years with high rainfall figures). It will however compensate possible over-estimation during years with moderate or low rainfall.

8.5 Conclusion

From Table 8.2 it can be concluded that if the variation in rainfall is taken into account, the instantaneous rate of harvest should fluctuate between 0.045 and 0.507 of the annual average guineafowl population density if nest density is between 11 and 15 nest/km^2. This implies that given the probability distribution of rainfall in the Waza area (Table 8.2), the average instantaneous rate of harvest ($\pm$ 95% confidence limits) is 0.297 $\pm$ 0.123. This average instantaneous harvest rate will be too high in dry years, and it is assumed it is assumed that the population will recover in wet years but the population would fluctuate quite widely and the danger exist with this harvesting strategy that the population could go extinct after a series of dry years.

However, if villagers would let their instantaneous harvest rate be dictated by annual rainfall, inter-annual sustainable harvest rates according to instantaneous harvest rate calculations would be large but without the danger of over exploitation. The safest strategy for villagers would be to harvest guineafowl *after* the rainy season, so that they can determine their quotum for that year. With an isolated rate of harvest for 5 months after the rainy season, they can expect to harvest guineafowl at the rates given in Table 8.2. For this safe strategy, villagers only need reliable rainfall figures to be collected during the rainy season, a strict quotum calculation (to be read from Table 8.2), and an adherence to this. However, for monitoring purposes, it would be wise if they collect data on nest density on a regular basis too. In the next chapter (Chapter 9), I will discuss the institutional side of this, but here if suffices to conclude that safe maximal sustainable harvest strategy is feasible with only very little information but only after an ecological sound model was developed.

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Chapter 9

Guidelines for Setting up of a Community Wildlife Association for the Management and Harvesting of Guineafowl in the Waza Region, Cameroon

9.1 Introduction

The classic approach to wildlife conservation in Africa of creating national parks has faced many problems mainly because of the top-down procedure adopted (see Anderson & Grove, 1987; Kiss, 1990; West & Brechin, 1991; Brown & Wyckoff-Baird, 1992; Lee, 1992; USAID, 1993; IIED, 1994). Under the label 'participation', many wildlife projects now pay attention to and advocate the involvement of local communities. However, the term participation has been used differently by different practitioners. In practice, there are two main interpretations (IIED, 1994):

1. Passive participation, where most of the decisions and funding come from a small number of technocrats or expatriates. The role of local communities in this approach is mainly limited to the provision of information and labour. Although this option is generally condemned by most practitioners, it might be the only option for some projects.
2. Active participation, on the other hand, is where local communities are involved in all the processes of finance, decisions and management. Practitioners consider this as the ideal option, but it might not be feasible or possible for all projects.

Most wildlife projects start hoping for active participation but end up in the passive form (for a review, see IIED, 1994). This chapter examines possibilities of developing a combined guineafowl management and harvesting project in the Waza region of North Cameroon, based on the active participation approach. Such projects with a dual aim (management and harvesting) will be called associations. Major issues that must be addressed in such projects are discussed and, assuming these issues can be resolved, a possible management structure for a Community Wildlife Association (CWA) for the management and harvesting of guineafowl is proposed.

9.2 Special requirements for the success of a Community Wildlife Association

Special requirements for the success of a CWA include:

9.2.1 National issues

Over the years, most local communities in Africa have lost the control of wildlife in their area because of present management practises where wildlife is controlled and managed by the state. Local communities are, however, in constant contact with wildlife in their area and are also exposed to all sorts of wildlife-related problems. These include, in particular, wildlife predation on domestic animals, damage to agricultural crops and sometimes even human casualties. In North Cameroon as a whole (Njiforti & Tchamba, 1993) and the Waza region in particular (Drijver, 1990; Tchamba, 1996), such losses have been a big source of conflict between local communities and the authorities of nearby national parks as well as wildlife in the region.

For a CWA to succeed in such circumstances, these conflicts must be resolved. New policies should be formulated at the national level delegating rights to local communities so that they can benefit from wildlife in their neighbourhood. These new policies should clearly define the rights of access to the wildlife and empower local communities, within set limits, to formulate and apply their own rules and regulations. To be sure, the handing over of rights has to go together with regulations at the national and local level regarding surveying, quota setting, financial aspects, and other. In this way, a balanced situation could be achieved.

Most African governments are, however, reluctant to hand over the control of resources to local communities (Van den Breemer & Venema, 1995) and this can be a big obstacle to community-based wildlife projects (see Baldus, 1991 for the community wildlife management around the Selous Game Reserve in Tanzania). However, some African countries have made major progress in this area and, at the time of writing, Cameroons' National Assembly has proposed a law that facilitates the handing over of forestry and wildlife management to local communities.

In the Luangwa Integrated Resource Development Project (LIRDP) in Zambia, the national issues are handled by a top level steering committee headed by the president of Zambia and made up of ministers of concerned ministries, and members of the central committee of the ruling party (Dalal-Clayton, 1988; Adams & McShane, 1992; Barbier, 1992; Mwima, 1994; IIED, 1994). In the Zambian Wetland Project (Kiss, 1990; Crutchley, Jeffery & Chooye, 1991), community empowerment and handing over of rights is achieved through Community Development Units (CDUs) which facilitate the integration and participation of local communities through elected membership. However, IIED (1994) reported that the Zambian Wetland Project links with the central government were poor in the past and efforts are currently being made to improve this. In the Wildlife Extension Project (WEP) in Kenya (Berger, 1993; Lee, 1992; Brandon & Wells, 1992; IIED, 1994), local government representatives work closely with the project ; but there is no formal government involvement. This coupled with a lack of understanding of the dynamics of the Massai resulted in constant conflict.

9.2.2 *Economic issues*

For a CWA to be successful it is important that the long term output of the association (money or meat) be large enough to make a difference for the community involved. In some cases, a good option has been to consider a multiple use system (e.g. tourism and safari hunting, or safari hunting and livestock breeding) which might generate a higher income than just wildlife use alone (IIED, 1994).

Most wildlife related projects in Africa benefit from nature conservation organisations, like the World Conservation Union (IUCN), World Wide Fund for Nature (WWF) and the African Wildlife Foundation (AWF). Such organisations and hunting clubs (e.g. Safari Club International) should be approached if necessary. This is particularly true because the initial stage of most wildlife projects is costly and economic returns may take a long time to realise (e.g. the CAMPFIRE Project, Murphree, 1994). However, conditions for such external funding must be clearly defined from the outset, especially when hunting clubs are to be involved. This is to avoid situations where decisions at the local level have to rely too much on donor conditions.

In Cameroon, an alternative would be to get loans from village banks that give loans at much more favourable conditions than most commercial banks. In fact these village banks developed also from local associations. A good example of such a locally initiated association in north Cameroon is the Gouzda case, described by Drijver & Van Zorge (1995). In this case a former schoolteacher initiated youth groups to take care of health, agriculture, roads and water problems in his village (Gouzda). These youth groups were later transformed into Village Development Committees (VDC) to cater for these issues. The success of these VDCs rose the interest of many nearby villages and many VDCs now exist in the whole region based on the Gouzda model.

Although wildlife is considered in this chapter mainly as an additional source of protein for local communities, it is important to note that wildlife can also be managed by local people for other reasons.

These include:

1. Tourism and safari hunting. In most community-based wildlife projects, this aspect has been found to be the greatest income generator, and has great potentials for the future. This has, for instance, been the case in the CAMPFIRE Programme in Zimbabwe (Olthof, 1995), the Dzanga-Sangha Dense Forest Reserve Project in Central African Republic (Doungoube, 1993) and the Luangwa Integrated Resource Development Project (LIRDP) in Zambia (Dalal-Clayton, 1988). Although the guineafowl, the species of interest in this chapter, can generate some income from sport hunting, it is unlikely that it could ever become a major tourist attraction.
2. Aesthetic and cultural values. This aspect of wildlife conservation is difficult to quantify in economic terms. In some Cameroonian villages some wildlife species were and are still hunted or used only during special ceremonies. For instance, some village chiefs sit on lion skin during traditional ceremonies. In other villages, carved elephant tusks are used as trumpets to announce the arrival of the village chief. Various parts of wild animals like skins, skulls or bones are used by many Cameroonian tribes during traditional dances and in some cases the dancers are believed to have been transformed into the species of which they are wearing the parts of or are carrying. Some wildlife species are also protected because of cultural reasons, religious beliefs and taboos. For example, Muslims in north Cameroon state they are forbidden by their religion from eating warthogs and monkeys (see Chapter 2).

9.2.3 Organisational issues

Organisational issues concern aspects like the structure of the association, power and decision trees, as well as the distribution of tasks and revenues. Other issues to be addressed here are the guiding of hunters, the control of hunting, the prevention of poaching, and the punishment of offenders.

The history of the communities involved in the CWA (in relation to the authority structure) must be well understood from the outset. For example, the village chief might have power to prevent certain activities of the association to be established in his village. To avoid conflict, traditional social structures should, where possible and when they exist, be incorporated in the association. Another important issue is the conflict of user rights that might arise from such associations. In most situations, a few individuals try to exploit the institution to their own benefit only.

It is equally important to know if the population is homogenous or heterogeneous. Experiences from other parts of Cameroon are that when an association is created in a heterogeneous community, e.g., between two tribes, one of the tribes might withdraw, which may later lead to the collapse of the association. The present political situation of Cameroon (multi-party democracy) must also be born in mind, because people from different political parties might not like to collaborate. There are also situations where political parties appropriate such organisations for their own benefit, which may lead to blackmailing and other forms of sabotage by other political parties (personal observation). A good mechanism must thus be found to guard against these potential sources of conflict.

As was mentioned earlier, in the LIRDP in Zambia (Dalal-Clayton, 1988; Adams & McShane, 1992; Barbier, 1992; Mwima, 1994; IIED, 1994), a top level committee is responsible for setting up project policies at the national level. A provincial executive committee implements these policies and manages the projects revolving fund. Technical sub-committees in the various sectors (agriculture, wildlife management, forestry, etc.) are responsible for developing a management plan for the wildlife (including the setting of hunting quotas) based on ecological information, including annual aerial surveys.

A local leaders' sub-committee made up of chiefs, ward chairmen, local members of parliament and local administrators is given the authority to carry out most local-level planning issues, for example settlement pattern, allocation of hunting quotas to safari hunting, local hunting, ceremonies and control of trouble animals.

Although the high-level political involvement in this project could be seen as a guarantee for the project's success, there are too many committees and according to IIED (1994) the project ended up becoming 'a maze of regulations and committees, the latter spending much time in discussing what other committees had done!'.

In the Zambian Wetland Project (Kiss, 1990; Crutchley, 1991; Jeffery & Chooye, 1991) each of the two wetlands has been divided into Wetland Management Units (WMUs) with subsidiary Community Development Units (CDUs). Local participation is achieved through elected membership at the CDU level. CDUs are responsible for determining and prioritising community needs and recommending projects for support.

In the Communal Area Management Programme for Indigenous Resources (CAMPFIRE) in Zimbabwe (Murindagomo, 1990; Hitchcock & Nangati, 1992; Murphree, 1994; IIED, 1994), the approach is different. The project is implemented by the Department of National Parks and Wildlife Management (DNPWLM) of Zimbabwe in collaboration with the Centre of Applied Social Sciences (CASS) at the University of Zimbabwe, WWF Multispecies Animal Protection Systems Project, the Zimbabwe Trust (ZimTrust) and the CAMPFIRE Association. For a community to benefit from the CAMPFIRE Program, they must first organise themselves and apply to the DNPWLM for the so called 'Appropriate Authority status', which is a recognition that the community can manage and use its wildlife. The community must also produce a wildlife management plan, and the institutional capacity to implement it.

9.2.4 Ecological issues

It is important that the biology of the wildlife species to be used by the CWA be well understood. Some approaches for gathering this biological information for the guineafowl is presented in chapters 3 to 8. This will include estimating the population density (and size) and how the population reacts to variation in ecological conditions as well as to human intervention (Chapter 3). The feeding habits, breeding ecology, mortality rates, migration and social organisation of the species should also be well understood (see chapters 4 to 7 for the guineafowl). Finally, a technique for establishing hunting quotas based on this biological information must be adopted. Suggestions makes of how to make estimations of hunting harvests in relation to yield for the guineafowl are made in chapter 8.

These ecological questions can hardly be handled by the local communities right from the outset. In almost all wildlife related projects, these issues have been addressed by outsiders. For example, in the CAMPFIRE programme, ecological issues are mainly handled by outsiders. The Department of National Parks and Wildlife Management (DNPWM) determines all hunting an cropping quotas with the help of World Wide Fund for Nature (WWF) Multispecies Research Project.

9.2.5 *Institutional issues*

Institutional problems to be addressed in a CWA or a similar project can be subdivided according to the project phases (see IIED, 1994).

Three important phases are discussed here and include:

1. The pre-association phase (or preparatory phase). During this phase, the major problems will be land-right allocation, labour and capital needed for the project to take-off. The government might also have to change legislation to permit the starting of the association. In most cases, this phase has been mainly carried out by independent ecologist and conservationist or NGOs (mostly non-locals). Village organisations which can initiate CWA are rare. Venema (1995) noted that most local communities only organised themselves because there were possibilities to obtain donor funds.
2. The starting phase. This phase usually involves the putting in place of all necessary sociological, ecological, construction, and managerial structures. All negotiations for the boundaries of the project are carried out during this phase. In most cases, this phase is carried out by a team leader who may or may not be a wildlife expert. This phase usually demands much input (financial and material), and most wildlife related projects never take off because of this requirement.
3. The implementation phase (which should be sustainable). Since the pre-association phase and the starting phase of most wildlife related associations are mostly funded by external agencies, it is important that some mechanism is developed to guarantee the long term survival of the project after such funding has stopped. It appears to be important that external funding be phased out progressively rather than being stopped abruptly.

9.2.6 *Educational issues*

As was stated earlier, most expertise during the initial stage of the CWA comes from non-local nationals and expatriates. However, it is important for sustainability that local expertise (both at national and village level) is developed during the three phases of the association discussed above. A way must be found to progressively pass over knowledge on the management aspects to both nationals and the local communities. In the CAMPFIRE project these training aspects are handled by Zimbabwe Trust (ZimTrust, a local NGO), Centre for Applied Social Science (CASS) at the University of Zimbabwe and some external agencies like the World Wide Fund for Nature (WWF).

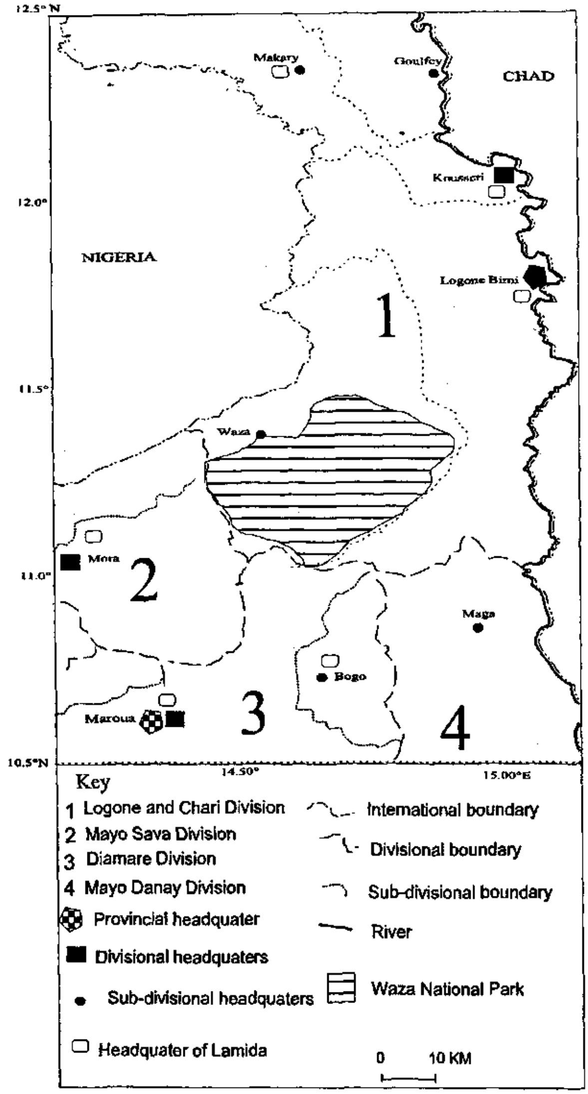

Figure 9.1
Partial map of the Far-North province of Cameroon showing administrative divisions and the headquarters of some chiefdoms (Lamida).

9.3 Community Wildlife Association: the Waza guineafowl case

9.3.1 The Waza region

The area that was investigated to see if it was possible to set up a CWA for the guineafowl lies between Latitudes 11.00° and 11.50° N and Longitudes 14.20° and 15.00° E (Fig. 9.1). Most of this area is covered by the Waza National Park (170,000 ha). Some 70% are of the Islamic religion consisting mainly of people of Choa-Arab and Fulbe tribes. Other prominent tribes include the Kotokos, the Musgums and Bornoans. Animal husbandry is a major activity in the region and is mainly carried out by the Fulbes and Choa-Arabs while other tribes practise agriculture, fishing and small scale animal breeding (BONIFICA, 1990). Recently, the sale of firewood has become a major source of income for villages located along passable roads, which has resulted in extensive deforestation in some places (Njiforti, unpublished data). There are very few schools in the region resulting in a very low literacy rate of about 25%. Most government services are concentrated in Waza and Mora towns. Health care facilities are limited to a dispensary with very poor facilities in Waza and a hospital in Mora.

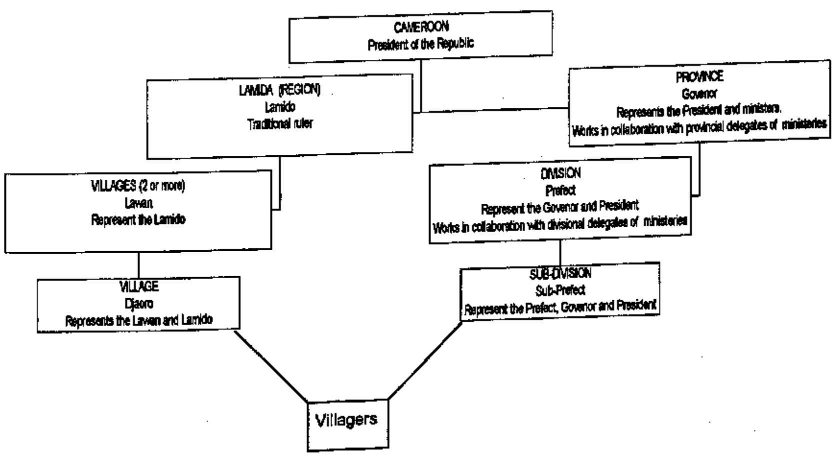

Figure 9.2
Administrative and traditional power structure in the Waza region of the Far-North province of Cameroon.

Natural resource use in the Waza region is achieved through 2 administrative systems, the governmental and the traditional system (Fig. 9.2). The traditional system is controlled by traditional leaders call '*Lamidos*' (singular, *Lamido*, Fulbe appellations are used for all traditional rulers), who commands a region 'Lamida' that is made up of many villages and towns, considered here as region. The *Lamido* appoints *Lawans* (singular *Lawan*), who commands a number of villages and *Djaoros* (singular *Djaoro*), who govern at the village level. In the past, these traditional leaders had widespread powers over natural resources in the region. Presently, some of these powers have been greatly reduced by the government. Administratively, although all land belongs to the state, control over land at the village level is still within the competence of these traditional leaders.

Governmental control over natural resource use is achieved through the president of the republic and his ministers at the state level, the provincial governor and provincial delegates of various ministries at the provincial level, prefects and divisional delegates of various ministries at the divisional level and sub-prefects and sub-divisional delegates of various ministries at the sub-divisional level. The study area falls under two divisions the Mayo Sava Division with headquarters in Mora and the Logon and Chari Division with headquarters in Kousseri (Fig. 9.3). It is important to note here that there is no parallel comparison of the governmental and traditional power structures in the region, a *Lamido* cannot thus be compared with a governor or a prefect. The governmental administrative divisions do not necessarily follow the traditional boundaries of the *Lamida*. This may result in a prefects or sub-prefects governing with more than one *Lamido* or vice versa, for example the town of Waza (Fig. 9.3) falls under the sub-prefect of Waza sub-Division following the governmental power structure, while depending on the *Lamido* of Logone Birni which is in the Logone Birni sub-Division.

9.3.2 *Questions that needed to be answered*

A socioeconomic survey was carried out in the study area region to provide answers to the following questions:

1. What is the local communities' impression of the Waza National Park?
2. What is the social acceptance of guineafowl and its eggs as food in the region?
3. Do people domesticate guineafowl?
4. Which part of the population hunts the guineafowl or collects eggs?
5. Amongst those who hunt, what hunting techniques are used, and do they sell or eat it?

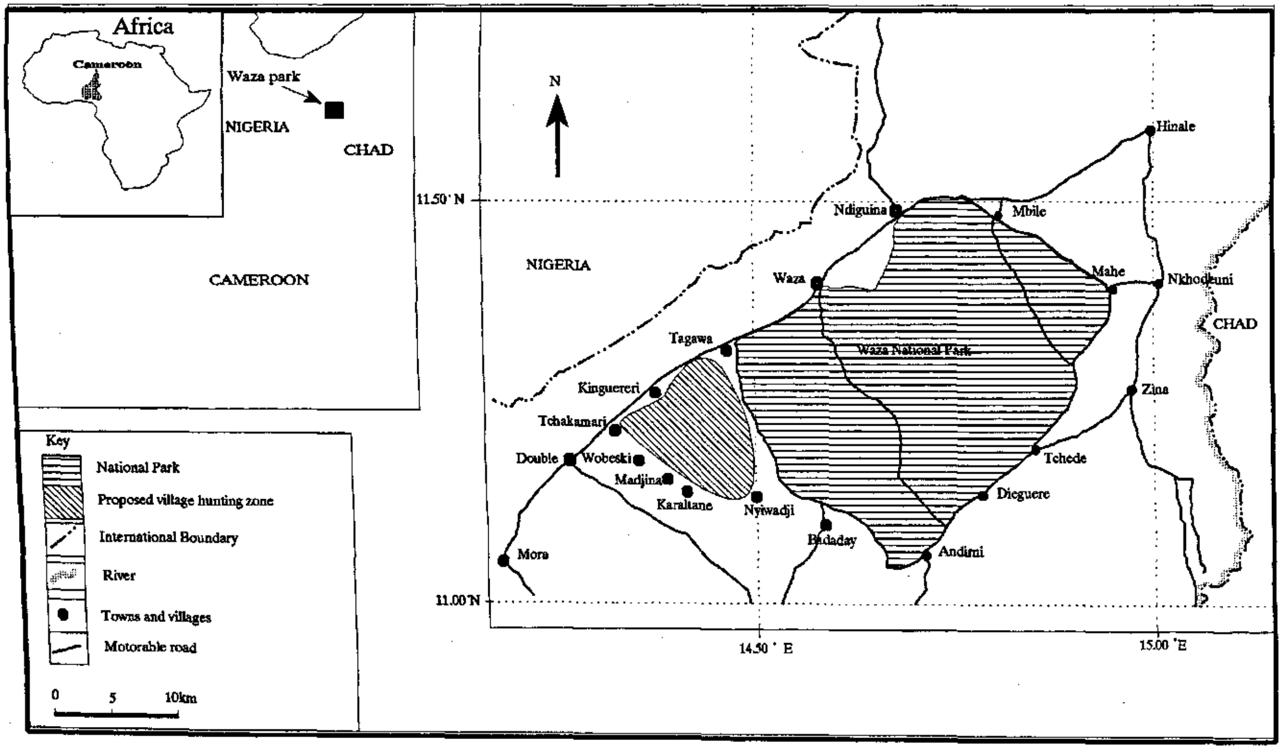

Figure 9.3
Map of the Waza region showing the best location of the proposed village guineafowl hunting zone and other potential areas for the hunting zones with lower guineafowl production.

6. What is the market price of the guineafowl, and how does it vary with season?
7. What is the legal situation with regard to hunting of this bird?
8. Is there any control system for guineafowl hunting? If not can one be created?

- Based on the answers to these questions and data from previous (ecological) studies, where can a village hunting zone for the management and harvesting of guineafowl) be created in the Waza region be located.
- What is the best way to organise a Community Wildlife Association for the management and harvesting of guineafowl in the Waza region?

9.3.3 *Methodology*

Village interviews were carried out in 1994, using the methodology described in chapter 2. In 3 small villages of less than 6 households, everybody who was present was interviewed. A total of 126 households were interviewed in 16 villages situated within 15 km from the park's boarder. The first survey was carried out in collaboration with the IUCN-Waza-Logone Project, a conservation and development project in the region. The research team consisted of one researcher, 2 students (from the Wildlife School in Garoua, Cameroon) and 1 interpreter. These first results showed a male bias in the respondents ; a second study focused on women was carried out by a female team consisting of one researcher and one interpreter.

The introductory questions gathered general information about respondents' sex, age, marital status, tribe, religion and how long they had been in the region. The main questions (results of which are reported here) focused on the relationship between respondents and the Waza national park, the present use of guineafowl and on the question whether respondents thought it necessary to create a village hunting zone to permit them to legally hunt guineafowl. Respondents were also asked if any village organisations exist that could manage these hunting zones if created, and if not, how they thought this should be organised. Data from ecological studies on the guineafowl was used in delimiting an area with high potentials as a village hunting zone for guineafowl management and harvesting. Based on all information gathered, a possible set-up for a Community Wildlife Association for the running of this village hunting zone is proposed.

9.3.4 Results

The importance of the park
Out of the 126 respondents, 117 (93%) said they knew of the existence of the Waza National Park, while the rest said they did not. As to the advantages of having the Waza National Park, 74 respondents (59%) said they had no benefits, while 37 (29%) said they have benefited from the park in one way or the other; and 15 (12%) said there were both benefits and disadvantages. Respondents who said they had benefited from the park's existence cited wood for domestic cooking and grass for roofing of houses as the main benefits they had from it. Problems with the national park included constant harassment by park authorities, destruction of agricultural products by wildlife and wildlife predation on domestic livestock. The most destructive animal was said to be *Quelea quelea* for sorghum, and lion, hyena, and jackal for domestic livestock. Although the Waza elephants are reported to be migrating and causing widespread damage to farmland in other parts of the province, (see Tchamba, 1996), only 3 respondents (0.02%) said they have had problems with elephants. This is probably due to that fact that most of these villages are not situated along the elephant's route. The high risk zones for elephant damage to agricultural crops are actually more than 50 km south of the park (see Tchamba, *op.cit.*)

Social acceptance of the guineafowl
Fifty-two per cent (n=66) of respondents found the guineafowl to be delicious while 48% (n=60) did not give an opinion. Comparing guineafowl to domestic chicken, (Table 9.1), 44% (n=55) of the respondents preferred domestic chicken to guineafowl, 30 (n=37) preferred the guineafowl , 27% (n=34) either had no preference or did not know which they preferred. The higher preference for domestic chicken was not statistically significant (χ^2= 21.5, df 2, p>0.1). Respondents who preferred domestic chicken said it was preferred because of ease of acquisition, while most of those who preferred the guineafowl said that the taste was the main reason for the preference. Respondents' preferences for the two birds, however, varied significantly with tribe (χ^2=78.8, df=5, p<0.01).

Guineafowl domestication, egg collection, hunting and selling
Asked whether respondents had ever tried to raise guineafowl, 99 respondents (79%) said they had never done so, while 27 (21%) had tried at one time or another to raise guineafowl. Most respondents were very suspicious on the question concerning guineafowl hunting. Twenty-six (21%) respondents said they hunted. Out of this number, 20 hunted individually, and 6 hunted sometimes in groups. All hunters said they hunted for home consumption only. The

males who hunted used net, locally made guns, spears, sticks and hunting dogs. The commonest hunting practice by women was egg collection during the breeding season.

Table 9.1
Tribal differences in the preferences between guineafowl and domestic chicken in the Waza region

Tribe	No. of respondents	% of total	Preference*		
			Guineafowl	Domestic chicken	No preference or Do not know
Musgun	10	8	8 (80.0)	2 (20.0)	0 (0)
Choa-Arab	49	39	14 (28.6)	22 (44.9)	13 (26.5)
Bornoan	29	23	6 (20.7)	15 (51.7)	8 (27.6)
Kotoko	11	9	2 (18.2)	5 (54.5)	4 (38.4)
Fulbe	13	10	1 (7.7)	6 (46.2)	6 (46.2)
Others	14	11	6 (42.9)	5 (35.7)	3 (21.4)
TOTAL	126	100	37	55	34

* Numbers in bracket represent tribal percentages.

All the respondents who hunted guineafowl did so for home consumption, occasionally offering some to their friends as presents. The main reasons respondents did not sell their hunt was the fear of being caught by national park workers. Of the 27 people who had raised guineafowl, 23 (18% of all respondents) did so for home consumption while 4 (3%) did so for marketing. The market price of guineafowl was said to vary between 500 and 1000 Francs CFA (between 1 and 2 US dollars), the highest prices being recorded during the rainy season.

Present legal situation for guineafowl hunting and hunting control system
Only licensed hunters (mainly not locals) are officially authorised to hunt outside the Waza National Park. Locals do not generally apply for these hunting licenses partly because of the long and costly procedure involved, (more than 10,000 CFA (US$20) is needed for a small game license needed for guineafowl hunting) and partly because of ignorance of the requirements for obtaining a license.

No traditional hunting organisations or control system exist in any of the villages visited. Only in two villages to the north (Ndiguina and Mahe) 2 old respondents mentioned the existence of a traditional fishing system in the past. Asked if villagers can organise themselves for the management and harvesting of guineafowl in a village hunting zone, 109 (87%) of the respondents said it could be easily done whilst 17 (14%) thought this would be a difficult task.

Of the 109 respondents who said they could organise themselves for the management of a village guineafowl hunting zone, 58 (46%) thought this could be in the form of village meetings presided by village chiefs (*Djaoros*). Forty-nine (39%) of the respondents thought the researchers or some project should initiate the association and 19 (15%) thought the government could organise them. On the question what the villagers could provided as services in such an organisation and how it should be funded, all respondents said they could provide labour if necessary, and 13 (10%) were willing to contribute money for such an association. Reasons for not contributing financially included poverty, lack of understanding on how the money will be used, and the suspicion that the association may just be another way of taxing people.

9.4 The proposed village guineafowl hunting zone and possible structures for a Community Wildlife Association for running it

Based on the information gathered from this sociological survey and the results of the ecological studies of on guineafowl (chapters 2-8), an area occupying about 10,000 ha was is proposed as a best bet for a guineafowl hunting zone. Other zones with lower potentials (lower guineafowl densities) are also proposed (Fig. 9.3).

The area proposed as the best bet for a guineafowl hunting zone was selected based on the following criteria:

- The zone is sparsely populated with only 7 major villages and a population of about 400 inhabitants (see Fig. 9.3).
- It includes a large uninhabited area with habitat that is suitable for the guineafowl.
- This is the only zone within the parks' buffer zone where the guineafowl population is high (Chapter 3). The eastern floodplains have no guineafowl, whereas the western boarder of the park is flooded during most part of the year resulting in low guineafowl density. The northern part of the region also has very low guineafowl density (<10 birds/km^2 most of the time, Chapter 3).
- Local communities in this zone are willing to organise themselves for guineafowl management and harvesting.
- In chapter 8, the population of guineafowl in a 400 km^2 study area in the Waza region was about 19,000 birds. The 10000 ha proposed village hunting zone will thus have about 4750 guineafowl. Harvesting this population at a sustainable instantaneous harvesting rate (H) of 0.42 per year (Chapter

8) will yield about 2000 guineafowl a year. This is equivalent to about 5 guineafowl or about 10 kg of (guineafowl) meat per villager per year for the 400 villagers in the proposed hunting zone. In chapter 2, 345 respondents were found to be consuming about 8160 kg of meat (from wildlife and domestic livestock) per year. This is equivalent to some 23.7 kg of meat per respondent per year. Assuming that meat consumption pattern in villages of the proposed village hunting zone follows the regional pattern, 10 kg of guineafowl meat will be representing about 42.2% of each villagers annual animal protein need which is a substantial contribution.

9.4.1 *Organisation of villages in a Community Wildlife Association for the management and harvesting of guineafowl in the hunting zone*

Considering the socioeconomic and political situation in the Waza region and the outcome of the sociological survey reported here, the creation of a Community Wildlife Association (CWA) in the Waza region following the active participation concept discoursed in the introductory section of this chapter might not presently be feasible. A combination of the passive and active participation approach might be the best option.

A possible set-up of a CWA for the management and harvesting of guineafowl might be one that follows the CAMPFIRE model modified to reflect local realities. In the CAMPFIRE model, villagers are encouraged to organise themselves (to benefit from the programme) by the Department of National Parks and Wildlife Management (DNPWLM) and the Centre of Applied Social Sciences (CASS) of the University of Zimbabwe (an active participation approach). In the Waza case, the social aspects handled by CASS in the CAMPFIRE Programme could be handled by the Centre for Environmental Studies and Development in Cameroon (CEDC), which is the nearest organisation with qualified manpower to play this role. Once created, such an association could be run by committees. The structure and functions of the committees are proposed later in this chapter.

Unlike in the CAMPFIRE programme where most of the land belonged to white farmers before the programme started (Olthof, 1995), any committees for the management and use of any natural resources in the Waza region (outside the national park) must include local leaders or their representatives since they still have a lot of control over land use outside the Waza National Park.

The Ministry of Environment and Forestry (MINEF), Department of Wildlife and National Parks might play the role DNPWLM play in the CAMPFIRE programme. MINEF can issue some form of authorisation (like the Appropriate Authority in the CAMPFIRE Programme) to villages that accept and organise themselves for the management and harvesting of guineafowl. Following the CAMPFIRE model, this authorisation will empower such villages to enter into contracts with private organisations for the management and exploitation of guineafowl in their area. They will also directly receive all payments resulting from such contracts. Furthermore, such villages should also be responsible for all law enforcement and protection of guineafowl in their area.

Ecological studies including the determination of hunting quotas could be handled by the Department of Wildlife and National Parks of MINEF as the Department of National Parks and Wildlife Management do in the CAMPFIRE programme (a passive participation approach). Ecological monitoring could also be handled at the level of the Waza National Park by the park Warden and his game guards. Additional ecological advice could be sorted from NGOs presently involved in the region, like the IUCN-Waza-Logone Project or GOs like the Wildlife School in Garoua. Following such a model, the IUCN Waza-Logone project has (successfully) started an association in one of the villages near the park boarder for the promotion of eco-tourism. The IUCN Waza-Logone project has equally proposed a permanent committee at the provincial level (headed by the provincial governor) for the management of the Waza National Park and its buffer zones.

The combined active and passive participation approach proposed here will have the following advantages :

- Involving government authorities (MNIEF) will ensure that villagers are legally protected. The administration also has the work-force and capacity (the National Park service) to address technical issues that might not be easily addressed at the village level. This is particularly true because of the low educational levels, inexperience in handling such associations and weak economic base of communities in the region that may make meaningful decision making, planning and implementation of management plan difficult.
- Involving traditional authorities (*Lamidos, Djaoros* and *Lawans*) will avoid situations of conflict that might arise if the village chiefs are not co-operative. This is equally true since traditionally all land still belongs to these highly respected chiefs.

The CWA thus formed could be function under two committees who's roles and functions could look as follows:

1. A Regional Committee

This body can be headed by a chairperson who for political backing can be the Governor of the province or one of the two sub-prefects of the region. Its membership can be made up of the *Lamidos* or theirs representatives, the prefects, the Department of Wildlife and National Parks (MINEF) and elected villagers village representatives. The involvement of both the traditional (*Lamidos*) and governmental authorities (governor or prefects) will act as a safeguard against outsiders who otherwise can be difficult to control at the village level. It will also give some political backing to the decisions taken.

This committee could have the following roles and functions:
- Taking care of all national issues related to the hunting zone.
- Allocating and demarcating land for the village hunting zone.
- Defining and defending the right of access to the hunting zone.
- Defining the association's policy in consultation with village committee.
- Negotiating for funds and association's technical advisers with central government and NGOs.
- Proposing how to share association's funds to the Village Committee.
- Discussing and forwarding proposals for funding to central government and NGOs.
- Being responsible for ecological studies (with the help of GOs or NGOs) in the hunting zone.
- Allocating hunting quotas (base on the quotas determined by MINEF) to the villages (or to safari hunters if necessary) and defining the system of control of the hunting zone.
- Sharing of the revenue amongst members of the association.
- Writing and forwarding proposal for funding to GOs and NGOs.
- Formulating and submitting funding requests.
- Reviewing complains from villages and taking appropriate decisions.
- Training of villagers (with the help of GOs and NGOs) on basic guineafowl management techniques, management of finances, guiding of hunters, and book keeping. The training aspect might justify the presence of the Wildlife School and the National Park service in this committee.
- Taking care of the accountability aspects.
- Helping in the writing and implementation of management plan for the hunting zone.
- Punishing and collecting fines from defaulters and forwarding recalcitrant poacher and defaulters the court of law.

2. *Village Committee(s)*

There can be one committee per village made up of elected representatives for large villages and all villagers for small villages. In that case, the choice of the committee chairperson should be left to the villagers. There could also be a single committee for all the villages involved in the association, its membership being limited to elected representatives of villages. In that case, the choice of the committee leader will be left to the committee.

This committee might have the following task:
- Electing representatives for the Regional Committee.
- Defining village priorities and forwarding these to the regional committee.
- Monitoring and reporting defaulters to the Regional Committee and the forces of law and order.
- Ensuring that revenue destined for the villagers are effectively distributed as well as determining and ensuring the collection of individual contributions.
- Forwarding complaints to the regional committee.

9.4.2 *Funding of the association*

Initial funds for the association might come from the government and international NGOs involved in wildlife activities. Local NGOs like the IUCN-Waza-Logone project which is actively involved in the region might also be a good source of initial funding. As results of the socioeconomic survey showed, local communities in the Waza region are willing to participate in such an association both financially and materially. Although the percentage of villagers who accepted to participate financially was low, (10%), this percentage could increase when in the long run once they start deriving some benefits from the association.

9.5 Discussion and conclusions

Mechanisms for involving local communities in wildlife related projects have evolved substantially during the decade, but it is impossible to prescribe a universal approach. Experiences from other countries or regions might help in setting up of wildlife related projects with local participation but it is impossible to directly transpose the approach in one country or region to another without modifications. It will thus be unrealistic to imagine a completely decentralised system of management and decision making for a CWA in the Waza region like in the CAMPFIRE Project given the present legal, political, and economic situation of Cameroon as well as the social system in the region. Thus the active participation that was envisaged for a Community Wildlife Association might not be presently feasible.

Local communities around the Waza National Park are willing to organise themselves into associations for the management and harvesting of guineafowl. The major constraint is that this approach is new to the area. This results in a lack of understanding on to how such an association will function, and suspicions by local communities that governmental or traditional institutions might be the ones to benefit from them. Presently, traditional and governmental institutions control all use of natural resources in the Waza region. These bodies must be willing to hand down some of these powers to the local population for any CWA to succeed in the region. It might thus take some time for mutual trust to be developed between local communities and these institutions, a prerequisite for the success of such a CWA. Such trust building might be achieved through an intermediary body or independent organisation (NGO) like the IUCN Waza-Logone Project which is presently highly respected and trusted by most local communities in the region (see Tchamba, 1996). The implication of all this is that governmental and traditional institutions must be involved in any CWA that is envisaged in the Waza region.

Although guineafowl management and harvesting will contribute substantially (42.2%) to the annual animal protein needs of local communities in the proposed village hunting zone, it is still unclear if this contribution is enough for local communities in the zone to see guineafowl management and harvesting as an alternative (productive) long term land use option. As was discussed in the introductory section of this chapter, the willingness of local communities to adopt wildlife management and harvesting as an alternative land use option is one of the conditions for the success of a Community Wildlife Association.

An alternative will be to study and include other potential species like elephants (which is presently hunted by safari hunters) in a multi-species management and harvesting programme. Wildlife management, and harvesting will then be able to contribute for a long time to more than half of the annual animal protein needs of the local communities in the hunting zone as well as provide them with a possible source of additional income. In that case, wildlife management and exploitation is bound to have a positive impact on the local community, with a possible increase in awareness at the local level of the importance of wildlife (conservation and exploitation) as in the Zimbabwe CAMPFIRE Programme.

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Curriculum Vitae

Hanson Langmia Njiforti was born in Bali Nyonga (Cameroon) on the 9 of February 1959. He completed his studies at the St. Anthony's Catholic primary school, Mamfe (Cameroon) in 1970 and continued to the Government Secondary School Mamfe where he obtained the General Certificate of Education Ordinary Level (GCE O/L) in 1977. He did his High School education in the Cameroon College of Arts Science and Technology (CCAST) Bambili, where he obtained the General Certificate of Education Advanced Level (GCE A/L) in the sciences in 1979. He then moved on to the University of Yaounde (Cameroon) where he obtained a BSc in zoology in 1983. Between 1984 and 1986, he worked as a Wildlife Senior Technician with the Institute of Animal and Veterinary Research (IRZV) Cameroon, before moving to the United Kingdom where he Obtained an MSc in Natural Resource Management at the University of Edinburgh in 1987.

On his return to Cameroon in 1988, he was recruited in IRZV as an Assistant Wildlife Research Officer and appointed as the Counterpart Director (1988 -1989) for the research and conceptual phase of a Dutch-funded environmental conservation and development project (the Waza-Logone Project). Before enrolment in his PhD program, he carried out research in all 5 National Parks of North Cameroon and has a number of wildlife and environmentally related reports and publications to his credit. Since September 1996 he has worked with the Netherlands Development Organisation (SNV) in Maroua, as a researcher attached to the Centre for Environmental Studies and Development in Cameroon (CEDC) Maroua.