Ecological and economic impacts of gorilla-based tourism in Dzanga-Sangha, Central African Republic

Promotor: Prof.Dr. H.H.T. Prins
Hoogleraar in het Natuurbeheer in de Tropen en Ecologie van Vertebraten

Co-promotor: Dr. A.M.H. Brunsting
Hoofddocent leerstoelgroep Natuurbeheer in de Tropen en Ecologie van Vertebraten

Promotie commissie:
Prof.Dr.Ir. G.M.J. Mohren
Wageningen Universiteit

Dr. L.E.M. Vet
Nederlands Instituut voor Oecologisch Onderzoek

Dr. C.E.G. Tutin
University of Stirling, UK

Dr. E.H.M. Sterck
Universiteit Utrecht

Allard Blom

Ecological and economic impacts of gorilla-based tourism in Dzanga-Sangha, Central African Republic

Proefschrift
ter verkrijging van de graad van doctor
op gezag van de rector magnificus
van Wageningen Universiteit,
Prof. Dr. Ir. L. Speelman,
in het openbaar te verdedigen
op maandag 11 juni 2001
des namiddags te vier uur in de Aula

Doctoral thesis (2001), Department of Environmental Sciences, Tropical Nature Conservation and Vertebrate Ecology Group, Wageningen University, Bornsesteeg 69, 6708 PD Wageningen, The Netherlands.

ISBN 90-5808-410-8

THESIS PROPOSITIONS
(Stellingen)

Accompanying the doctoral thesis:

"ECOLOGICAL AND ECONOMIC IMPACTS OF GORILLA BASED TOURISM IN DZANGA-SANGHA, CENTRAL AFRICAN REPUBLIC"

1. Western lowland gorillas can not be classified as strictly vegetarian because they digest considerable amounts of insects, most notably termites.
this thesis

2. The main reason that law enforcement in central Africa is presently insufficient to stop the bushmeat trade, is lack of sustainable funding.
this thesis

3. Regular daily contact and forewarning the gorillas of one's imminent arrival are the two most important factors in promoting habituation in western lowland gorillas.
this thesis

4. Notwithstanding the potential of tourism to generate substantial revenues for protected areas, it will never generate enough to sustainably and sufficiently manage those in the Guinean-Congolian Forest Region.
this thesis

5. Given the poor economic development of most of the countries of the Guinean-Congolian Forest Region, the international community is going to have to pay the costs of biodiversity protection in this region.
this thesis

6. On average African nations spend almost three times as much of their national budget on protected area management as do wealthy European and North American nations.
Wilkie, D.S. & Carpenter, J.F., in prep. The under-financing of protected areas in the Congo Basin: so many parks and so little willingness-to-pay

7. The evolution of sociality and cognition are apparently intertwined with inequality and information sharing.
Prins HHT (1996) Ecology and behaviour of the African buffalo. London: Chapman & Hall.

8. The refractive index (R), as a measure of the consistency of butter, is negatively related both to the daily fat production of the cow (K in g) and the fat content of the milk (V in %).
Blom, G.F. (1962) Het verband tussen de lipiden in het gras en de consistentie van de boter. Proefschrift. Mededelingen der Landbouwhogeschool te Wageningen/Nederland 62 (9), 1-134. p:124-127.

Allard Blom
Lope, Gabon
April 23, 2001

In memory of:

Urbain Ngatoua

National Director Dzanga-Sangha Project

and

Dr. Gunther Merz

World Wildlife Fund - Germany

Abstract

This thesis investigates the potential role of tourism in the funding of protected area management in the Congo Basin. An assessment of the protected areas and gazetted forests of the Central African Republic (CAR) showed that only about one third of the protected areas is more or less effectively managed. Almost all the gazetted forest and the remainder of the protected areas are insufficiently protected from human disturbance, which is mostly in the form of poaching. This example underlines the fact that long term under-financing of the management has seriously affected the integrity of protected areas in the Congo Basin. Even in relatively well managed areas, such as the Dzanga-Sangha protected area complex, in southwestern CAR, human impact on wildlife can still be measured and is related to the distance from roads.

The costs of management to effectively protect the forests of the Congo Basin are high. The potential role that tourism could play in raising revenue for management and for the local communities was investigated based on the case study of ape viewing in Dzanga-Sangha. Ape-viewing is a high return type of tourism and conditions to develop such tourism in Dzanga-Sangha were good. The area harbors high densities of western lowland gorillas (*Gorilla gorilla gorilla*) and several previous studies on these apes had been carried out. In order for visitors to be able to view the apes they needed to be habituated to human presence. This thesis shows that habituation of gorillas for tourism is feasible. Although feasible, the habituation process requires a substantial investment in time and money and is not without risks. It is unlikely that tourism, including ape-viewing, will be economically viable from a commercial point of view. It is unlikely that revenue form tourism will cover the management cost of the Dzanga-Sangha protected area now or in the foreseeable future. Even though tourism can bring important gains to the region, such as revenue and employment, managers have to carefully weigh these advantages against the apes' well being and the risky economics of tourism in Central Africa.

Given the fact that Dzanga-Sangha provides one of the best opportunities for this type of tourism in the Congo Basin and that even here the economic success is highly questionable, it is unlikely to be a realistic option in but a few exceptional places in this part of the world. This case study clearly demonstrates that although some user fees have the potential to generate substantial revenue for protected areas in the Congo Basin, these fees will be far from sufficient to manage the protected area system.

Acknowledgements

This research was supported by the Dzanga-Sangha Project, specifically through funding from the World Wildlife Fund, Inc. and grants from the World Wide Fund for Nature – Germany. Several students working on this program received student grants from the FONA Foundation, Lucie Burgers Foundation for Comparative Behaviour Research and the Wageningen Agricultural University Foundation.

I would like to thank the late Urbain Ngatoua, Director of the Dzanga-Sangha Project and his entire staff. The seven years I spent in Bayanga were special. The circumstances were not always easy, but we achieved so much. The dedication of people like Valentin Bombo, Jonas Bobero, Honore Ngaima and Jean-Bosco Kpanou made it all happen. Joseph Pamba kept me safe and was good company while we were driving those awful long miles to and from Bangui. Gabriel Yikili and Victor Babon did not only provide good medical help when I needed it, but did so to all our staff. They were also very active in the community of Bayanga. Pierre and Denis looked after me and always assured that the household was run like a professional hotel. Indeed it sometime seemed to function that way, but they always kept things under control and took my best interest at hart. Merci mingi, Pierre and Denis.

Trying to juggle two jobs and doing my thesis at the same time was a challenge and without the support from Urbain Ngatoua it would not have been possible. His calm and diplomacy kept things moving along even if I was away for long periods. Without his leadership and steadfast dedication the Dzanga-Sangha Project might have crumbled during the period of the prolonged army mutiny, when I was unable to get back to Bayanga. His presence will be missed by many.

In Bayanga I made many friends. Thanks for being there. My "Dzanga-Sangha" colleagues: Gunther Klemm, Jean-Marc Garreau, "Dobre" Strgulec Slavko, Christoph Oertle, Daniela Renner, Guy Rondeau, Lisa Steel, Nigel Orbell, Jean-Claude Thibaud and Anna Kretsinger, all the Peace Corps volunteers, and fellow researchers especially Andrea Turkalo. Anna Kretsinger and Louis Sarno were friends who helped me better understand the BaAka and hopefully helped me in better taking their interest at heart. Michele Goldsmith helped me discover Bai Hokou and its gorillas.

The research camp of Bai Hokou is an amazing place to live and work. Richard Carroll was the first to work here and his research and his subsequent dedication to Dzanga-Sangha were an inspiration for me. Richard not only hired me originally to run the Dzanga-Sangha project, but he also supported my "crazy" idea of habituating of western lowland gorillas for tourism, although he must have thought (as most people did) that it was a waste of time and money. Gunther Merz was convinced from the start that we would be able to do it and went to work to find the funding needed. He succeeded beyond his own expectations. I am very grateful to him and glad that he was able to see the gorillas before his tragic death in Germany. Dzanga-Sangha lost a dear friend.

Andrea Almasi, Jean-Bosco Kpanou, Kenneth Otto, Pladele Godobo and Eugene Mbea were instrumental in getting the gorilla habituation program started. Cloe Cipolletta made it happen. Her energy was even too much for the gorillas. They decided that running away from this persistent "gangu wali" was just too much work and by default became habituated to us as well.

I especially would like to thank the field team, consisting of the permanent field staff, students and volunteers: Cloe Cipolletta, Jean-Bosco Kpanou, Kenneth Otto, Pladele Godobo, Eugene Mbea, Jean Tetoungbou, Michel Pounguinza, Flavien Pani, Jason Fink, David Ritchie, David Greer, Franca Donati, Andrea Almasi, Claudia Sieler, Linda Haartsen, Robert van Zalinge, Sandra de Jong, Igor Dijkers, Birgit Janssen, Nasja Arends, Esther van der Wal, Pim Vugteveen, Guus Kruitwagen, Liesbeth Noor, Christine de Siant-Rat, Christine Amalfaltino, Veronica Vecellio and Brigitte Mbassangoa,

Gorilla research and habituation would not have been feasible without the knowledge of the BaAka trackers. They showed me how to track gorillas and I probably achieved the level of a three year old in their opinion. On the other hand I amazed them by never getting lost (a compass is a neat little trick). A special thanks to Nyele, who became a hero when he was bitten, and all the other BaAka trackers: Bakombo, Balambe, Bokombi, Benzaba, Bessekele, Boangu, Elemo, Epecekele, Gaito, Gbalake, Gbelema, Kambi, Koto, Likpoyo, Makizou, Mapoko, Mamondele, Matofi, Mayenda, Mbanda, Mbembele, Mbokola, Mbokombo, Messan, Mobambu, Modebe, Mokedi, Mokoko, Mokonja, Molimba, Molongo, Mondebe, Mondoubou, Mongamba, Mongo, Mosimba, Mossombo, Mosakou, Mouama, Moukandi, Moyekele, Ndiki, Ndondo, Ngombo, Ngoumbie, Ngulake, Poupe, Samedi, Singale, Taleke, Tototombo, Toutou, Wassi, Wonga, Yangassou and Zou. I will never forget Wonga's stories around the camp fire.

The WWF staff in Bangui worked hard to keep us supplied and were an essential link with the outside world. They defended the premises during the mutiny and helped me safely get away during the worst of the fighting. Their dedication set a standard. Gustave Doungounbe and his staff were a big help in the early years. Rarely does one come across someone as hard working and dedicated as Francois. Special thanks to the late Astrid Mombe and Claude Kokot. Tony Mokombo, Bernard Difara and Jean Yamindou all worked hard in their jobs as program officers. They provide technical backstopping as well as essential liaison with Government and other agencies. Jean Yamindou has very capably taken over my job in Bangui and remained helpful throughout the research and write up phase.

In Bangui I had many friends and colleagues. The Embassies of the United States and Germany took a special interest in our project and were a major support as was the US Peace Corps. During the period I was in CAR we went through so many changes in Government that I can not name all the Ministers that were involved, some for better some for worse, with the Dzanga-Sangha project. President Patasse and his Government have made a dedication to conservation that should be an example for other countries. Although we experienced major disappointments and setbacks, thanks to the CAR Government the Dzanga-Sangha Project and protected area complex is a reality today, even though they must have other priorities. Special thanks to Reinhard and Sabine Wolf and the family Weinstable for their technical assistance, but foremost their friendship. I would like to thank my friend Nassif, for not only keeping our cars running, but also for support in difficult times

I thank the entire WWF staff in Washington and Frankfurt for their support, with a special thanks to Tony Mokombo, Richard Carroll and Gunther Merz.

I would like to thank the State University of New York at Stony Brook for providing the opportunity to use their facilities. I would like to thank Andrea Almasi, Conrad Aveling, Andrew Balmford, Richard Barnes, Arend Brunsting, Tom Butynski, Richard Carroll, Cloe Cipolletta, Diane Doran, Bernard Difara, Gustave Doungoube, Michele Fernandez, Jean-Marc Garreau, Michele Goldsmith, David Greer, Jefferson Hall, Rebecca Hardin, David Harris, Ignas Heitkonig, Pieter Ketner, Anna Kretsinger, Annette Lanjouw, Tony Mokombo, John Oates, Herbert Prins, Melissa Remis, Guy Rondeau, Natasha Shah, Thomas Struhsaker, Lisa Steel, Andrea Turkalo, Caroline Tutin, Lee White, David Wilkie, Jean Yamindou and Robert van Zalinge for their assistance, comments and suggestions in writing this thesis.

Without Herbert Prins, my supervisor, this thesis would not even have started and certainly would not have finished. He was supportive from the beginning. Although I only had a vague idea when I first approached him, Herbert really pushed me to go ahead. Arend Brunsting, the co-promotor, helped with all the logistical problems of getting the right students for such a remote place. I think he succeeded very well in suggesting the right people to come to Dzanga-Sangha. A total of 12 students made it from Wageningen to Bayanga and back in one piece. Arend made most of the arrangements and supervised many of them during their preparation and write-up. Ignas Heitkonig also supervised some students and was helpful with statistics. He provided useful comments on most manuscripts. Pieter Ketner supervised students and helped with vegetation classification.

The list has been long, but last I would like to thank my parents, because simply without them I would not have been here. They always encouraged me to find my own way. I guess I inherited my "green" interest from my grandfather who was an inspiration from an early age. It was my parents who encouraged and made it possible for me to pursue a career in conservation and ecology. They provided financial support for me to go to Africa for the first time, although they must have been very worried when they would not hear from me for months. Then suddenly they would get a call again that I was in some other country, once again evacuated due to some war or other. Thanks for the patience and encouragement. Natasha Shah has been my companion these last few years both in the field and later while writing up. Always a good listener, she has coached me through adapting to the American way of life. Even though she was doing her own PhD. research she always took the time to help me. Thanks for being there when the going was tough. Having survived this together has created a lasting bond.

Sound Beach, February 2001

Table of contents

Chapter 1 General introduction and outline of thesis

Management of protected areas: a simple matter of money?

In a recent article, Leakey (2000) called upon the world's richest nations to provide money for the preservation of the world's biodiversity, of which a large part resides in the poorest nations. He called for setting up a permanent global endowment to provide for sustainable funding for wildlife protection. This call poses a series of interesting questions:

1. Is sustainable funding essential for protected area management and thus biodiversity conservation? In other words do areas with funding do better than those without?
2. What is the present situation of protected area management in the poorest nations? Is additional funding needed or can those countries cope themselves?
3. Is it indeed necessary for the richest countries to provide the funding or are alternatives available?

The Congo Basin provides an opportunity to answer parts of these questions. It is one of the poorest regions in the world, but it also harbors one of the world's most diverse forests. Protected areas in the Congo Basin cover approximately 6 % of the region and substantial additions are being proposed (Blom, et al., in prep.). However according to Wilkie & Carpenter (in prep.) long-term under-funding of the management has seriously affected the integrity of these areas. According to the data presented by Wilkie & Carpenter (in prep.) the Congo Basin countries spend about the same percentage of their national budgets on protected area management as do wealthy European and North American nations. The Central African Republic (CAR) is ranked among the poorest nations in the world (PNUD, 1995), yet spends roughly the same percentage of its budget on protected areas as the United States of America (0.17 versus 0.15 %: data from Wilkie & Carpenter, in prep.).

Ecotourism is seen by many as a possibility to finance the long-term costs of biodiversity conservation and in particular protected area management, but questions about sustainability and contributing value have been raised (e.g. Boo, 1990; Tobias & Mendelsohn, 1991; Lindberg, 1991; Inskeep, 1992; Cater & Lowman, 1994; Navrud & Mungatana, 1994; The Nature Conservancy, 1995; Brandon, 1996; Langholz, 1996; Durbin, 1996; Wells, 1997). The CAR has had a history of limited tourism and its potential is still considered viable (Plumier, 1992; UNDP/WTO, 1998).

The Dzanga-Sangha protected area complex, in the southwest of the CAR, offers an exceptional potential for the development of ecotourism. It has unique wildlife viewing possibilities combined with the experience of BaAka (pygmy) culture. It was thought that this potential would provide sustainable development options (Telesis, 1991, 1993). Ecotourism based on apes has been successful in raising park revenue, local employment as well as public awareness of nature conservation issues at the national level in other parts of Africa (Harcourt, 1986; Aveling & Aveling, 1989; Shackley, 1995; McNeilage, 1996; Butynski & Kalina, 1998a & 1998b; Lanjouw, 1991, 1999). Based on this experience ape-viewing ecotourism in Dzanga-Sangha, was seen as an additional possibility of substantially raising revenue, for the park and the local community. The conditions for such tourism were thought to be good. Dzanga-Sangha has a high density of gorillas (Carroll, 1986, 1988, 1997) and gorilla research had been, although intermittently, on-going since 1984 (Remis, 1994, 1997; Carroll, 1997; Fay, 1997; Goldsmith, 1997, 1999; Doran et al., 1996; Doran & McNeilage, 1998). Furthermore the park has the necessary infrastructure as well as an innovative legislation for revenue sharing: forty percent of tourist fees go to a local Non-Governmental Organization for rural development activities and 50 % remains with the park administration for management (Blom, 1999).

For ecotourism based on gorilla viewing, it is essential for the apes to be habituated, except maybe in the case where gorillas visit forest clearings (e.g. Magliocca, 1999; Magliocca & Querouil, 1997; Magliocca et al., 1999; Olejnczak, 1996, 1997). Habituation is the slow process by which gorillas become accustomed to the presence of humans in their vicinity. As gorillas become more and more used to people, the distance between the gorilla and the observer can be reduced. Ideally habituation leads to the acceptance of human observers by wild animals as neutral elements in their environment (Tutin & Fernandez, 1991). Even though mountain gorillas have been successfully habituated for both tourism as well as scientific pursuits (e.g. McNeilage, 1996; Fossey, 1983), the process of habituation has come under some recent well-founded criticism (Butynski & Kalina, 1998a; 1998b). Gorilla habituation carries certain risks for the groups being habituated (McNeilage, 1996; Butynski & Kalina, 1998a; 1998b: Goldsmith, 2000; Kalema, 1998; Sholley, 1989; Wallis & Lee, in prep.; Mudikikwa, 1998, Macfie, 1996). Butynski & Kalina (1998a) and McNeilage (1996) stress the need to establish studies of the reactions of gorillas to tourists and to monitor the potentially disastrous impact of habituation on gorillas (see for chimpanzees Johns, 1999 and for bonobos Krunkelsven et al., 1999).

In the study presented in this thesis I investigated the situation in the Central African Republic (CAR). I evaluated the present status of the protected areas in light of management investments. This allowed me to address the question of whether the under-funding of protected area management is indeed resulting in a progressive ecological impoverishment and loss of biodiversity as postulated by Wilkie & Carpenter (in prep.). It also gives an overview of the situation in one particular country within the Congo basin.

I then focussed my research on one particular protected area in the southwest of the CAR, the Dzanga-Sangha protected area complex, which consists of the Dzanga-Sangha Special Dense Forest Reserve and the Dzanga-Ndoki National Park. The case study of Dzanga-Sangha provides important information on how to address issues concerning tourism in protected areas and how tourism could contribute to sustainable development of protected areas, while minimizing potential negative impacts. It offers standard methods for monitoring human impact in protected areas and baseline data to be used in evaluating the effectiveness of the management of the Dzanga-Sangha complex. The results of the habituation monitoring and its subsequent recommendations are important for those cases were habituation is carried out in a similar context of ecotourism development (e.g. Lope: Tutin et al., 1996; Tutin & Abernethy, 1997; Lossi: Aveling, 1996; Bermejo, 1997, 1999).

In the Congo Basin, tourism is probably the only substantial revenue that could be generated locally to supplement Government spending on protected areas. In order to justify Leakey's (2000) call for funding from the richest countries, it is necessary to show the role tourism could play as a source of sustainable internal revenue for protected area management. Furthermore, Leakey's (2000) suggestion of an endowment is just one of the options for sustainable financing of protected areas in the Congo Forest Region which are being investigated (Spergel, et al., in prep.). Substantial additional funding will be needed to protect the biodiversity in the Congo Basin as the present protected area system is insufficient both in quantity as well as quality (Blom, et al., in prep.).

Outline of thesis

The study starts with an analysis of the status of the protected areas and gazetted forests of the Central African Republic (chapter 2) to illustrate the national context in which the case study took place. In the following chapter, I provide background information on the Dzanga-Sangha area (chapter 3). In order to be able to start habituating gorillas it was essential to have a better understanding of their distribution and densities in the Dzanga-Ndoki National Park (chapter 4). Likewise the human impact on wildlife (chapter 5) is essential as a baseline against which to monitor the effectiveness of overall management as well as the impact of habituation on the wildlife and gorillas in particular. The results outlined in these two chapters also helped identify the most appropriate area for the actual habituation, the Bai Hokou study area. The process of habituation and the results of its monitoring are described in chapter 6. This is followed by an analysis of the impact of tourism prior to the gorilla habituation on protected area management and the local economy in Dzanga-Sangha (Chapter 7). The synthesis in chapter 8 puts the findings of the entire study within the perspective of potential of tourism as a viable long term funding mechanism for protected area management in order to protect the biodiversity of the Congo Basin.

References

Aveling, C. (1996) Update on gorilla news from the ECOFAC programme. Gorilla Conservation News 10: 7-9.

Aveling, C. & Aveling, R. (1989) Gorilla conservation in Zaire. Oryx 23: 64-70.

Bermejo, M. (1997) Study of western lowland gorillas in the Lossi forest of North Congo and a pilot gorilla tourism plan. Gorilla conservation news *11:* 6-7.

Bermejo, M. (1999) Update on the Lossi gorillas study and future sancuary of gorillas, 1998, Popular Republic of Congo. Gorilla conservation news *13.*

Blom, A. (1999). Ten years Dzanga-Sangha Project: 1988 – 1999. World Wildlife Fund – CAR.

Blom, A., Kamdem Toham, A., D'Amico, J., O'Hara, D., Abell R. & Olsen, D. (in prep.) Assessment of biological priorities for conservation in the Guinean-Congolian Forest Region. World Wildlife Fund, Inc. Washington.

Boo, E. (1990) Ecotourism: the potentials and pitfalls. Washington: World Wildlife Fund.

Brandon, K. (1996) Ecotourism and Conservation: A Review of Key Issues. Environment Department Papers, Biodiversity Series, World Bank 33: 69.

Butynski, T.M. & Kalina, J. (1998a) Gorilla Tourism: A critical look Milner-Gulland, E.J. Mace, R. Conservation of biological resources. Oxford Blackwell Science. p: 294-370.

Butynski, T. & Kalina, J. (1998b) Is Gorilla Tourism Sustainable? Gorilla Journal, 16: 15-19.

Carroll, R.W. (1986) Status of the lowland gorilla and other wildlife in the Dzanga-Sangha region of southwestern Central African Republic. *Primate Conservation* 7, 38-41.

Carroll, R.W. (1988) Relative density, range extension, and conservation potential of the lowland gorilla (Gorilla gorilla gorilla) in the Dzanga - Sangha region of southwestern Central African Republic. *Mammalia,* 52, 309-323.

Carroll, R.W. (1997) Feeding ecology of lowland gorillas (Gorilla gorilla gorilla) in Dzanga-Sangha Reserve of the Central African Republic. PhD thesis, University of Yale.

Cater, E., & Lowman, G.E. (Eds.) (1994) Ecotourism: a sustainable option? Wiley: Chichester: Wiley. P.:1-101.

Doran, D.M. & McNeilage, A. (1998). Gorilla ecology and behavior. Evolutionary Anthroplogy, 6 (4): 120-129.

Doran, D., McNeilage, A. & Demmers, P. (1996) Mondika Research center, Central African Republic. Gorilla Conservation News 10: 9.

Durbin, J.C. (1996) Can tourism make a major contribution to conservation of protected areas in Madagascar? Biodiversity and conservation, 5: 345-353.

Fay, J.M., 1997. The ecology, social organization, populations, habitat and histiry of the western lowland gorilla (gorilla gorilla gorilla Savanga and Wyman, 1874). Dissertation, Washingon University.

Fossey, D. (1983) Gorillas in the mist. BostonHoughton Mifflin Co.

Goldsmith, M.L. (1996) Ecological Influences on the ranging and grouping behaviour of werstern lowland gorillas at Bai Hokou, Central African Republic. Phd thesis. State University of New York at Stony Brook, New York

Goldsmith, M.L. (1999) Ecological constraints on the foraging effort of western lowland gorillas (Gorilla gorilla gorilla) at Bai Hokou, Central African Republic. International Journal of Primatology, 20 (1): 1-23.

Goldsmith, M.L. (2000) Effects of ecotourism on the behavioral ecology of Bwindi gorillas, Uganda: preliminairy results. American Journal of Physical Anthropology *AAPA Abstracts Supplement 30:* 161.

Harcourt, A.H. (1986) Gorilla conservation: anatomy of a campaign. In: Ernischke, K. (ed.): Primates: the road to self-sustaining populations. New York: Springer-Verlag

Inskeep, E. (1992) Achieving sustainable tourism development. WTO-News, 6: 4-6.

Johns, B. (1999) Responses of chimpanzees to habituation and tourism in the Kibale forest, Uganda. Biological conservation 78: 257-262.

Kalema, G. (1998) An outbreak of sarcoptic mange in free-ranging mountian gorillas (Gorilla gorilla berengei) in Bwindi Impenetrable National Park, South werstern Uganda. AAZV and AAWV joint conference, pp. 438.

Krunkelsven, E. van, Dupain J., Elsacker L. van & Verheyen, R. (1999) Habituation of bonobos (Pan paniscus): first reaction to the presence of observers and the evolution of response over time. Folia Primatol 70: 365-368.

Langholz, J. (1996) Ecotourism impact on independantly owned nature reserves in Latin America and Sub-Saharan Africa. The Ecotourism Equation: Meausuring the Impacts. Yale F&ES Bulletin

Lanjouw, A. (1991) Tongo Chimpanzee Conservation Project: an experiment in long-term conservation. Understanding Chimpanzees Symposium. Chicago.

Lanjouw, A. (1999) Tourisme aux gorilles en Afrique centrale. Canopée 13: 25-26.

Leakey, R. (2000). Extinctions past and present. Time 155 (17): 35.

Lindberg, K. (1991) Policies for maximizing nature tourism's ecological and economic benefits. International Conservation Financing Project Working Paper. World Resource Institute: 37pp

Nature Conservancy (1995) Compatible Economic Development: Ecotourism: First edition. The Nature Conservancy.

Navrud, S. & Mungatana, E.D. (1994) Environmental valuation in developing countries : the recreational value of wildlife viewing. Ecological Economics 11: 135-151

Macfie, L. (1996) Case report on scabies infection in Bwindi gorillas. Gorilla journal 13: 19-20.

Magliocca, F. (1999) 1998 Update on the gorillas of the Odzala National Park, Popular Republic of Congo. Gorilla Conservation News, 13.

Magliocca, F. & Querouil, S. (1997) Preliminairy report on the use of the Maya-Maya north saline (Odzala National Park, Congo) by lowland gorillas. Gorilla Conservation News, 11: 5.

Magliocca, F., Querouil, S., and Gautier Hion, A. (1999) Population Structure and Group Composition of Western Lowland Gorillas in North-Western Republic of Congo. American Journal of Primatology 48:1-14.

McNeilage, A. (1996) Ecotourism and mountain gorillas in the Virunga Volcanoes. V. Taylor and N. Dunstone. The exploitation of mammal populations London Chapman and Hill. p: 334-344.

Mudakikwa, A.B. (1998) An indicator of human impact: gastrointestinal parasites of mountain gorillas (Gorilla gorilla berengei) from the Virunga volcanoes region, central Africa. AAZV and AAWV joint conference, p.: 436-437.

Olejniczak, C. (1996) Update on the Mbeli Bai gorilla study, Nouabale-Ndoki National Park, Congo. Gorilla conservation news 10: 6-7.

Olejniczak, C. (1997) 1996 update on the Mbeli Bai gorilla study, Nouabale-Ndoki national park, Congo. Gorilla conservation news 11: 7-10.

Plumier, J.F. (1992) L'écotourisme dans la Région Nord de la République Centrafricaine. Tropicultura 10: 163-165.

PNUD (1995) Rapport mondial sur le developpement humain 1995. Paris: Economic.

Remis, J.M. (1994) Feeding Ecology and Positional Behavior of western lowland gorillas (Gorilla gorilla gorilla) in the Central African Republic. Ph.D. thesis Yale University, New Haven, CT

Remis, M.J. (1997) Ranging and grouping patterns of a western lowland gorilla group at Bai Hokou, Central African Republic. American Journal of Primatology, 43: 111-133.

Shackley, M. (1995) The future of gorilla tourism in Rwanda. Journal of Sustainable Tourism. 3: 61-72.

Sholley, C.R. (1989) Mountain gorilla update. Oryx 23: 57-58.

Spergel, B, Wilkie, D. S. & Blom, A. (in prep.) Prospects for sustainable financing of protected areas in the Congo Forest Region through user fees.

Telesis (1991) Sustainble economic development options for the Dzanga-Sangha Reserve Central African Republic, Telesis USA, Inc.

Telesis (1993) Supplementary study of the sustainable economic development options for the Dzanga-Sangha Reserve Central African Republic, Telesis USA, Inc.

Tutin, C.E.G. & Abernethy, K.A. (1997) Station d'Etude des Gorilles et Chimpanzes, Reserve de la Lope, Gabon. Gorilla Conservation News 11.

Tutin,C.E.G., Abernethy, K.A. & Fontaine, F. (1996) Station d'Etude des Gorilles et Chimpanzes, Reserve de la Lope, Gabon - 1995. Gorilla Conservation News 11: 4-5.

Tutin, C.E.G. & Fernandez, M. (1991) Responses of wild chimpanzees and gorillas to the arrival of primatologists: behaviour observed during habituation. In: Box, H.O. (ed.) Primate responses to environmental change. Chapman & Hall, New York: 187-196.

Tobias, D. & Mendelsohn, R. (1991) Valuing ecotourism in a tropical rain-forest reserve. Ambio. 20: 91-93.

UNDP/WTO (1998) Plan directeur pour le développement du tourisme, République Centrafricaine, volune 1: diagnostics et orientations. Madrid: United Nations Development Program & World Tourism Organization

Wallis, J. & Lee, D.R. (in prep.) Primate conservation: the prevention of disease transmission. 27 p.

Wells, M.P. (1996) Economic Perspectives on Nature Tourism, Conservation and Development. Environment Department Papers, Environmental Economics Series, 5 World Bank, 54 p.

Wilkie, D.S. & Carpenter, J.F. (in prep.) The under-financing of protected areas in the Congo Basin: so many parks and so little willingness-to-pay. Biological Conservation (in review)

Chapter 2

Status of the protected areas and gazetted forests of the Central African Republic

Allard Blom[1,2,4], Jean Yamindou[3] & Herbert H.T. Prins[1]

[1] Department of Terrestrial Ecology and Nature Conservation, Wageningen University, Bornsesteeg 69, 6708 PD Wageningen, The Netherlands
[2] Department of Anthropology, State University of New York at Stony Brook, Stony Brook NY 11794, USA
[3] World Widlife Fund, B.P. 1053 Bangui, Central African Republic
[4] Corresponding address: Zuivelweg 5B, 7255 XA, Hengelo (Gld), The Netherlands. E-mail: allardblom@msn.com

Summary

Although the Central African Republic (CAR) is ranked among the least developed countries in the world, it has made an impressive commitment to biodiversity conservation. A total of 15 protected areas covering about 10.9 % of the country have been gazetted. An additional 1.0 % has been set apart as gazetted forests, mainly for sustainable production of forest resources.

However in many parts of Central Africa protected areas only exist on paper. This study critically examined the status of the protected areas and gazetted forest in the Central African Republic in the light of their potential for long-term protection of biodiversity. First of all the protected area system does not at present protect a representative sample of the ecoregions of the CAR. Even more important is the fact that only 32 % of the protected areas and only 2 of the 47 gazetted forests are adequately managed. In all protected areas law-enforcement to stop the rampant poaching is inadequate, and poaching poses the largest threat to biodiversity conservation. Faced with this threat to the survival of its protected area system, the Government must make a strong commitment to law-enforcement to bring poaching under control.

Given the meager financial resources of the country and the dim economic prospects it is clear that the CAR will need both financial as well as technical assistance to deal with protected area management. Experiences have shown that such intervention can make a difference, but only if the Government makes the necessary commitment.

Introduction

The Central African Republic, as the name indicates, is located in the heart of Africa. Landlocked and without mountains it still is one of the most diverse countries on the continent, because of its climatic range from the dry desert north to the wet rainforest in the south. With a land area of about 623,000km^2 and a population of less than 4 million the country has a low population density. Furthermore this population is largely concentrated in the capital Bangui and the west (Nana Mambere – Mambere Kadei), center-north (Ouham) and center-east (Ouaka), leaving the remainder of the country almost empty of human habitation. These factors combined create a situation which could potentially be very beneficial for the long-term conservation of the enormous biodiversity of the Central African Republic through a system of well-managed protected areas and gazetted forests.

Indeed the Central African Republic (CAR) has an impressive number of such protected and gazetted areas covering a large part of the country. On paper the situation looks rather promising, however this impression is deceiving. Many of the protected areas only exist on paper, often referred to as so called "paper parks". However no complete picture exists of the present situation of many of the areas in CAR. To mitigate this situation World Wildlife Fund (WWF) initiated this study as part of a larger regional study carried out in the framework of the Central African Regional program for the Environment (CARPE) and the World Bank – WWF Alliance.

By using clear definitions and a standard method for evaluating it will be possible to assess the development of the protected area system over time and also compare efforts made in different countries. The problem so far has been that only the total area gazetted has been taken into consideration, but no attempts have been made to qualify these areas. This can present a distorted impression of conservation in the region.

We hope that this study will provide first of all an update database of existing protected areas and gazetted forest of the CAR, as unfortunately the present databases of such organizations as World Conservation Monitoring Center (WCMC), UNEP and IUCN are incomplete or even non-existing (e.g. WCMC, 1994).

Secondly, it will provide a baseline against which future conservation initiatives can be measured. It also will provide an outline of a methodology which could be expanded to cover the entire Guinean-Congolian Forest Region.

Thirdly, an updated overview of the status of biodiversity protection the CAR will provide a new stimulus in the ongoing discussion on prioritization and effective conservation of biodiversity in the Guinean-Congolian Forest Region (Blom, et al. in prep.).

The Central African Republic: background

The CAR is among the least developed countries in the world. It ranks 149 among 174 countries on the UNDP Indicator of Human Development (IHD), with a life expectancy of only 49.4 years, an adult literacy rate of 53.9% and a GNP per inhabitant of only 410 US$ in 1992 (UNDP, 1995). The same report estimated the population of CAR at 3.1 million in 1992, with an expected annual increase of 2.4 %, expecting to reach 3.7 million people by the year 2000.

Estimates of the size of the Central African Republic vary slightly from source to source (Boulvert, 1983, Carroll, 1992, Fay, 1997, UNDP, 1995, Green & Paine, 1997, IUCN 1992), but average at about 623,000 km^2. Including or excluding rivers and lakes may account for some of these differences. In any event it does illustrate that any figures for CAR have to be taken with some caution, as few accurate data exist. Nevertheless the economic situation has only deteriorated further in recent years, due to severe political disturbances combined with violence and looting. So overall one can conclude that the Central African Republic is one of the least developed and populated countries in the world.

The ecosystems of the CAR

The altitude varies from 325 m in the valley of the Oubangui to 1410 m at Mount Ngaoui, on the border with Cameroon (Boulvert, 1983). The country overall shows little relief and is almost entirely situated below 1000 meters. Two thirds of the country forms part of the Congo Basin drainage system, the remaining largely going to the Tchadian system (Boulvert, 1983). Most of the relief is related to the rivers of these drainage systems.

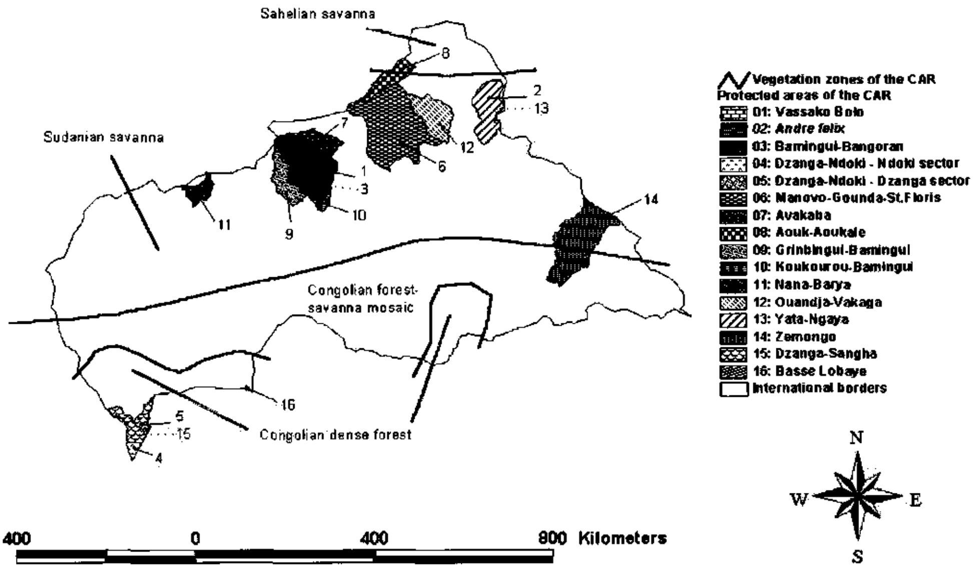
The Central African Republic has 4 main climate zones (Boulvert, 1983; Carroll, 1997). The vegetation zones of the CAR are strongly correlated with these climate zones (Boulvert, 1986). From north to south the following can be distinguish (adapted from Boulvert, 1986 and Carroll, 1997) (Figure 1):

1. *Sahelian savanna*: consists of open savannas
2. *Sudanian savanna*: vast grasslands with small groups of trees
3. *Congolian forest-savanna mosaic*: includes wooded savanna and dry decidious forest
4. *Congolian dense forest*: from deciduous forest through transition forest to evergreen forest.

These vegetation zones correspond fairly well with the ecoregions described by Underwood, et al. (1998). These authors distinguish from north to south the Sahelian Acacia Savanna, the East Sudanian Savanna and the Northern Congolian Forest-Savanna Mosaic. The dense forest zone they split in two: the Northwestern Congolian Lowland Forests and the Northeastern Congolian Lowland Forests.

Figure 1 Protected areas of the Central African Republic with vegetation zones

Protected areas of the Central African Repubilic with vegetation zones



Methods

This study was carried out by using the existing data from different sources such as CAR Government records and laws, World Conservation Monitoring Center, IUCN, UNESCO, UNDP and WWF. These data were, whenever possible, corroborated and combined with our own experiences, Government sources and interviews with people familiar with the different regions of the country.

Considerably more data were available on the protected areas than on the gazetted forests. For the protected areas we made extensive use of the existing protected area database at WCMC such as the United Nations list of protected areas (IUCN, 1998)
We used the following definition of a protected area as adopted by IUCN (1994):

An area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means.

In the case of the CAR this describes an ideal rather than an actual situation, because many of the protected areas are certainly not managed. The following definition for gazetted forest was adopted:

An area of land especially dedicated to the sustainable production of forestry products and/or protection of such resources on which this production is based.

In practice these are areas which have been temporarily or permanently withheld from commercial logging, for various reasons such as protection of resources, local use of forest products and research or reforestation.

It is important to note the clear distinction between protected areas whose main focus are biodiversity protection and maintenance, and gazetted forests, which are reserves of forest products. Even though their stated purpose of sustainable use brings them close to the definition of category VI of IUCN (1994), they differ in some essential aspects. These gazetted areas are often no longer predominantly unmodified natural systems and rarely are they indeed managed for sustainable use. In this study they have not been considered as protected areas as per above definition and thus fall into the category unassigned (UA) of IUCN (1994). Although they do not aim to protect biodiversity, in some cases these gazetted forests have played an important role in biodiversity protection, both directly by maintaining forest cover as well as often being the precursor for protected areas. For that reason they are included in this study.

We used the following categories, as outlined in Table 1, of the IUCN categories of protected areas for defining the types of protected areas present in the CAR.

Table 1: IUCN categories of protected areas (IUCN, 1994)

Category	Description
1a	Strict Nature Reserve: protected area managed mainly for science
1b	Wilderness Area: protected area managed mainly for wilderness protection
II	National Park: protected area managed mainly for ecosystem protection and recreation
III	Natural Monument: protected area managed mainly for conservation of specific natural features
IV	Habitat/Species Management Area: protected area managed mainly for conservation through management intervention
V	Protected Landscape/Seascape: protected area managed mainly for landscape/seascape conservation and recreation
VI	Managed Resource Protected Area: protected area managed mainly for the sustainable use of natural resources

In table 2 we give the corresponding CAR categories that are in use to define protected areas.

Table 2: Central African Republic categories of protected areas and their equivalent IUCN categories

CAR category	Description	IUCN equivalent
RI	Réserve Integrale	1a
PN	Parc National	II
PP	Parc Presidentiel	IV
RF	Réserve de Faune	IV
RS	Réserve Spéciale	VI
RB	Réserve de Biosphére	VI

The Central African Republic has made an important effort in the field of conservation and has over the years gazetted 15 protected areas (Table 3 & Annex 1). All of these still exist on paper, although some have gone through name changes, upgrades or extensions. For an historical overview we refer to IUCN (1992). The total area protected is 6,818,500 ha, which represents 10.9 % of the national territory.

Table 3: Protected areas of the Central African Republic

Name	**IUCN[a]**	**CAR[b]**	**Year Gazetted**	**Ecoregion[c]**	**Location**	**Size (in ha)**
Vassako-Bolo	Ia	RI	1960	41	08°06'N; 19°47'E	86000
Andre Felix	II	PN	1960	41	09°29'N; 23°18'E	170000
Bamingui-Bangoran	II	PN	1933	41	08°35'N; 19°43'E	1070000
Dzanga-Ndoki (Ndoki sector)	II	PN	1990	14	02°27'N; 16°15'E	72500
Dzanga-Ndoki (Dzanga sector)	II	PN	1990	14	02°57'N; 16°22'E	49500
Manova Gounda-St Floris	II	PN	1933	41	09°31'N; 21°21'E	1740000
Avakaba	IV	PP	1980	41	08°40'N; 20°40'E	250000
Aouk-Aoukale	IV	RF	1939	39/41	09°52'N; 21°25'E	330000
Gribingui-Bamingui	IV	RF	1940	41	07°41'N; 19°17'E	450000
Koukourou-Bamingui	IV	RF	1940	41	07°24'N; 19°57'E	110000
Nana-Barya	IV	RF	1960	41	07°40'N; 17°29'E	230000
Ouandjia-Vakaga	IV	RF	1925	41	09°02'N; 22°18'E	480000
Yata-Ngaya	IV	RF	1960	41	09°15'N; 23°25'E	420000
Zemongo	IV	RF	1925	44	06°54'N; 26°04'E	1010000
Dzanga-Sangha	VI	RS	1990	14	02°53'N; 16°13'E	335900
Basse Lobaye	VI	RB	1977	14	03°40'N; 17°50'E	14600
Total						6818500

Updated and corrected from IUCN, 1998 with:

[a] IUCN: IUCN categories of protected areas as in Table 2 (IUCN, 1994)

[b] CAR: CAR categories of protected areas as in Table 3

[c] Ecoregions, with 14=Northwestern Congolian Lowland Forest; 39=Sahelian Acacia Savanna 41=East Sudanian Savanna; 44=Northern Congolian Forest-Savanna Mosaic (Underwood, et. al., 1998)

The UNESCO Man and Biosphere Reserve Directory (UNESCO, 2000) lists the Basse-Lobaye Forest and the Bamingui-Bangoran Conservation Area as designated areas, the former since 1977 and the latter since 1979. Both designations include areas outside the actual protected area, following the MAB model. In practice these designations have contributed little to their actual functioning, except for a brief study of agricultural practices around Basse-Lobaye under the MAB Young Scientist Award program (Mborohoul, 1993)

The Manavo-Gounda-St.Floris National Park was inscribed on the list of World Heritage Sites in 1988 (World Heritage Committee, 1988; UNESCO, 1999). The site was added to the list of World Heritage in danger in 1997 (World Heritage Committee, 1998) following reports of illegal grazing and poaching. The World Heritage Committee (1999) confirmed this listing in 1998 with a strong request for the preparation of a detailed state of conservation report and a rehabilitation action plan. Submission of the Dzanga-Ndoki National Park as a World Heritage Site is being considered.

In order to obtain an indication of the conservation potential of these protected areas we used several factors in an overall assessment of the present status of the protected areas. All the assessments were based on the authors own impressions, which were verified by Ministry staff (Doungoube, pers. comm.). The data were comparable with information obtained during informal interviews with people familiar with the areas. We should add that most areas had been visited by the authors in the last 5 years, but some were not (Nana-Barya, Zemongo, Andre-Felix and Yata-Ngaya). The following factors were assessed and then used to arrive at an overall conservation potential:

1. *Significance*:

Biodiversity significance at the national level, taking into consideration overall representation. Significance was ranked: 1=high (only protected area or complex in vegetation zone or essential core area), 2=moderate (at least one other protected area in vegetation zone), 3=low (at least two other protected area in vegetation zone), 4=very low to none (at least two other protected area in vegetation zone).

2. *Threat:*

Threats were assessed by looking at the types of potentially threatening activities that are taking place in these areas. They can be summarized as follows:

1. *Logging*: presence or absence of logging activities, which was ranked (1=none, 2=low, 3=moderate, 4=high). We defined the type of logging as traditional (wood sawn in field), or commercial (logs transported to mills or exported). We also looked at the way the logging was regulated (certified, supervised or unregulated) to assess the overall ranking.

2. *Mining*: presence or absence of mining activities, which was ranked (1=none, 2=low, 3=moderate, 4=high).
3. *Hunting*: presence or absence of hunting activities, which was ranked (1=none, 2=low, 3=moderate, 4=high).
4. *Grazing*: presence or absence of cattle grazing activities, which was ranked (1=none, 2=low, 3=moderate, 4=high).
5. *Farming*: presence or absence of farming activities, which was ranked (1=none, 2=low, 3=moderate, 4=high).
6. *Villages*: presence or absence of villages, which was ranked (1=none, 2=low, 3=moderate, 4=high).
7. *Roads*: presence or absence of roads and/or paths, which was ranked (1=none, 2=few (only foot paths), 3=moderate (logging roads or commercial), 4=many).

Then for each protected area the top activities seen as the main source of threat or disturbance were noted and an overall threat assessment was made by multiplying these main sources numbers by two before adding all the activities together and averaging the result. This gives a figure between 1 and 4. A score of 1 represents an area with no threatening or disturbing activities present and 4 indicates an area being overrun by activities incompatible with protected area management.

We did take into consideration the stated objective of the protected area. If for example sustainable logging is allowed in a reserve and such logging was indeed carried out in a sustainable way then this would not be noted as a threatening or disturbing activity. Also the size factor was taken into consideration, as a local disturbance, even a serious one, can be negligible in relation to the overall size of the protected area. In the CAR this is often the case with agriculture.

3. *Integrity*:

Integrity is a snapshot assessment of the present status of the protected area taking into consideration destruction, degradation and fragmentation. Integrity was ranked as follows: 1=high (less than 5 % of the area is destroyed or severely degraded and/or less than 10 % is moderately degraded or fragmented), 2=medium (less than 10 % of the area is destroyed or severely degraded and/or less than 25 % is moderately degraded or fragmented), 3=low (less than 25 % of the area is destroyed or severely degraded and/or less than 50 % is moderately degraded or fragmented), 4=very low (more than 25 % of the area is destroyed or severely degraded and/or more than 50 % is moderately degraded or fragmented).

4. *Management:*

The present status of the management of the protected area was assessed in the following way:

1. *Type*: type of management was described as 1=Government plus external partner, 2= Government alone, 3=none.
2. *Guards*: presence or absence of law enforcement staff, which was ranked (1=high (well staffed), 2= moderate, 3=low (inadequately staffed), 4= none).

3. *Support*: level of financial support (1=high (well financed), 2=moderate, 3=low (inadequately funded), 4=none).
4. *Participation*: level of local (village) participation (1=high (local people involved in all aspects), 2=moderate (involved in some activities and consulted on others), 3=low (no active participation, some consultation), 4=none).

The last three factors were all considered equally important and were averaged to give an overall assessment of the present management, with 4 indicating no management at present and 1 indicating that management is excellent. Type of management was directly linked to level of financial support and was not further taken into consideration. We used Pearson correlation coefficient of significance to examine if certain assessment variables co-varied or were interdependent (SPPS, 1997).

To reach an overall assessment of the present status of the protected areas and their conservation potential, we added biodiversity significance, integrity, management and threat together and finally averaged this number. We considered that the area had the following potential based on their final score, which was the maximum ranking of 4 minus the average number, in the following matter: 1=none, 2=low, 3=moderate, 4=high. The higher the number the more conservation potential. This result was used to rank the protected areas in priorities and opportunities for conservation in the CAR.

Unfortunately, due to a lack of even the most basic data, it was not possible to repeat the same exercise for the gazetted forests in the CAR. In most cases we were able to establish size and year of gazetting and in some cases if any active management was implemented.

Status of protected areas in CAR

The present threats and problems concerning disturbances facing the protected area network are summarized in Table 4. This table provides furthermore information on their management, significance and integrity. The final column assess the overall potential for conservation of biodiversity in the mid (10 years) to long-term (50 years). A full breakdown of the details is provided in Annex 1.

Table 4: Assessment of the present status and conservation potential of the protected areas of the Central African Republic, ranked by potential (with 4 = highest, 1 = lowest)

Name	Significance	Threat	Integrity	Management	**Potential**
Dzanga-Ndoki (Ndoki sector)	1	1.5	1	2	**2.6**
Dzanga-Ndoki (Dzanga sector)	1	1.8	1	1.7	**2.6**
Manova Gounda-St Floris	1	2.6	3	2	**1.9**
Dzanga-Sangha	1	2.4	2	2	**1.9**
Aouk-Aoukale	3	2.3	3	2.7	**1.8**
Vassako-Bolo	2	2.1	3	2.7	**1.6**
Bamingui-Bangoran	2	2.3	3	2.7	**1.5**
Ouandjia-Vakaga	3	2.3	3	2.7	**1.3**
Gribingui-Bamingui	3	2.3	3	2.7	**1**
Koukourou-Bamingui	3	2.4	3	2.7	**1**
Nana-Barya	3	1.9	3	4	**1**
Basse Lobaye	4	2.6	3	3.7	**0.9**
Andre Felix	3	2.3	4	3.7	**0.8**
Avakaba	3	2.3	3	3.7	**0.8**
Zemongo	3	2.3	4	4	**0.7**
Yata-Ngaya	4	2.3	4	4	**0.5**
Average	2.5	2.2	2.9	2.9	1.4

With: Threat=average threat assessment; Management=average management assessment; Significance=relative significance for biodiversity conservation; Integrity=assessment of the present status of the protected area taking into consideration destruction, degradation and fragmentation; Potential=conservation potential. (See methods section for scoring techniques used in this assessment)

The average management assessment is positively correlated with both the relative significance and the integrity assessment (Pearson correlation two-tailed, resp. 0.838 and 0.768, N= 16, $p<0.01$), but not with the average threat assessment (Pearson correlation two-tailed, 0.240, N=16, NS).

Status of gazetted forests in the CAR

As mentioned, virtually no recent data were available on the status of the gazetted forests prior to this paper. Only Damio (1997) and Namsenei (1999) give some data on the present situation concerning these forests. As far as could be assessed from Government and other sources a total of 47 areas have been gazetted and are still recognized on paper. All were established before independence. The total area declared as gazetted forest is 634,947 ha or 1.0 % of the national territory. In recent years the national Forestry and Tourism Development Fund (FDFT), which was created under World Bank sponsorship in 1993 has been active in some of the existing gazetted forests and has established several new reforestation areas. However the Government has so far officially gazetted none of these new areas.

Only 13 of the gazetted forests or a total of 70,578 ha, seem to have any active management (Namsenie, 1999; Government sources and pers. obs.), representing only 11 % of the gazetted forests. Virtually no information is available on the present status of the other forests or their management. Given the overall situation in the country it is safe to assume that the majority is not managed at all. Most of the gazetted forests have been managed through the FDFT as reforestation plantations (Damio, 1997, Namsenei, 1999). Notable exceptions are the hills behind the capital called "Collines de Bangui" or "Gbazoubangui", which due to impressive erosion have become a major discussion point in the capital. This has led to the gazetting of this area as a special forest reserve in 1998 and an upgrade in the management, with some technical assistance from GTZ. Furthermore the Ngotto forest has had special attention due to being part of the European Union sponsored project on sustainable forestry and conservation (ECOFAC) based at the village of Ngotto itself. This project has forged a successful collaboration with a logging company in jointly developing a management plan for the region, which is now being implemented. This includes a core area for biodiversity conservation purposes.

Discussion

The 1997 United Nations list of protected areas in the CAR mentions 14 protected areas, with a total area of 5,445,600 ha (IUCN, 1998). This list is fairly accurate. In fact only one protected area has been omitted: the Basse-Lobaye Reserve of 14,600 ha. However, this list does not provide any further information other than category, location, size and year of establishment.

With well over 10 % of the country designated as protected areas, the Central African Republic has made an exceptional commitment to biodiversity conservation. Given the fact that not all the areas predate independence, clearly demonstrates a continuing commitment. This commitment is real, also in economic terms. Even though many of these areas are on marginal lands, some, like the Dzanga-Ndoki National Park, could have generated important revenue from logging and/or safari hunting.

Given the fact that most of that population is concentrated in the cities in the south and west of the country, leaving the north and east almost completely barren of human population, one would have expected that this would have resulted in large untouched wilderness areas. This fact combined with the extensive system of protected areas seem to provide an almost perfect situation for effective biodiversity conservation.

Although this is the situation on paper, the reality is different. First of all the system does not protect a representative sample of the vegetation zones or ecoregions of the CAR. Both the Sahelian Acacia Savanna (except for a part of the Aouk-Aoukale Reserve) as well as Northeastern Congolian Lowland Forest are not at all represented in the protected area system of the CAR.

More important is the present status of the protected areas. From Table 4 we can see that on average the management of the protected area system is inadequate. In fact 3 protected areas (Zemongo, Yata-Ngaya and Nana-Barya) have no management at all, representing 24 % of the area under protection by law. An additional 3 protected areas (Andre-Felix, Avakaba and Basse-Lobaye) or 6% have only superficial management and 6 other areas (37% of area under protection) are managed inadequately. This leaves only the Dzanga-Sangha protected area complex and the Manovo-Gounda-St.Floris. Even in these moderately well managed areas problems remain.

Due to the lack of management and most specifically law-enforcement, poachers have overrun most of the protected areas (e.g. Moussa, 1992). The main reason to put the Manovo-Gounda-St.Floris on the list of World Heritage in Danger list was that poaching had decimated more than 80% of the Park's wildlife populations (UNESCO, 1999). These poachers are well organized and equipped. They operate on a professional basis and concentrate on bushmeat as well as ivory. In the past they also collected rhinoceros horn, but they have long since eliminated the rhinoceros in CAR. In the north and east the problem is especially serious, resulting in the death of 4 park rangers in 1997 in Monovo-Gounda-St.Floris and disruption of tourism to this park (WCMC, 1997). Here the park rangers confront local poachers as well as regular infiltration from Sudan and Chad.

As most of the European Union financed "Projet de Developpment du Region Nord (PDRN)" effort to protect the diversity of the northern savannas went into this park the situation in other areas is certainly worse. Recent observations in the north and east by the authors, conservation staff as well as safari hunters confirm this overall picture. The authors were unable to visit the 3 eastern most areas (Zemongo, Andre-Felix and Yata-Ngaya) in recent years and few others have, as this area has become dangerous for travel. However a recent river rafting expedition on the Chinko river, close to Zemongo, indicated that little wildlife was left in that area. Gunther Klemm (pers. com.) of the GTZ Dzanga-Sangha Project, who visited the area in 1997 as well as the safari hunters (Haut-Chinko Safaris, pers. com.), who had to abandon the region due to intense poaching confirmed this situation.

A WWF team surveyed the forests of Bangassou, south west of Zemongo, in 1995-96. Even that far from the north/eastern border they found evidence of intense poaching. An estimated 1600 elephants remain in this forest (Kpanou et al, in prep.). The Bangassou forest is at present the subject of a new conservation initiative, which may lead to the establishment of CAR's first protected area in the Northeastern Congolian Lowland Forest ecoregion.

Overall poaching is by far the most important threat in the short and medium term to the survival of the entire protected area system in the CAR. In the south the situation is somewhat better, but even here poachers armed with automatic rifles, as up north, have been reported (Blom, 1999). Illegal grazing is also a major problem in some of the areas in the north (e.g. WCMC, 1997).

Many would argue that the biological significance is the most important determent for assigning priorities for protection and assessing overall potential. However even doubling the score for this value would not make a major difference in the end result of table 4. In any event the main point to be made here is the present status of protected areas and how that affects future potential for effective biodiversity protection. As illustrated in table 4 only 3 areas, which together make up the Dzanga-Sangha protected area complex, seem to have escaped major degradation and fragmentation. We consider that any area with an overall score of 1 or less on the potential scale would probably be difficult or impossible to restore in the present situation. In effect we consider such areas "paper parks", especially because none of these areas have any serious effort in management. One national park (Andre-Felix) and 7 reserves fall in this category, representing 39 % of the area officially under protection. Thus more than one third of the protected area of the CAR are so called "paper parks", with little or no management.

If no action is taken in the near future it is likely that we can add an additional national park (Bamingui-Bangoran) and 1 reserve (Ouandjia-Vakaga) to this list, which both have a score of less than 1.5. That would leave only the strict nature reserve of Vassako-Bolo, 2 national parks (Manovo-Gounda-St.Floris and Dzanga-Ndoki), the faunal reserve of Aouk-Aoukale and the Dzanga-Sangha special reserve, representing no more then 38 % of the present protected area system, relatively intact. These areas are also being degraded at present, but at a reduced rate.

Our analysis shows that there is a positive correlation between the average management assessment and the relative significance of the protected area, indicating that the Government has made the most of its limited resources by concentrating management efforts in the most significant areas. These areas also show the highest integrity in our snapshot assessment. This could indicate that the management has been effective and does make a difference. Now with this assessment available as a baseline, future assessments can make an evaluation of the effectiveness of management.

Little is known about the status of the gazetted forests, but many of these forests are very small, 20 are less then 1,000 ha, and many are plantations (Namsenei, 1999) so probably contribute little to overall biodiversity conservation. Furthermore even though some of these forests have been the subject of some occasional interventions though the country's forestry and tourism development fund (Damio, 1997, Namsenei, 1999), these interventions came after many years of neglect and even now their interventions remain irregular and the overall impact is questionable. Due to the political and security situation in the CAR, a survey of these forests to establish their present status and contributions to biodiversity conservation is not possible at present.

Thus overall we can conclude that only 4.2 % of the Central African Republic is in reality under some form of protection for biodiversity conservation on the mid to long term. The main threat for the survival of the remaining protected area network is large-scale poaching, followed by uncontrolled cattle grazing and logging.

What follows from this analysis is a rather somber picture of a situation that looks more promising on paper. Rather than being exceptional this situation seems to present the realities of conservation in the Central African region. The situation in for example the Democratic Republic of the Congo is even worse then the one described here for the CAR (Blom, pers. obs.).

First and foremost the responsibility for finding solutions lies with the Government. Although the CAR Government has made some remarkable commitments to conservation, these have clearly been insufficient. Faced with the survival of the protected area system the Government has to make some hard choices. So far the Government has been unwilling to pay the political price for taking action against poaching. Two main reasons for this lack of action can be identified. The first reason is corruption and high level involvement in the highly profitable poaching schemes. A second reason, is the popular support at local village level for poaching activities. As local villagers rarely derive any benefits from the wildlife under protection, which they consider either food or pests, they often seem eager to participate in eradicating their own future life support.

Some fairly recent initiatives by PDRN and the Dzanga-Sangha project (e.g. Blom, 1999) have shown that when villagers are involved in revenue sharing there are opportunities to develop collaboration and reduce poaching. However it remains evident from the analysis that law enforcement at all levels is a prerequisite for the survival of the protected area system in the CAR.

Given the meager financial resources of the country and the dim economic prospects it is clear that the CAR will need both financial as well as technical assistance to deal with protected area management, even though the country could probably contribute more resources (Wilkie & Carpenter, in prep.). Experiences, both positive as well as negative, with PDRN, ECOFAC-Ngotto and Dzanga-Sangha (e.g. Blom, 1999) have shown that such intervention can make a difference, but only if the Government makes the necessary commitment.

Acknowledgements

We would like to thank the World Wildlife Fund, Inc. and the different Government agencies for supporting this research. We are particularly grateful to David Wilkie, John Oates, Gustave Doungoube and Natasha Shah for the constructive comments on the manuscript.

References

Boulvert, Y., 1983. Carte pedologique de la Republique Centrafricaine, a 1:1,000,000. Notice explicative #100. ORSTOM, Paris, 126 p.

Boulvert, Y., 1986. Republique Centrafricaine. Carte phytogeographique a 1:1,000,000. Notice explicative # 104. ORSTOM, Paris, 131 p.

Blom, A., 1999. Ten years Dzanga-Sangha Project: 1988 – 1999. World Wildlife Fund – CAR.

Blom, A., Kamdem Toham, A., D'Amico, J., O'Hara, D., Abell, R. & Olsen, D., in prep. Assessment of biological priorities for conservation in the Guinean-Congolian Forest Region. World Wildlife Fund. Washington, DC.

Carroll, R.W. 1992. Central African Republic. In: Sayer, J.A., Harcourt, C.S. & Collins, N.M. (Eds.) Conservation Atlas of tropical forests: Africa. MacMillan Publishers, Ltd., Hants, UK.

Carroll, R.W. 1997. Feeding ecology of the western lowland gorilla (Gorilla gorilla gorilla) in the Central African Republic. Dissertation, Yale University.

Damio, T., 1997. Le Fonds de Developpement Forestier et Touristique, Ministere de l'Environnement, des Eaux, Forest, Chasses et Peches, Bangui, CAR, 27pp.

Fay, J.M., 1997. The ecology, social organization, populations, habitat and histiry of the western lowland gorilla (gorilla gorilla gorilla Savanga and Wyman, 1874). Dissertation, Washingon University.

Green, M.J.B. & Paine, J., 1997. State of the world's protected areas at the end of the twentieth century. Paper presented at IUCN World Commission on Protected Areas Symposium on "Protected areas in the 20th Century: from islands to networks". Albany, Australia, 24-29th November 1997.

IUCN, 1992. Protected areas of world: a review of national systems. Volume 3: Afrotropical. Prepared by the World Conservation Monitoring Center (WCMC). IUCN, Gland, Switzerland and Cambridge, UK. xxii+360pp.

IUCN, 1994. Guidelines for protected areas management categories. IUCN, Cambridge, UK and Gland, Switzerland

IUCN, 1998. 1997 United Nations list of protected areas. IUCN, Cambridge, UK and Gland, Switzerland

Kpanou, J-B., Otto, K., Mbea, E., Godobo, P. & Blom, A., in prep. Wildlife survey of the Bangassou Forest, Central African Republic.

Mborohoul, J-B., 1993. La Réserve de Biosphère de la Basse-Lobaye. UNESCO MAB, 96pp., figs., tabs.

MEFCPTE/Banque Mondial/Projet Dzanga-Sangha, 1995. Developpement touristique et conservation de ecosystemes. Table ronde 21-22 Mars 1995

Moussa, M., 1992. Le grand bracconage en Centrafrique. In K. Cleaver, M. Munasinghe, M. Dysan, N. Egli, A. Peuker, and F. Wencelius (eds.), *Conservation of West and Central African rainforests.* Washington, D.C.: World Bank. pp.: 182-188.

Namsenei, R., 1999. Les perimetres de reboisement et forets classees du Fonds de Developpement Forestier et Touristiques (FDFT). Ministere de l'Environnement, des Eaux, Forets, Chasses et Peches, Bangui, RCA. 17pp.

SPSS, 1997. SPSS Base 8.0, SPSS, Inc. Chicago.

Underwood, E., Itoua, I., Olson, D., Dinerstein, E., Loucks, C. & Wettengel, W., 1998. Terrestrial ecoregions of Africa. WWF-US Conservation Science Program, WWF-US, Washington.

UNDP, 1995. Rapport Mondial sur le Developpement Humain. Economica, Paris. X+251 pp.

UNESCO, 1999. World Heritage list in danger. www.unesco.org/whc/danglist.htm. site last updated: 30 November 1999

UNESCO, 2000. UNESCO MAB Biosphere Reserve Directory. www.unesco.org/mab/br/brdir, site last updated: 14/02/2000

WCMC, 1994 Biodiversity data sourcebook. World Conservation Press, Cambridge, UK

WCMC, 1997. Description of Natural World Heritage Properties. www.wcmc.org.uk/protected_areas/data/wh. Last updated: August 1997, Access date: 9 March 2000.

World Heritage Committee, UNESCO, 1988. Report of the World Heritage Committee. Convention concerning the protection of the world cultural and natural heritage. Twelfth Session, Brasilia, 5-9 December 1988

World Heritage Committee, UNESCO, 1998. Report of the World Heritage Committee. Convention concerning the protection of the world cultural and natural heritage. Twenty-first Session, Naples, Italy, 1-6 December 1997

World Heritage Committee, UNESCO, 1999. Report of the World Heritage Committee. Convention concerning the protection of the world cultural and natural heritage Twenty-second Session, Koyoto, Japan, 30 November- 5 December 1998

Wilkie, D.S. & Carpenter, J.F., in prep. The under-financing of protected areas in the Congo Basin: so many parks and so little willingness-to-pay. *Biological Conservation* (in review)

Annex 1: Data Sheet for Protected Areas of the Central African Republic

Name	Log	Mine	Hunt	Graz	Farm	Vil	Road	Main	Threat	Type	Guard	Supp	Part	Manage	Sign	Int	Pot.
Vassako-Bolo	1	1	3	4	1	1	3	H	2.1	1	3	2	3	2.7	2	3	1.6
Andre Felix	1	1	4	3	1	1	3	H	2.3	3	3	4	4	3.7	3	4	0.8
Bamingui-Bangoran	1	1	3	4	1	2	3	H	2.3	1	3	2	3	2.7	2	3	1.5
Dzanga-Ndoki (Ndoki sector)	1	1	2	1	2	1	2	H	1.5	1	3	1	2	2	1	1	2.6
Dzanga-Ndoki (Dzanga sector)	2	2	2	1	1	1	3	H	1.8	1	2	1	2	1.7	1	1	2.6
Manova Gounda-St Floris	1	1	3	4	1	2	4	H,G	2.6	1	2	1	3	2	1	3	1.9
Avakaba	1	1	3	4	1	1	3	H,G	2.3	2	3	4	4	3.7	4	3	0.8
Aouk-Aoukale	1	1	3	4	1	1	3	H,G	2.3	1	3	2	3	2.7	1	3	1.8
Gribingui-Bamingui	1	1	3	4	1	1	3	H,G	2.3	1	3	2	3	2.7	4	3	1
Koukourou-Bamingui	1	1	3	4	1	2	3	H,G	2.4	1	3	2	3	2.7	4	3	1
Nana-Barya	1	1	3	3	1	1	2	H	1.9	3	4	4	4	4	3	3	1
Ouandjia-Vakaga	1	1	3	3	1	2	4	H,G	2.3	1	3	2	3	2.7	3	3	1.3
Yata-Ngaya	1	1	4	3	1	1	3	H	2.3	3	4	4	4	4	4	4	0.5
Zemongo	1	1	4	2	1	1	4	H	2.3	3	4	4	4	4	3	4	0.7
Dzanga-Sangha	3	3	2	1	2	2	4	H,L	2.4	1	3	1	2	2	2	2	1.9
Basse Lobaye	3	1	4	1	3	3	2	H	2.6	3	4	4	3	3.7	3	3	0.9
Average	1.2	1.2	3	3	1.1	1.3	3.1		2.2	1.6	3.1	2.4	3.1	2.9	2.5	2.9	1.4

Field attributes

Field	*Description*	*Possible Values*	*Source*
Name	Name of type	Official names in use.	
Log	Presence/absence of logging activities	1=None	
		2=Low	
		3=moderate	
		4=High	
Mine	Presence/absence of mining activities	1=None	
		2=Low	
		3=moderate	
		4=High	
Hunt	Presence/absence of hunting in area	1=None	
		2=Low	
		3=Moderate	
		4=High	
Graz	Presence/absence of grazing in area	1=None	
		2=Low	
		3=Moderate	
		4=High	
Farm	Presence/absence of farming activities	1=None	
		2-Low	
		3=moderate	
		4=High	
Vil	Presence/absence of villages	1=None	
		2-Low	
		3=moderate	
		4=High	
Road	Presence/absence of roads in area	1-no (no motorable roads)	
		2=few (Only foot paths)	
		3=moderate (Logging roads)	
		4=many (Logging, and commercial roads)	
Main	Main source of threat	H=Hunting	
		G=Grazing	
Threat	Overall threat assessment	1=None	
		2-Low	
		3=moderate	
		4=High	
Type	Type of management	1=Government plus external partner(s)	
		2=Government	
		3=None	
Guard	Presence/absence of guards	1=Well Staffed	
		2=Moderately Staffed	
		3=Inadequately staffed	
		4=No staff	
Supp	Level of external support	1=High	
		2=Moderate	
		3=Low	
		4=None	
Part	Level of local (village) participation	1=high (local people involved in all aspects)	
		2=moderate (involved in some activities and consulted on others)	
		3=low (no active participation, some	

		consultation)
		4=none
Manage	Assessment of the present management	1=None
		2-Low
		3=moderate
		4=High
Sign	Biodiversity significance	1=High
		2=Moderate
		3=Low
		4=None
Int	Assessment of the present status	1=High
		2=Moderate/Medium
		3=Low
		4=Very low
Pot	Conservation potential	1=None
		2=Low
		3=Moderate
		4=High

Chapter 3 Dzanga-Sangha context

History of Dzanga-Sangha

In the 19th century tribal wars led to serious disruption of life for most inhabitants of the Dzanga-Sangha region (Figure 1). Many people were displaced, enslaved or killed. The present distribution of ethnic groups was the result of these continuous wars. Nola, the regional capital, was established by the Ngoundi, only about a decade before the arrival of Brazza (Anaclet Amion, pers. comm. in Kretsinger & Zana, 1997). However it seems that it was Fourneau who was the first European to reach Dzanga-Sangha (Extrait du Journal de Fourneau, 9 Avril 1891, COAM, AEF 4(Y)15 in Kretsinger & Zana, 1997). Apparently in that period the Bakongo from Congo had already started a lively trade in ivory, animal skins and other products along the river with their dugout canoes. European companies were granted trading concessions in the newly "discovered" territories (Coquery-Vidrovitch, 1972; Giles-Vernick, 1996).

The commercial development of the Sangha river by the French was rapid and by 1892 a trading post was already established in Bayanga. The famous French author André Gide in his book "Voyage au Congo" (Travels in the Congo) of 1927 gives a good impression about the often brutal exploitation of the local tribes by this concession system.

But ivory was not the only commercial interest of these companies (Coquery-Vidrovitch, 1972). By the second decade of the 20th century, ivory was replaced by rubber as the principal commercial product of the region. Rubber was collected in the forest by local villagers either to be sold or usually to pay their taxes.

In July 1928 a revolt started in the Oubangui-Chari region, but was put down swiftly. According to the historian Kalck (1992) the revolt was caused by the abuses of some of the staff of the concession companies and the recruitment for the railway between Brazzaville and Point Noire. The construction of the railway facilitated trade all along the Congo, including the Sangha. However, its toll on human lives and misery was felt as far away as Chad. It is unknown how many people died during the construction of this railway, but this combined with the outbreak of an epidemic of sleeping sickness led to a dramatic decrease in the human population density in the region (Kretsinger & Zana, 1997).

In 1950 the colonial administration proposed to improve the road from Nola to Bayanga, at that time only a small village, to allow the development of trade. However, the road to Bayanga was abandoned before 1960. On the other hand Lidjombo, established around the plantations of Lopes and Santini, had become much more important. Most of these people had come to Lidjombo to work on the newly established coffee plantations (Giles-Vernick, 1996). Coffee by that time had become the major export product, replacing rubber and ivory.

The conference of Brazzaville in 1958 clearly put the entire Central African region on the road to independence. That same year the constitution of Oubangui-Chari was accepted by its people. Boganda, who was the founder of the Central African Republic, died in a plane crash on the 29th of March 1959, while on election tour. The agreement for independence from France was signed on the 13 of August 1960 (Kalck, 1992).

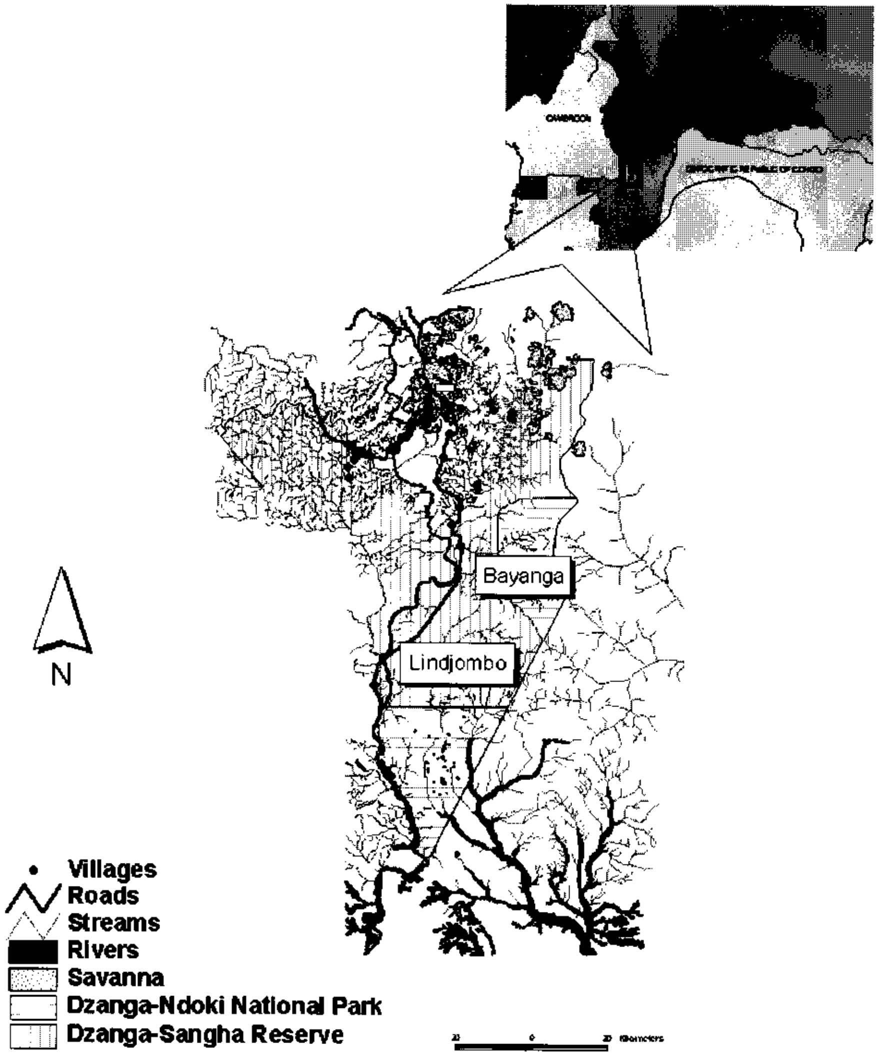


Figure 1 The Dzanga-Ndoki National park and the Dzanga-Sangha Dense Forest Special Reserve in the Central African Republic

Around 1965 the first diamond mines were opened just north of Dzanga-Sangha. Diamond mining soon became a major economic activity followed soon afterwards by forestry exploitation (Kretsinger & Zana, 1997). The area of Dzanga-Sangha was only on the southern limit of the diamond fields. Salo and Yobe saw major diamond activities, but the area around Bayanga and further south were only marginally involved. Here the economic impact of the establishment of the logging company Slovenia Bois in 1972 was much more important. Furthermore the arrival of the logging companies in the area of Dzanga-Sangha pulled the area out of its isolation. The road to Bayanga was reopened and in 1976 Slovenia Bois opened the road to Lidjombo (Strgulec Slavko, pers. comm.).

Slovenia Bois (SB) is at the origin of the "new" Bayanga. SB was responsible not only for the construction of the sawmill and its own houses, but also of most of the rest of the town. Furthermore they built the school, dispensary and airstrip (Strgulec Slavko, pers. comm.). The late seventies and early eighties were the good years for the logging industry in CAR. Slovenia Bois closed due to financial difficulties in 1986. Sangha-Bois in 1988 attempted to work this concession. They also failed and were closed by the government in 1990 (Yamindou, pers. comm.). The Slovenia-Bois concession was bought by a French investment group in late 1992. Operations restarted in early 1993. They changed the name into Sylvicole de Bayanga. From the start this company had serious operational problems, apparently caused by under-capitalization. Once again operations were suspended by the Government in 1997. The current status and future of this concession remains as yet unclear and considerable legal matters remain unresolved.

A second logging company was granted a permit within the reserve in the region of Salo on 2 Sept. 1991. This company, The Societe d'Exploitation Forestiere de la Sangha-Mbaere, SESAM, has concessionaire rights to 106,700 hectares in 4 Forestry Production Units in the northwestern portion of the Reserve. They established a mill and production facility at Salo. They received a loan from the CFD (Caisse Francaisse de Developpement) which allowed for the installation of their sawmill in Salo. Recently this company was recapitalized with Malaysian funding and was able to extend its operations north, by buying up dysfunctional logging operations around Nola.

In a reaction to these continued boom and bust cycles of the logging companies as well as disastrous environmental impact their operations caused, the Central African Government requested technical assistance from WWF to investigate alternatives. In 1991 WWF commissioned the consulting firm TELESIS to examine the sustainable economic options for the Park/Reserve area and examine in detail the economics of logging. The conclusions of this report were that the economic advantages of logging are minimal at best and the ecological costs are very high. They recommended the development of ecotourism combined with associated small enterprise development, and non-timber forest product exploitation as the best and most compatible alternatives to logging in the area (Telesis, 1991 & 1993).

History of the park and the reserve

In the late 1970's surveys by Guigonis (Guigonis, 1977), Loevinsohn (Loevensohn, 1978), Spinage (Spinage, 1979, 1981a & 1981b), Carroll and Hulberg (Carroll & Hulberg, 1982) all indicated the need for additional systematic surveys aimed toward the establishment of a park or reserve to protect the dense forest ecosystem. A bongo sanctuary was proposed by Spinage (Spinage, 1981a). At the request of the Government, Carroll and Fay carried out a more in-depth survey in 1985/86 (Carroll, 1982, 1986a, 1986b, 1986c;

Fay, 1989, 1991). Following these surveys a management plan for the creation of the park/reserve system was presented in 1986 (Carroll, 1986c).

The surveys confirmed the region's reputation of containing the largest concentration of forest elephants (*Loxodonta africana cyclotis*) in the country. They also established the presence of other animal species including the western lowland gorilla (*Gorilla gorilla gorilla*) and chimpanzee (*Pan troglodytes*).

In 1988 an agreement was signed between the Central African Republic and WWF (World Wide Fund for Nature known as World Wildlife Fund in the USA and Canada) for the creation and management of a protected area system in the Dzanga-Sangha region. This was the origin of the so-called "Dzanga-Sangha Project".

The Dzanga-Ndoki National Park and The Dzanga-Sangha Dense Forest Special Reserve were officially gazetted on December 29, 1990 (République Centrafricaine, 1990a & b). The `special reserve' classification allowing for multiple use of resources within a conservation area is a new category of protected area created for Dzanga-Sangha (Chapter 2). It indicates also a major shift in policy by the CAR Government, from classic protected area management towards more participatory and integrated management policies. These policies were set out even more clearly in the Interior Regulations of the Park and Reserve which were passed in March 1992 (République Centrafricaine, 1992a & b). These regulations for the first time in the CAR, permit the local distribution of the financial benefits of conservation as an incentive for the local population to support conservation (see chapter 6).

Dzanga-Sangha protected area complex

The area comprising both sectors of the national park as well as the special reserve is often simply referred to as Dzanga-Sangha. The total Dzanga-Sangha complex covers an area of 4381 km^2 of mostly dense rainforest. The southern Ndoki sector of the national park covers 727 km^2 and the western Dzanga sector 495 km^2, the remaining 3159 km^2 being made up by the surrounding reserve (Figure 1).

The name Dzanga-Sangha comes from the two most important features of the area: the bai (clearing) and stream "Dzanga" and the river "Sangha" a tributary of the Congo.

The name "Ndoki" featured in the name of the National Park is again a river. This time it is a river well known for its large extents of swamp forest. The name "Ndoki" means witchcraft.

Dzanga-Sangha Project

The Government of the Central African Republic and WWF as mentioned above initiated the Dzanga-Sangha Project in 1988. Field activities started in 1989 with an emphasis on anti-poaching to combat elephant poachers who were overrunning the area (Carroll, pers. comm.). From the start of the project, it was felt that collaboration with the local population was essential, as they are some of the primary resource users (Carroll, 1986c, see also Hunsicker & Ngambesso, 1993, Kretsinger, 1993 and Doungoubé, 1990). Their economic livelihood is directly or indirectly linked to the natural resources of the region. The local population also claimed - rightly so - direct benefits from the project. With increasing funding becoming available in the early 90's, the project started expanding into rural development and realizing its original strategy now often referred to as "Integrated Conservation and Development Project (ICDP)" (Blom, 1998, 1999a).

The original purpose of the Dzanga-Sangha Project was ***"the development, protection, and management of the forest of Southwestern Central African Republic for the conservation of its' important floristic, faunal and human components".***

Based on the wildlife surveys as well as socio-economic surveys, and after consultation with stakeholders, the following long-term objective for the Dzanga-Sangha Project was defined:

To protect the biodiversity of the forest of the southwestern Central African Republic by the management and the development of a protected area system with a multiple use conservation buffer zone (Special Reserve), with in its core a strictly protected area (National Park).

The multiple use zone was envisioned to function as a buffer zone around the national park and would allow for sustainable use practices. These practices could include sustainable forestry, tourism development and safari hunting. It should be noted in this context that at the time of establishment no logging was being carried out in the area as the previous logging operations were suspended. However the re-opening of logging operations in the buffer zone was an accepted principle from the beginning.

The gazetting in 1990 of the Dzanga-Ndoki National Park and the Dzanga-Sangha Dense Forest Special Reserve was a major step forward in reaching the long-term objectives of the Project.

Although the original purpose of the Project has not changed, the Project as such has evolved and its objectives have been adapted accordingly. The objective for the phase during which most of this study took place was defined as follows:

Reduce the rate of ecosystem degradation in Dzanga-Sangha and at the same time, ensure the acceptance and partial implementation of long-term sustainable land use specifically adapted to the region.

To achieve this objective the Project was, during that phase, putting an emphasis on:

- Improving and extending the law enforcement system
- Reducing the negative impact of logging on the ecosystem
- Increasing revenues from sustainable activities into the local economy
- Increasing tourism revenue
- Improving the internal organization of the local population as to permit better participation
- Improving the management of research
- Improving overall project administration

The Project possesses a management structure working in 4 different domains: conservation, rural development, tourism and administration. In total the project employs about 120 people. Most of these people have been recruited locally among the roughly 4,500 Reserve and Park inhabitants. Some people were brought in from outside the

Dzanga-Sangha area, as their specific qualifications needed were not available within the region. For a more detailed description and history of the Dzanga-Sangha Project see Blom (1999a).

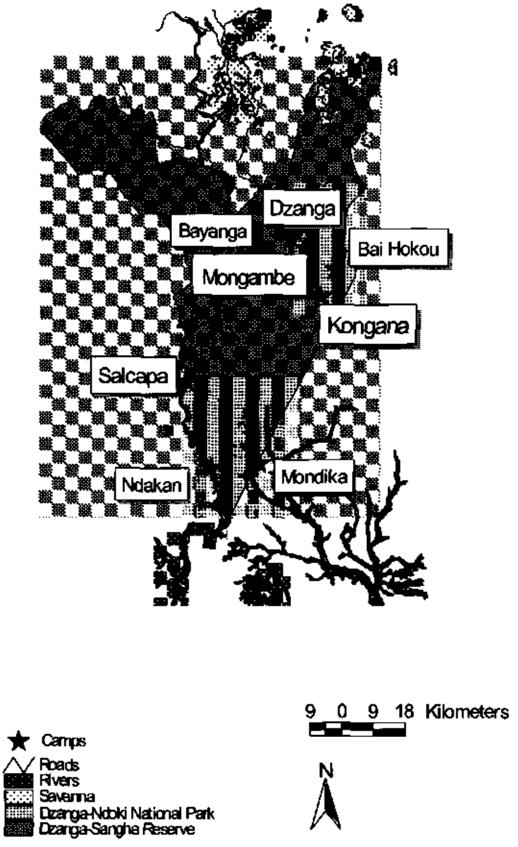
The regional context: the tri-national park

Currently, discussions sponsored by the World Wildlife Fund, Wildlife Conservation International, the German Technical Cooperation (GTZ) and the MacArthur Foundation are underway to create a tri-national conservation system centered around the Dzanga-Sangha area. This effort hopes to establish conservation and management of the forest in the contiguous areas of northern Congo, the Nouabale-Ndoki National Park, and southeastern Cameroon, in the Lake Lobeke forests. It is anticipated that these areas would be managed individually but with an increasing coordination between the different countries, especially in fields such as anti-poaching, tourism and research. For example the recently established Sangha river network will contribute to the exchange of information on research and other topics (Eves, et. al., 1998).

Research at Dzanga-Sangha

Six research centers have been established (figure 2). Bai Hokou in the northern National Park area is the main study area for the gorilla habituation program discussed here. Mongambe has been used as well for preliminary studies and serves as a base camp for the line transect monitoring. Ndakan in the southern National Park zone has had active gorilla ecology studies and is at present the site of research on the regeneration of terrestrial herbaceous vegetation (THV). Mondika is a third site of gorilla research, which is still ongoing. Mondika was also the site of research on mangabeys. Dzanga Bai, in the Dzanga park sector and its associated camp are the site of long-term elephant research. Kongana Bridge has been used for a research program on the ecology of nocturnal carnivores and is at present a training camp for guards and guides.

Figure 2 Research and other camps in Dzanga-Sangha



Over the past 20 years Dzanga-Sangha has been an important area for improving the knowledge of the Congo Basin rainforest and its inhabitants. At least 10 theses have been finalized based on work carried out in Dzanga-Sangha (Table 1)

Table 1: Thesis research carried out at Dzanga-Sangha

Subject	Author
Gorillas	Remis, 1994; Carroll, 1997; Fay, 1997; Goldsmith, 1997
Oral history	Giles-Vernick, 1996
Small carnivores	Ray, 1997
Geophagy	Klaus, 1998
Cultural ecology of hunting	Noss, 1996
Bongo	Klaus-Hugi, 1998
Irvingiaceae	Harris, 1993

Several others are in preparation. Furthermore the Dzanga-Sangha area has been the site of many other types of research, ranging from archeology to socio-economics (see Blom, 1999a for an overview).

Topography and Hydrology

Dzanga-Sangha is on the northern fringe of the Congo Basin plateau. The terrain in general is flat to slightly undulating, with altitude varying between about 200 and 800 meters (Boulvert, 1983). The valleys become more pronounced towards the east and are steep and pronounced in the northwest, forming clear ridges running northeast-southwest. Large areas are seasonally inundated plains, especially along the Sangha and the Ndoki rivers in the south. These two rivers are also the main hydrological features of Dzanga-Sangha, roughly running from the north to the south. The Sangha is a large navigable river at this point and traverses the entire area. The Ndoki is characterized by its large extents of swamps and seasonally inundated forests.

The Dzanga area is characterized by a slightly undulating area rising slightly from the basin of the Sangha river towards Bai Hokou. Bai Hokou (at roughly 500 meters altitude) is located on the border with Congo and is several hundred meters higher than Bayanga (see also Boulvert, 1983 &1986). The terrain here is also more pronounced with some steep valleys with small streams running through them. These streams all run towards the Sangha in the west.

Geology

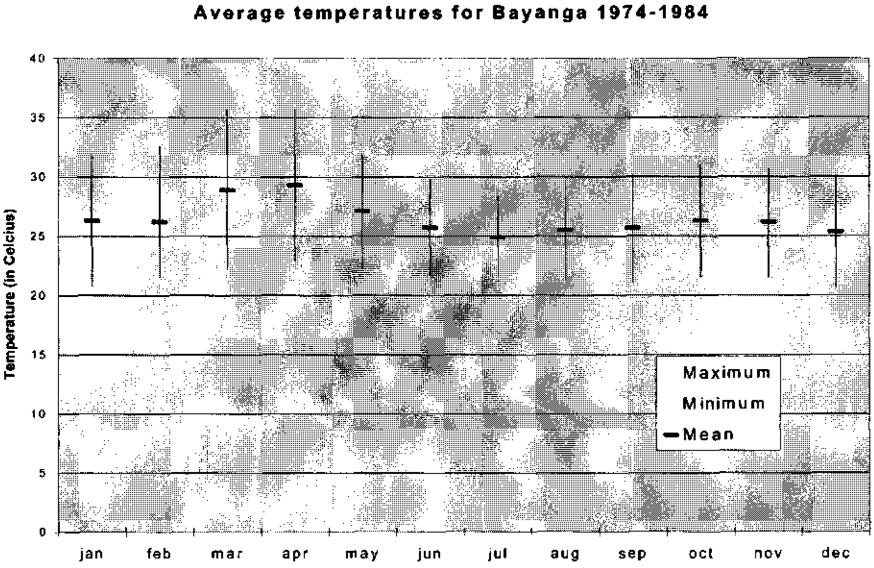
According to Boulvert (1986) the area of Dzanga-Sangha can be geomorphologically classified as recent alluvial. He refers to the area as the Sangha plain (Boulvert, 1983 & 1986). The principal soil type in the region is iron soils comprised of kaolinite and gibbsite and is characterized by laterite shields (Carroll, 1992).

Dzanga-Sangha has many natural clearings, locally called "bais". These bais are visited by many forest animals and make an excellent tourist attraction. Especially the otherwise rarely seen forest elephant is daily encountered in these bais digging for soil (geophagy). The soil layer eaten by the elephants is clayish weathered volcanic rock. Geological investigations showed that the volcanic material can only be found on the bais (Klaus, 1998). If volcanoes ever existed to a great extent they are long since eroded by the tropical rain. The only volcanic material that remained is the material that filled the rifts where the lava streamed out from a great depth. The rifts belong to the rift system of the Mt Cameroon that stretches from there towards the northeast. As the whole Dzanga-Sangha region is covered with sedimentary sands, the volcanic material appears only at the surface when a river cuts the rift. As a consequence of the digging activity of the elephants, the trees fall and die and in the course of millenia large natural clearings, the bais, evolve (Klaus, pers.comm.).

Climate

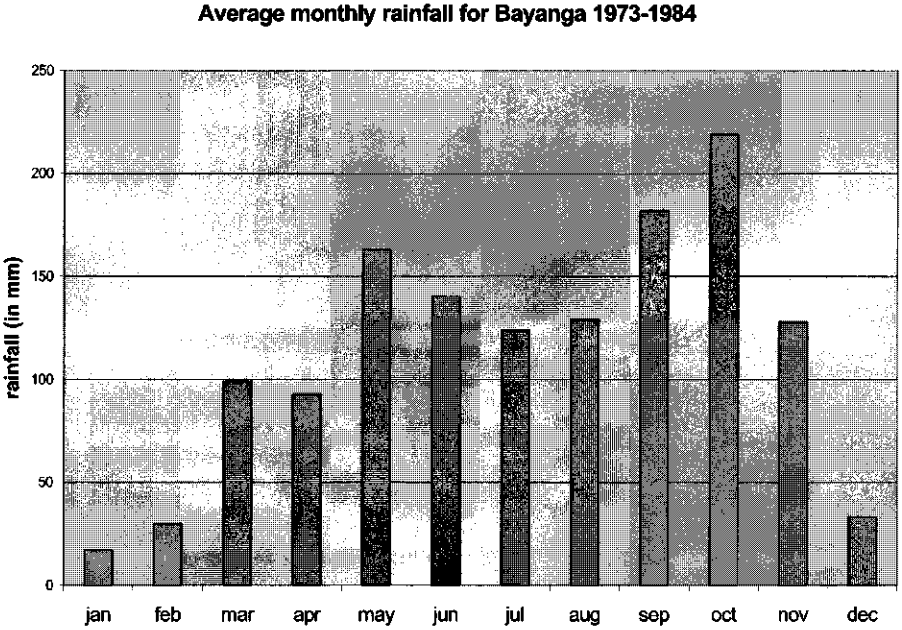
Continued climatic data has been collected at Bayanga by Slovenia-Bois, the Yugoslavian logging firm which operated in Bayanga. Bayanga falls in the transition zone between the Congolese Equatorial and Subequatorial climatic zones (Carroll, 1992). The average minimum, average maximum and monthly average temperatures recorded by Slovenia-Bois at Bayanga and averaged over the years 1974 through 1984 are as follows (figure 3 based on data from Carroll, 1992). Temperature varies little over the year with an average of 26.4 °C. Mean monthly minimum temperatures vary from 20.6 °C to 22.9 °C, and mean monthly maximum temperatures from 28.4 °C to 35.7 °C (Carroll, 1996).

Figure 3: The average minimum, average maximum and monthly average temperatures recorded by Slovenia-Bois at Bayanga and averaged over the years 1974 through 1984



The year is characterized by a dry season of three months (from early December until the end of February) and a long rainy season with a relative minimum of rainfall in June and July (Figure 4). The length of the dry season decreases from North to South. The rainy season, therefore, is approximately 9 months with frequent heavy rainstorms. The average yearly rainfall is approximately 1400mm. per year (Carroll, 1992).

Figure 4: Average monthly rainfall for Bayanga for 1973-1984



Rainfall data for Bayanga, collected by Slovenia-Bois and averaged over the years 1973 through 1984 (based on data from Carroll, 1992)

Vegetation

Introduction to the forests of CAR

In the Central African Republic forest covers in total 92,500 km^2, or close to 15% of the territory. Most of this forest consist of semi-humid and dry forest and gallery forest. Only approximately 37,500 km^2 is covered by dense forest (Carroll, 1992). With reductions for cultivated areas and swamps, the total exploitable forest is estimated at 27,000 km^2 (Carroll, 1992). A large part of this is under exploitation. The only area fully protected is the Dzanga-Ndoki National Park (Chapter 2) presenting only 1222 km^2 or less than 5 % of the total exploitable forest.

The forest of Dzanga-Sangha can best be described as a semi-deciduous forest with a transition from semi-deciduous in the north to evergreen further south across the border in the Congo (see also Boulvert, 1986). Within the north of this forest zone several small patches of savanna exist. Every stage of degradation and succession due to human activities such as village clearing, native slash and burn agriculture, extensive coffee plantations, traditional gathering activities and large areas of exploitation by logging operations, as well as disturbance caused by elephants, windfalls and lightening, form a variety of habitats. The forest of Dzanga-Sangha and its floristic composition are extensively described in Carroll (1992, 1997), but also see Boulvert (1986) and Fay (1997). Additionally Harris (1994) provides a species list.

The forest of Dzanga

Our main study area, the forest of the Dzanga sector of the national park, including Bai Hokou, can best be categorized as a semi-deciduous transition forest, lightly to locally moderately disturbed by selective logging activities carried out in the 1970's. For a description of these logging activities I refer to Carroll (1992). Here I just want to underline that in the CAR the most important species for exploitation in recent years are: *Triplochiton scleroxylon* (Ayous), *Entrandrophragma utile* (Sipo), *E. cylindricum* (Sapelli), *E. candollei* (Kosipo), *E. angolense* (Tiama), *Khaya grandifolia* (Acajou) and *Aningeria altissima.* (Aningré) (PARN, 1995). Of these trees, those selected for harvest are greater than 60 cm. dbh and each tree cut represents approximately 12-14 m^3. In Dzanga-Sangha Ayous comes mostly from the north in the Yobe region, where it is found in a density of 80-90 stems 60cm. dbh or larger on a 25 ha. parcel (Carroll, 1992). Sipo, Sapelli and Tiama come from the southern area. Sipo is very rare, on average, one stem per 25ha. and is the most expensive wood (Carroll, 1992). The Dzanga area was selectively logged in the 1970's, mostly for Sipo and Sapelli. Since the creation of the National Park no logging is allowed and is strictly enforced, which has led to conflicts with the local logging company.

We distinguished the following forest types in the Dzanga area:
Mixed Open (MO): mixed forest with open under story (visibility > 20m);
Mixed Closed (MC): mixed forest with closed under story (visibility < 20m);
Light Gap (LG): major light gaps resulting from natural tree falls;
Dense Understorey (DU): mixed open canopy forest, locally called Ebuka, with a very dense understorey. The canopy is discontinuous allowing light to penetrate to the forest floor. The understorey is covered with dense herbaceous growth, which is dominated by

Haumania sp. and other *Marantaceae* and *Zingerberaceae*. Thick liana tangles can be locally common.
Secondary (SC): human induced secondary forest and shrub, often close to roads or rivers;
Monodominant (MD): monodominant forest of *Gilbertiondendron dewevrei*, locally called Malapa or Bemba, which are distributed in low densities. Sparse understorey, of mostly *Palisota sp.*;
Swamps (SW): inundated throughout the year. Trees below 15 meters and lianas are observed regularly;
Seasonally Inundated (SI): seasonally inundated often along the banks of the streams and rivers. Undergrowth has a low density;
Low Closed Shrub (LC): low canopy with very dense under storey, often with *Ancistrophyllum* palms;
Clearing (CL): open clearings in the forest with no tree canopy and grassy or marshy vegetation (elephant bais & swamp bais).

In Table 2 the percentage of the forest habitat types is presented. This estimate is based on 5 transects of 20 km each through the Dzanga area from north to south crossing the main drainage (Almasi, et al., in prep.). The mixed open forest, the monodominant forest and inundated forest, habitat types with a relatively little undergrowth, form 34% of the forest habitat type. The habitat types with dense understorey (mixed closed forest and low closed shrub forest) form 44% of the forest habitat type. Within all forest habitats the light gaps, secondary forest and dense understorey forest form patches of very dense herbaceous vegetation, mainly of *Marantaceae sp.* and these habitats form 18% of the forest habitat type.

Table 2: Forest habitat types present in the Dzanga sector of the Dzanga-Ndoki National Park

Forest habitat type	Percentage
1. Mixed Closed	43
2. Mixed Open	28
3. Light Gap	9
4. Dense Understory	5
5. Secondary	4
6. Monodominant	4
7. Swamp	2
8. Seasonally Inundated	2
9. Low Closed Shrub	1
10. Clearing	1
Unknown	1
	100

Forest habitat types along 100 km of transect as percentage of total habitat observed (modified from Almasi, et al., in prep.)

Fauna

Many species of wildlife exist in Dzanga-Sangha, representing a wide variety of dense forest fauna, but also including some savanna species. Tropical forests are complex and diverse ecosystems and Dzanga-Sangha is no exception. However the most striking aspect of Dzanga-Sangha is the visibility of its wildlife, especially its amazing mega-fauna.

The diversity in insects is high, but very little is known about the species composition. Only some collecting by the American Museum of Natural History (AMNH) and private collectors (J-C. Thibaud, pers. comm.) has taken place. Likewise the amphibians are largely unknown as is the entire aquatic fauna, except for some work carried out by Peace Corps and the AMNH, which as yet remains unpublished.

The reptiles of CAR have been studied by Chirios. He has indicated that a new species of lizard might be amongst his collections from Dzanga-Sangha (Chirios, pers. comm.). The AMNH also collected several specimens in recent years.

Approximately 700 species of birds have been recorded for the CAR, with over 400 from the forested regions (Carroll, 1987). The first breeding record of the rare brown nightjar (*Caprimulgus binotatus*) was made in the Bayanga region (Carroll and Fry, 1986). Several checklists of the birds of the region have been produced (Green & Carroll, 1991; Blom, 1993b; Rondeau & Blom, in prep.). These are still constantly being updated. The most recent checklist by Patrice Christy includes 42 new species for the region (L.Steel, pers. corr. Feb 4, 2000), bringing the total for the region to at least 350 species, including the recently discovered endemic Sangha Forest Robin (*Stiphronis sanghensis*) (Bereford & Cracraft, 1999).

At present 105 species of non-volant mammals have been identified at Dzanga-Sangha (Blom, 1993a). Most noteworthy is the forest elephant (*Loxodonta africanus cyclotis*) and not only because of its size. Dzanga-Sangha harbors one of the highest densities of forest elephants in Africa (Carroll, 1986b, 1988a, 1988b; Fay, 1991; Almasi, et al., in prep.). Their impact on the forest is profound. They are a major disperser of seeds and have an important effect on forest regeneration and architecture (Carroll, 1992). They may play a role in the creation of the clearings or bais and certainly help to maintain them (Klaus, 1999). Twenty species of primates are listed for the CAR, with 15 occurring in Dzanga-Sangha alone (Carroll, 1992). The reserve is home to two species of apes, to nine diurnal species of monkeys (four guenons, two mangabeys, two species of colobus monkeys and one baboon) and to four nocturnal prosimians (Blom, 1993a).

The subspecies of gorilla in Dzanga-Sangha is the western lowland gorilla (*Gorilla gorilla gorilla*). It is reportedly the smallest of the three generally recognized subspecies (Kingdon, 1997), reaching 168 cm in vertical position (Napier, in Meester & Setzer, 1971). According to Kingdon (1997) it is brownish with a broad face but relatively small jaws. However the easiest distinction in the field is that in general western lowland gorillas have less heavy fur than mountain gorillas and that females often have a distinct russet crown of hair, covering the whole head above the ears. Males from 10 years of age begin to develop a grayish saddle-back, or `silver-back', which sometimes spreads to the thighs. Adult male gorillas may reach 140 kg and females 75 kg (Carroll, 1992). Some discussion is ongoing on the taxonomy of the gorillas (e.g. Butynski, in prep.). The western lowland might be considered a separate species (Kingdon, 1997).

Lowland gorillas are primarily terrestrial, though they climb in trees quite frequently to feed on fruits and leaves (Remis, 1994). Gorillas are social animals that, with the exception of solitary males, live in groups from 2 to 30 animals (Carroll, 1992). The average group size in Dzanga-Sangha has been estimated at 5.4 by Carroll (1992). Solitary males can make up 17% of the population (Carroll, 1992).

At Bai Hokou gorillas feed heavily on the pith and bark of herbaceous and woody material throughout the year. Additionally they feed on over 100 species of fruit and several species of ants and termites (Carroll, 1992). They are diurnal and construct sleeping nests mainly by bending the herbaceous or woody materials into a roughly circular structure. Each adult usually builds his or her own nest, either on the ground or low in trees. This habit of building nests every night can be used for density estimates (Chapter 3).

Lowland gorillas reach high population densities in Dzanga-Sangha (see chapter 3). Carroll (1992) estimated between 0.2 and 11 per km^2 in the various habitats, being most frequent in secondary forest and light gaps, but using primary forest and marshy areas regularly.

The second ape present in Dzanga-Sangha is the chimpanzee, which is more arboreal. Chimpanzees also build sleeping nests, but these are almost always above 3 meters high in trees. Chimpanzees are found in much lower densities in Dzanga-Sangha than gorillas (chapter 3).

Local people hunt both gorillas and chimpanzees for meat, even though they are fully protected by law (Rėpublique Centrafricaine, 1984). However this seems rather limited and as yet, there seems to be little trade in their meat. Also no trophy trade in gorilla body parts is evident in the region. Only during a brief period of about 3 months was there any evidence of trade of live gorillas. Three incidences of gorilla poaching occurred in a period when it was rumored that a European trader was buying live gorillas for trade just across the border in Cameroon. After we informed the Cameroon authorities and colleagues in Cameroon this trade stopped. In two of the three incidences Park authorities arrested the perpetrators. The third poaching party was able to escape into neighboring Cameroon.

The people of Dzanga-Sangha

This dense forest region has traditionally had a very low human population density of approximately 0.5 person per $km.^2$ (Carroll, 1992). Even at present the density in the Dzanga-Sangha protected area complex remains extremely low. The human population density in this area has been estimated to be 1 person per km^2, based on a census carried out in 1995 by World Wildlife Fund (Gonda Ngbalet, 1995; Blom, unpublished data). Almost 60 % of the people live in the town of Bayanga (2,365 inhabitants in 1995). The rest of the population is largely distributed along the road leading from the northern limit of the Reserve to Lindjombo (720 inhabitants), the second largest settlement in the Reserve (Figure 1). However the same census has indicated that at least 10,000 people live just north of the Reserve within a 25-km radius. Although population density in the forest is low and permanent settlements are few and localized, the entire forest is inhabited or used to a certain degree by people for their livelihood.

Ethnic Groups

Southwest CAR, northern Congo and southeast Cameroon form one continuous expanse of rain forest inhabited by numerous Bantu and Oubangian-speaking farmers and three principal groups of pygmies. The pygmies of southern CAR and northern Congo are generically referred to as BaAka. Other pygmies living in northern Congo, near the border with Cameroon, refer to themselves as Bangoumbe, but they are continuous with and linguistically indistinct from the pygmies of southeast Cameroon who call themselves BaKa (not to be confused with BaAka). The BaAka pygmies comprise the largest ethnic group in Dzanga-Sangha (Gonda Ngbalet, 1995; Blom, unpublished data). Apparently many of the BaAka, as the pygmies in this region are called, came from Impfondo in Congo - Brazzaville (Kretsinger & Zana, 1997).

The farmers and fishermen living in the CAR forests are Oubangian speaking groups which include the Ngbaka, Yangere, Bofi, and Biyanda and Bantu-speaking groups which include the Ngando, Mbati, Pande, Pomo, Mbimu and Kako (Carroll, 1992).

The indigenous populations are considerably augmented by transient workers coming long distances to work in the logging operations in Bayanga and Salo. For example at one point the town of Bayanga harbored people from probably every region of CAR as well 15 different foreign countries. People are also attracted by the activities of the Dzanga-Sangha Project, not withstanding its policies to diminish immigration. Additionally many people are attracted to the diamond mines just north of Dzanga-Sangha. Some of these mines have complete towns with thousands of inhabitants associated with them. However these towns usually provide only the most basic social services, with such essentials as schooling and health facilities entirely lacking. This combined with the harsh working conditions in the mines often leads to miserable living conditions. Many complain but have no other alternatives in the CAR.

Economy

The CAR is ranked among the least developed countries in the world. It ranks 149 among 174 countries on the UNDP Indicator of Human Development (IHD), with a life expectancy of only 49.4 years, an adult literacy rate of 53.9% and a GNP per inhabitant of only 410 US$ in 1992 (UNDP, 1995). The same report estimated the population of CAR at 3.1 million in 1992, with an expected annual increase of 2.4 %, expecting to reach 3.7 million people by the year 2000. These figures for CAR have to be taken with some caution, as few accurate data exist. Nevertheless the economic situation has only deteriorated further in recent year, due to severe political disturbances combined with violence and looting. Therefor, we can conclude that the Central African Republic is one of the least developed and populated countries in the world.

As in most other rural areas in central Africa the majority of people are farmers, practicing subsistence slash and burn agriculture, and rely on the forest for hunting, gathering insects, fruits and nuts, and collecting building materials and traditional medicines. Many supplement their incomes by growing coffee or cassava commercially. Along the rivers, many are commercial fishermen. Even people with permanent employment almost all participate in these activities to supplement their household income.

A survey carried out in 1994 showed that 52 % of the men in Bayanga were formally employed by various employers and received a regular salary (Garreau, 1996a). Formal employment is therefore a very important economic factor in the region. This is very atypical in the CAR, where employment opportunities are very scarce. The same survey showed that of those employed in the formal sector, 34 % were employed by the Dzanga-Sangha Project.

Increasing population densities as well as an increased access to markets and hunting areas through logging roads has led to a rapid development from sustainable subsistence hunting to a commercial bushmeat enterprise. Hunting with cable snares and more and more frequently, with shotguns, has made a considerable impact on wildlife populations (Blom, 1999a). This type of hunting and poaching is unlikely to be sustainable for many species of duikers (Noss, 1996 & 1998). This subject will be further discussed in chapter 4.

Tourism has had an increasing impact on the economy in more recent years (Chapter 7). Some of the park revenue is shared with the local population through a Non-Governmental Organization called "Committeee de Developpement de Bayanga" (CDB). The CDB is playing an important role in Dzanga-Sangha in improving collaboration (Garreau, 1996b & 1996c).

As recently as about 10 years ago, no BaAka had fields or plantations for themselves. They preferred to work the fields of Bantou/Oubangui villagers for meager wages and spending still large amounts of time in the forest to hunt wildlife and collect various plants, mushrooms, insects and honey (Kretsinger, pers. comm.). This situation has changed dramatically. Most BaAka now own their fields and go less and less into the forest. They have changed within one generation from nomadic hunter/gatherers into semi-sedentary agriculturists. Furthermore many are now employed by logging companies as well as the Dzanga-Sangha Project (see also Kretsinger, 1993) and associated researchers.

Conclusions

The Central African Republic is a poor and underdeveloped country, depending heavily on extraction of resources to fuel its economy. In the Dzanga-Sangha region, this is mostly mining and logging. However, as in most of the country the majority of people still depend on slash and burn agriculture, combined with gathering, hunting and/or fishing. The region harbors a highly diverse and mobile community, due to both historical as well as recent migrations.

In the Dzanga-Sangha region, the exploitation of natural resources has had a long history, starting with the exploitation of elephants for ivory and duikers for their skins, later followed by rubber and timber. The banning of elephant hunting by the Government and the subsequent enforcement by the Dzanga-Sangha Project has provided respite for the elephants. Still the main threat for biodiversity conservation in Dzanga-Sangha remains poaching, especially of duikers and primates. Both logging and mining have contributed significantly by providing both a market as well as access to the forest. The human impact on the fauna is further investigated in this thesis.

However the establishment of the Dzanga-Sangha Project with its innovative approach to management and revenue sharing provide some hope for the long-term protection of this outstanding region for biodiversity. As we will see further on in this thesis the main challenge will be to find ways of perpetuating the Project itself and assuring its future functioning.

Acknowledgements

I would like to thank the World Wildlife Fund, Inc., World Wildlife Fund, the different Government agencies and private donors for their support to the Dzanga-Sangha Project and biodiversity conservation. Special thanks to Urbain Ngatoua and all the staff of the Dzanga-Sangha Project for their collaboration. I'm particularly grateful to Richard Carroll and Natasha Shah for their constructive comments on the manuscript of this chapter.

References

Almasi, A, Blom, A., Kpanou, J.-B., Otto, K., Mbea, E., Godobo, P. (in prep.) Elephant surveys of the Dzanga sector of the Dzanga-Ndoki National Park, Central African Republic

Beresford, P. & Cracraft, J., (1999). Speciation in African Forest Robins (Stiphrornis): species limits, phylogentic relationships, and molecular biogeography., American Museum Novitates Number 3270, 22pp., American Museum of Natural History.

Blom, A. (1993 a) List of the large mammals of the Dzanga-Sangha Dense Forest Reserve and the Dzanga-Ndoki National Park. World Wildlife Fund - CAR.

Blom, A. (1993 b) List of the birds of the Dzanga-Sangha Dense Forest Reserve and the Dzanga-Ndoki National Park. World Wildlife Fund - CAR.

Blom, A. (1999a) Ten years Dzanga-Sangha Project: 1988 – 1999. World Wildlife Fund – CAR.

Blom, A. (1999b) Ecological monitoring. Dzanga-Sangha project technical report.World Wildlife Fund – CAR.

Boulvert, Y. (1983). Carte pedologique de la Republique Centrafricaine, a 1:1,000,000. Notice explicative #100. ORSTOM, Paris, 126 p.

Boulvert, Y. (1986). Republique Centrafricaine. Carte phytogeographique a 1:1,000,000. Notice explicative # 104. ORSTOM, Paris, 131 p.

Butynski, T.M. (in prep.) Africa's great apes: an overview of current taxonomy, distribution, numbers, conservation status, and threats.

Carroll, R.W. (1982). Preliminary survey of the forests of southwest CAR. Report to the Central African Government.

Carroll, R.W. (1986 a) Status of the lowland gorilla and other wildlife in the Dzanga-Sangha region of southwestern Central African Republic. *Primate Conservation* 7, 38-41.

Carroll, R.W. (1986 b) The creation, development, protection, and management of the Dzanga-Sangha dense forest sanctuary and the Dzanga-Ndoki National Park in southwestern Central Africa Republic. Unpublished report. New Haven: Yale University.

Carroll, R.W. (1986 c) The status, distribution, and density of the lowland gorilla (Gorilla gorilla gorilla (Savage and Wyman)), forest elephant (Loxodonta africana cyclotis), and associated dense forest fauna in southwestern Central African Republic: research towards the establishment of a reserve for their protection. Unpublished report. New Haven: Yale University.

Carroll, R.W. (1987). Birds of the CAR. *Malimbus 10.*

Carroll, R.W. (1988a). Elephants of the Dzanga-Sangha Dense Forest of southwestern CAR. *Pachyderm 10:12-15.* January 1988.

Carroll, R.W. (1988b) Relative density, range extension, and conservation potential of the lowland gorilla (Gorilla gorilla gorilla) in the Dzanga - Sangha region of southwestern Central African Republic. *Mammalia* 52, 309-323.

Carroll, R.W. (1992) The development, protection, and management of the Dzanga-Sangha Dense Forest Special Reserve and the Dzanga-Ndoki National Park in southwestern Central African Republic. Dzanga-Sangha Reserve Project and World Wildlife Fund, Washington.

Carroll, R.W. (1996) Feeding ecology of lowland gorillas (Gorilla gorilla gorilla) in Dzanga-Sangha Reserve of the Central African Republic. PhD thesis, University of Yale.

Carroll, R.W. & Hulberg, B. (1982). Wildlife investigations in the Manovo-Gounda-Saint Floris National Park, CAR. Report to the CAR Government.

Carroll, R.W. & Fry, H. (1986). A range extension and possible breeding record of the Brown Nightjar (Caprimulgus binotatus Bonaparta) in southwestern CAR. *Malimbus 9.*

Coquery-Vidrovitch, C. (1972). *Le Congo au temps des grands compagnies concessionaires. 1898-1930.* Paris: Mouton.

Doungoubé, G. (1990). Central African Republic: the Dzanga-Sangha Dense Forest Reserve. In A. Kiss (ed.), *Living with wildlife: wildlife resource management with local participation in Africa.* Washington, D.C.: World Bank. pp.: 75-79.

Eves, H.E., Hardin, R. & Rupp, S. (1998) Resource use in the trinational Sangha river region of equatorial Africa: Histories, knowledge forms, and institutions. Bulletin Series # 112. Yale School of Forestry and Environmental Studies.

Fay, J.M. (1989) Partial completion of a census of the lowland gorilla (Gorilla g. gorilla (Savage and Wyman)) in southwestern Central African Republic. *Mammalia* 53, 203-215.

Fay, J.M. (1991) An elephant (Loxodonta africana) survey using dung counts in the forests of the Central African Republic. *Journal of Tropical Ecology* 7: 25-36.

Fay, J.M. (1996) The distribution, habitat, ecology, evolution, and origin of the Western Lowland Gorilla (Gorilla gorilla gorilla Savage and Wyman). PhD. thesis, Washington University

Garreau, J-M. (1996a) Enquete socio-economique sur quelques productions de la ville de Bayanga. Non-published report. Projet Dzanga-Sangha. pp. 17.

Garreau, J-M. (1996b) Demarche de développement rural au sein du PCDI Dzanga-Sangha. Non-published report. Projet Dzanga-Sangha.

Garreau, J-M. (1996c) Evaluation du CDB aupres de la population de Bayanaga apres un an d'existence legale. Projet Dzanga-Sangha.

Gide, A. (1927). Voyage au Congo.

Giguet, R. (1975). La foret dense Centrafricaine. Ministere des Eaux et Forets, Bangui, 16 p. multigr.

Giles-Vernick, T. L. (1996)
A dead people: migrants, land and history in the rain forest of central Africa. PhD. Dissertation. Baltimore: John Hopkins University.

Guigonis, (1977). Unpublished report to CAR Government

Goldsmith, M.L. (1997). Ecological influences on the ranging and grouping behaviour of werstern lowland gorillas at Bai Hokou, Central African Republic. Phd thesis. State University of New York at Stony Brook, New York.

Gonda Ngbalet, M. (1995) Données démographique de Dzanga-Sangha. Rapport intermediare. Projet Dzanga-Sangha, Université de Bangui.

Green, A.A. & Carroll, R.W. (1991). The avifauna of Dzanga-Ndoki National Park and Dzanga-Sangha Rainforest Reserve, Central African Republic. Malimbus, 13: 49-66.

Harcourt, A.H. (1986) Gorilla conservation: anatomy of a campaign. In Bernischke, K. (ed.) *Primates: the road to self-sustaining populations.* New York: Springer-Verlag,

Harris, D. J. (1993). A taxonomic revision and an ethnobotanical survey of the Irvingiaceae in Africa. Ph.D. Thesis, University of Oxford, UK

Harris, D. J. (1994) Interim check-list to the vascular plants of the Dzanga-Sangha Project Area Central African Republic. Unpublished report. University of Oxford 31pp.

Hunsicker, P.M. and F. Ngambesso (1993)
Banking on a nature reserve. In E. Kemf (ed.), *The law of the mother: protecting indigenous people in protected areas.* San Francisco: Sierra Club Books. pp.: 233-237.

Kalck, P., (1992). *Histoire Centrafricaine – Des origines à 1966.* L'Harmattan

Kingdon, J., (1997) *The Kingdon field guide to African mammals.* Academic Press Limited, London.

Klaus, G. (1998). Natural licks and geophagy (soil ingestion) by large mammals in the rainforest of the Central African Republic. Inaugural-Dissertation, Universitat Zurich

Klaus-Hugi, C. S. (1998) Home range, feeding behaviour and social organization of the bongo (Tragelaphus eurycerus) in the rainforest of the Central African Republic. Dissertation, Mathematische-Naturwissenschaftlichen Falkutat der Universitat Zurich

Kretsinger, A. (1989)
Guide des mammifères à Bayanga. Bangui: World Wildlife Fund.

Kretsinger, A. (1993)
Dome development options for the BaAka within the dzanga-Sangha Dense Forest Reserve. Unpublished report. Bangui: World Wildlife Fund.

Kretsinger, A. (1995). Produits cru exportes par CFSO – Douanes Brazzaville. Source: Les archives Aix-en-Provence.

Kretsinger, A. & Zana, H., (1997). Souvenirs de Bayanga 1890 – 1960. Projet Dzanga-Sangha.

Loevinsohn, M.E., (1978). Etudes preliminaires de la foret dense. Document de travail #9, FAO, Rome.

Meester, J. & Setzer, H.W. (1971). The mammals of Africa: An identification manual. Smithsonian Institution Press, Washington, D.C.

Noss, A.J. (1995) Duikers, cables, and nets: a cultural ecology of hunting in a central African forest. PhD. dissertation. University of Florida. P. 415.

Noss, A.J. (1998) The impact of cable snare hunting on wildlife populations in the forests of the Central African Republic. Conservation Biology, 12 (2), 390-398.

PARN, Projet d'Amenagement des Ressources Naturelles (1995). Annuaire statistique du secteur forestier Centrafricain 1989 – 1993. Ministere des Eaux, Forest, Chasses, Peches, du Tourisme et de l'Environnement, Bangui, CAR.

PNUD (1995) Rapport mondial sur le développement humain 1995. Programme des Nations Unies pour le Développement (PNUD), Paris: Economica

Ray, J.C. (1997). Resource use patterns among mongooses and other carnivores in a Central African Rainforest. PhD. dissertation, 1996, 255 p. University of Florida.

Remis, M.J. (1994). Feeding ecology and positional behavior of western lowland gorillas (Gorilla gorilla gorilla) in the Central African Republic. PhD. Thesis. University of Yale.

République Centrafricaine. (1984)
Code de protection de la faune sauvage, Ordonnance N0. 84.045. Bangui: Ministère des Eaux, Forêts, Chasse, Pêche, Tourisme et de l'Environnement.

République Centrafricaine. (1990a)
Loi 90.017 portant création du Parc National Dzanga-Ndoki., République Centrafricaine. Bangui.

République Centrafricaine. (1990b)
Loi 90.018 portant création de la Réserve Speciale de Forêt Dense de Dzanga-Sangha. République Centrafricaine. Bangui.

République Centrafricaine. (1992a)
Portant règlement intérieur du parc national Dzanga-Ndoki., Arreté No. 008. Bangui: Ministère des Eaux, Forêts, Chasse, Pêche, Tourisme et de l'Environnement.

République Centrafricaine. (1992b)

Portant règlement intérieur du la Réserve Speciale de Forêt Dense de Dzanga-Sangha., Arreté No. 007. Bangui: Ministère des Eaux, Forêts, Chasse, Pêche, Tourisme et de l'Environnement.

Rondeau, G & Blom, A. (in prep.) The avifauna of Dzanga-Sangha, Central African Republic.

Spinage, C.A., (1979). Unpubl. Report to CAR govt. FAO, Bangui

Spinage, C.A., (1981a). Resume des aires protegees et proposee pour etre protegees. Document de terrain #2, FAO, Rome.

Spinage, C.A., (1981b). Some faunal isolates of the Central African Republic. Blackwell Sci. Publ.

Telesis (1991) Sustainble economic development options for the Dzanga-Sangha Reserve Central African Republic, Telesis USA, Inc.

Telesis (1993) Supplementary study of the sustainable economic development options for the Dzanga-Sangha Reserve Central African Republic, Telesis USA, Inc.

Chapter 4

A survey of the apes in the Dzanga-Ndoki National Park, Central African Republic.

A comparison between the census and survey method for estimating the gorilla (*Gorilla gorilla gorilla*) and chimpanzee (*Pan troglodytes*) nest group density.

Blom, A.[1,2], Almaši, A.[2], Heitkönig, I.M.A.[2], Kpanou J-B.[1] and Prins, H.H.T [2,3]

[1] Dzanga-Sangha project, WWF, BP 1053 Bangui, Central African Republic
[2] Department of Environmental Sciences, Tropical Nature Conservation and Vertebrate Ecology Group, Bornsesteeg 69, 6708 PD Wageningen, The Netherlands
[3] Corresponding author

(Journal of African Ecology, in press)

Abstract

A survey of the diurnal primates was carried out between October 1996 and May 1997 in the Dzanga sector of the Dzanga-Ndoki National Park, Central African Republic (CAR), to estimate gorilla (*Gorilla gorilla gorilla*) and chimpanzee (*Pan troglodytes*) densities. The density estimates were based on nest counts. This article describes how the strip transect census and the line transect survey method were used to estimate the gorilla nest group density. The strip transect has been most commonly used to date. It assumes that all nest groups within the width of the strip are detected, but as this assumption is easily violated in the dense tropical rainforest the line transect survey was also used. For the latter method, only all nest groups on the transect line itself should be detected. That method proved to be an adequate and easy technique for estimating animal densities in dense vegetation.

The gorilla density of 1.6 individuals/km^2 (line transect survey method) found for the Dzanga sector is one of the highest gorilla densities ever reported in literature. The density estimate for chimpanzees was 0.16 individuals per km^2 (census method). The results of this study confirm the importance of the Dzanga-Ndoki National Park for primate conservation.

Introduction

The Dzanga-Ndoki National Park (1222 km^2) and the Dzanga-Sangha Special Dense Forest Reserve (3159 km^2) in the extreme south-west of the Central African Republic (CAR) (Figure 1) were designated in 1990. Their abundance of wildlife and range of pristine dense forest habitats have been described by Carroll (1986) and Fay (1989). The forest contains 15 of the 19 primate species recorded in the CAR, of which gorilla (*Gorilla gorilla gorilla*) and chimpanzee (*Pan troglodytes*) are of prime interest.

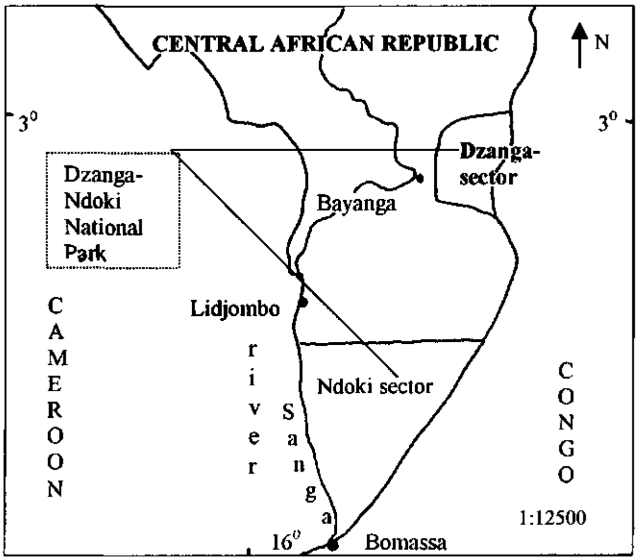


Figure 1: Study area in the Central African Republic

It is essential to have accurate data on the density of these animals in order to conserve and manage the CAR protected areas, and specifically, to monitor trends in order to establish whether their populations are stable, declining or increasing. To design an appropriate system for monitoring gorilla and chimpanzee populations we needed to establish an adequate survey technique based on indirect observations of animal presence, such as nest groups.

The usual methods of estimating mammal density in dense forest habitat are the strip transect census and the line transect survey. The strip transect (Burnham, *et al.*, 1980), is the most commonly used method for estimating nest group densities. It assumes that all nest groups within the width of the strip are counted. This assumption however is easily violated in the dense tropical rainforest. The line transect survey (Buckland, *et al.*, 1993) assumes that all nest groups on the transect line are detected. A proportion of the nest groups on either side of this line may go undetected, but a detection function corrects for the decreasing probability of detecting a nest group further away from the transect line.

The data we collected will be used for an ongoing study of primates and other large mammals in the Dzanga sector, and to monitor the overall impact of project activities such as eco-tourism development and law enforcement.

Study area

This study was undertaken from the Mongambe research camp in the Dzanga sector ($2^0 55'$N, $16^0 20'$E) of the Dzanga-Ndoki National Park. This sector covers an area of 495 km^2 (Figure 1), which from 1972 until the 1980s was selectively logged mainly for two species of hardwood.

The topography of the Dzanga sector is relatively flat. A few streams flow from east to west through the park, towards the Sangha river. In the northwestern part of the park there is a large marshy area. The forest structure in the Dzanga sector is a patchwork of primary forest habitats and secondary forest with much herbaceous undergrowth. Light gaps created by natural tree fall or elephant activity (Carroll, 1986), account for almost 9.5% of the forest habitat (Almaši et al., in prep.). The selective logging also created disturbed forest habitats: the herbaceous plants are also abundant in the abandoned logging roads.

The climate is characterised by a dry season of three months (December - February) and a long rainy season with a drier period in June-July. The mean annual rainfall in Bayanga is 1365 mm (Carroll, 1986). Temperature varies little over the year, with an average of 26.4 °C. Mean monthly minimum temperature ranges from 20.6 °C in December to 22.9 °C April, and mean monthly maximum temperature ranges from 28.4 °C in June to 35.7 °C in March (Carroll, 1986).

The designated conservation area is managed by the Dzanga-Sangha project in an integrated manner. This means that limited traditional and safari hunting, agroforestry development and commercial logging are allowed in the reserve, while there is full protection of the natural forest ecosystem in the designated core area of the park (Carroll, 1986).

Materials and methods

Direct counts along transects, the most commonly used technique for surveys of mammals, are of limited value for surveying gorillas and chimpanzees in the tropical rainforest because the dense understory of the forest and the extreme wariness of the apes make direct observations rare (Tutin et al., 1995). To overcome this problem of obtaining sufficient data, population studies must therefore rely on interpreting the signs of ape activity. We opted to estimate density from nest counts, as each individual of a group of gorillas/chimpanzees, except for suckling infants, usually builds a nest to sleep in each night, thereby leaving tangible signs of both their presence and their numbers (Tutin et al. 1995).

Transects

Data were collected during 5 months of fieldwork between October 1996 and March 1997. To estimate nest density, 5 20-km transects were laid across a map of the area randomly, but at least 1 km apart and parallel to each other, at right angels to the country drainage. Each transect then was walked once, following a fixed compass bearing; distances along the transect were measured by hip-chain. Each habitat type and topography change encountered along the transect was noted, with its distance along the transect, as well as all signs of simiam and human activities. At least two BaAka assistants helped the observer to search for signs and indications of simian and human activity. The BaAka are a tribe of forest dwelling people with excellent knowledge of the forest. When a group of nests was encountered, the distance from each nest to the transect line was measured.

To overcome the problem of clumped distribution for the statistical analyses, the counted nests were analysed in terms of nest groups. All nests of the same age recorded along a 20 m stretch of the transect line were arbitrarily designated as one group.

Ape nests

The data collected on each nest were species, location, habitat type, age class of the nest, construction type and height above the ground. Four nest age classes were distinguished:

- fresh: moist dung present, sometimes gorilla / chimpanzee odour too;
- recent: vegetation still green, some flattened dung may be present;
- old: intact, but all vegetation dead;
- very old: decomposition advanced.

Six nest construction types were distinguished for gorillas:

- "zero": flattened patch and gorilla odour and dung, indicating that the gorilla had slept on the ground;
- minimal: nest made from a few herbaceous stems;
- herbaceous: more complex structure made exclusively from herbaceous materials;
- mixed: nest constructed from mixture of woody and herbaceous material;
- woody: nest constructed exclusively of woody material;
- tree nest: nest constructed in tree, mostly constructed exclusively of woody material.

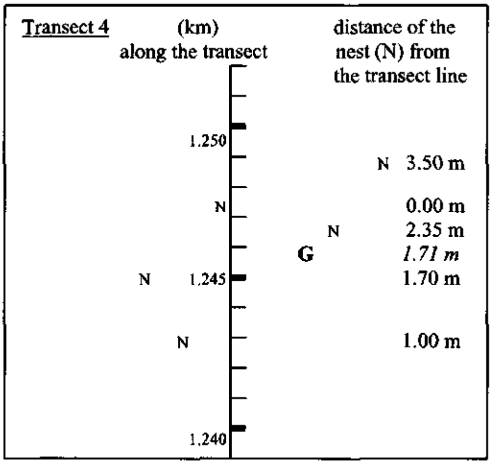
Chimpanzees only build tree nests.

Gorilla nests were distinguished from chimpanzee nests by their construction, the height distribution of nests within a nest group (gorilla nest groups usually have at least one nest on the ground and are rarely constructed at height above 15 m), and the presence of gorilla scent, dung or hairs in the nests.

Calculating nest group density

Both the strip transect census and the line transect survey method were applied to estimate the nest group density. Both methods require the distance from each nest to the transect line to be measured. The distance of the geometrical centre of the nest group from the transect line is used to estimate nest group density (Figure 2).

Figure 2: Calculation of the geometrical centre (G) of the nest group from the transect line



Strip transect census

This method calculates the nest group density by dividing the number of nest groups within the width of the strip by the total area of the strips (Formula 1).

$$\text{Nest group density} = \frac{\text{number of nest groups}}{\Sigma(L_{ij} * (2 * w))} \qquad (1)$$

L_{ij} = length transect line i – j
w = width of the strip transect

A marked drop in the percentage of nests groups recorded beyond a particular width of the strip indicates the cut-off point for reliable counting (w). For gorillas the drop was detected at 4 m., which means it was crucial to record all nests within this distance. The transect width for chimpanzees found was 15 m.

It seems probable that the difference in transect width between gorillas and chimpanzees is a consequence of the distribution of nest groups over the various habitat types. Over 80 % of gorilla nest groups were detected in a habitat type with dense understorey and low visibility, but 84% of the chimpanzee nest groups were situated in forest with little ground cover and good visibility.

Using the method described above, all nest groups that have their centres within the area of the strip should be detected. However, in dense tropical rainforest this assumption is easily violated. The application of this method is expected to yield reduced density, leading to underestimates of nests (i.e. gorilla) density.

Line transect survey

Unlike sampling methods that are based on fixed-width transects, the line transect method (Buckland, *et al.*, 1993) does not assume that all nest groups within a specified width are detected. Rather the assumption is that there is 100% probability that the objects on the transect line are seen. The number of nest groups sighted away from the line decreases in some fashion. The detection function corrects for the lower probability of detecting a nest group as distances increases from the transect line. This method, therefore considers only the nest groups that are seen from the transect line. Its assumption is more realistic given the conditions prevailing in our area. Therefore we expected that it would yield higher and more reliable figures for nest group density than the strip transect method.

The DISTANCE sampling program (Buckland, *et al.*, 1993) uses the perpendicular distances of the geometrical centre of the nest group from the transect line to estimate density. A rule of thumb is to truncate between 5% and 10% of the data to facilitate data modeling by deleting extreme data (Buckland, *et al.*1993). Truncation at 7 m resulted in 7% of the data being suppressed . We tested the influence of group size on detectability from the transect line ("sizebias"), but found it to be insignificant.

Three key models were applied to fit the detection function: the Uniform model with cosine adjustment, the Hazard rate model and the Half-Normal model. The Half-Normal model was selected by Akaike's Information Criterion to fit nest group data. We did not use the survey method to estimate chimpanzee nest group density because we only counted 12 nest groups.

Calculating the density of nest-building individuals

Equation 2 (Tutin and Fernandez, 1984) was used to estimate the density of nest-building individuals per km^2. We did not adjust the density figures to include non-nest-building individuals, since we had no data on the group structure of gorillas in CAR.

$$\text{Nest group Density} \times \frac{1}{\text{no. of nests built by a individual/day}} \times \frac{1}{\text{mean nest life span}} \times \text{Median nest group size} = \text{number of nest building individuals per km}^2 \qquad (2)$$

$$\bar{L} = \sum_{1}^{5}(l_i \times p_i)$$

$\bar{L}$ = average life span of nest

l_i = life span of type i nest

i = nest construction type

p_i = proportion of observations of nest types (see Table 1)

Table 1: Life span of the nest types distinguished by Tutin and Fernandez (1984) and the number of observations of these nest types present in this study.

Nest construction types [a]	mean nest lifespan (days) [b]	number of observations (%)
Zero	**4.3**	**7 (9%)**
Minimum	**19.1**	**5 (6%)**
Herbaceous	**61.7**	**35 (43%)**
Mixed	**52.7**	**27 (33%)**
Woody and tree	**50.9**	**8 (10%)**
Total number of nests		**82**

[a] For explanation, see text

[b] Data from Tutin and Fernandez (1984).

The mean nest life span, the average number of days the nest remains identifiable as a nest, was obtained by multiplying the life span of each nest type as determined by Tutin and Fernandez (1984) by the frequency of occurrence (Equation 3). This approach assumes that the nest decomposition factors are sufficiently similar in the Gabon study site and Dzanga to justify this extrapolation. We felt justified in making this assumption because the climate and the type of forest are similar in both study sites. The gorilla nest life span was estimated to be 50 days (Formula 3, Table 1). Chimpanzees only build tree nests so nest life span has as an average of 50.9 days (Table 1).

Results

Gorilla density

In total, 82 gorilla nests were counted in 29 nest groups, ranging from 1 to 8 nests. Square root transformed data fitted a normal distribution. The mean group size was 2.6 (95% confidence limits: 2.0-3.2).

The gorilla density calculated with the strip transect method was 1.5 gorilla/km^2 (Table 2). The gorilla density calculated by line transect survey method was 1.6 gorilla/km^2 (95% confidence interval 1.1 - 2.3) (Table 3).

Table 2: Density of nestbuilding gorillas and chimpanzees estimated by the strip transect census method

Species	Width (m)	Area censused (km^2)	no. nest groups	no. of weaned ind. km^2
Gorilla	4	0.8	20	1.5
Chimpanzee	15	3.0	12	0.16

Table 3: Density of nestbuilding gorillas estimated by the line transect survey method

Species	Width (m)	no. nest groups	no. nest groups km^2 (95% confidence limits)	no. of weaned ind. km^2 (95% confidence limits)
Gorilla	7	29	26.7 (18.6 - 38.3)	1.6 (1.2 - 2.1)

Despite sampling 100 km of transect, in this study the data for gorillas did not reach the minimum number of 40 nest groups required for the line transect survey method. Due to the small data set the coefficient of variation did not reach the desired accuracy of estimation of <10% (Buckland, *et. al.,* 1993).

Chimpanzee density

We counted a total of 38 nests, in 12 nest groups. The mean group size value was 2.8 (95% confidence interval: 1.7 - 4.3, median=2). Square root transformation was applied to fit the data to a normal distribution (Kolmogorov-Smirnov p>0.05). The density estimate as calculated by the strip transect method was 0.16 chimpanzee/km^2 (Table 2). The line transect survey method was not applied since there were too few data to fit the detection function.

Discussion

In census/survey relying upon the estimation of traces left by animals (nests) rather than sightings of animals themselves, sources of error are introduced. On the other hand, sample size will increase, thus improving statistical resolution (White, 1994). For a more detailed discussion on the accuracy of data collection and the correctness of Equations 1 and 2, see Tutin and Fernandez (1984).

In this study, we found a gorilla density of 1.6 individuals/km^2 for the Dzanga sector of the Dzanga-Ndoki National Park. The density calculations were based on nest group estimates, which were analysed by the survey method. The strip transect method yielded an estimate of 1.5 gorilla/km^2. In view of the assumptions underlying in the latter method, we consider that this value represents a lower limit.

A possible reason for the good agreement between estimates is that the data were collected as the transects were being walked for the first time. The speed of progress was less than 500 m an hour, with more than four BaAka assistants helping to cut the trail at the same time. This minimized the possibility of missing a nest group within the width of the strip transect.

The gorilla density in the Dzanga area is one of the highest densities recorded based on nest observations (Table 4), surpassed only by Mitani's (1993) estimate of 4 - 5 individuals per km^2. His estimate was based on direct observation of gorilla groups in the Ndoki forest in Northern Congo. The high density of gorillas at his study site is expected to be a result of the presence of aquatic plants in swamps. Gorillas used these plants extensively without ecological competition from sympatric chimpanzees.

The high gorilla density in the Dzanga sector can be understood in view of the typical habitat of the Dzanga area. Moderately disturbed forest, such as that found in Dzanga, can be relatively rich in high quality folivore foods and can support higher densities of folivorous primates (Oates, 1996). Oates (1996) has demonstrated that gorilla density is correlated with the abundance of terrestrial herbaceous vegetation. Fay (1995) states that all monocotyledonous plants, but especially those belonging to the families *Marantaceae* and *Zingiberaceae*, are favourable for a high gorilla density. Not only are these herbs used for constructing most of the nests, but their pith is also an important gorilla food (Carroll, 1986).

Our density estimate of 0.16 chimpanzee/km^2 is slightly higher than the figure of 0.01-0.13 chimpanzee/km^2 that Carroll (1986) calculated in 1984 for the various sectors of the Dzanga-Ndoki National Park, and remains low compared to other sites in Africa. A possible explanation for the low chimpanzee density in the Dzanga sector is the proximity of the village of Bayanga. Tutin and Fernandez (1984) claim that chimpanzees are affected more seriously by hunting pressure than gorillas. Poaching occurs in the Dzanga sector, but does not appear to form a serious threat to the population of apes. This might be because poachers usually hunt with cable snares since their chief prey is mainly duikers. Another explanation for the low density of chimpanzees could be the unavailability of suitable habitat: they prefer undisturbed forest.

The typical rainforest habitat in Dzanga, characterised by the frequent occurrence of natural secondary forest habitats containing abundant herbaceous regrowth, favours high gorilla densities. The high gorilla density we found confirms this and shows that the National Park is important role in the conservation of the western lowland gorilla. Overall, the park appears to offer sufficient protection to the gorilla and chimpanzee. We suggest that the monitoring programme be continued, using line transect surveys as the main tool.

Acknowledgements

This work was supported by the Dzanga-Sangha Project, specifically through a grant from the World Wildlife Fund for nature in Washington, and grants from the FONA Foundation, Lucie Burgers Foundation for Comparative Behaviour Research and the Wageningen Agricultural University Foundation. We would also like to thank the field team, K. Otto, E. Mbea and P. Godobo, and all the BaAka trackers for their assistance with the field work. Furthermore, we would like to thank G. van der Kroon, Dr. W. van Schaik and Ir. C. Sieler for their assistance. Finally, we would like to thank the entire Dzanga-Sangha Project staff and the World Wildlife Fund staff in Bangui, Frankfurt and Washington for their support.

References

ALMAŠI, A., BLOM, A., OTTO, K., KNAPOU, J-B. AND PRINS, H.T.T. Survey of elephants (Loxodonta Africana) in the Dzanga-Sangha National Park, Central African Republic. (in prep.)

BUCKLAND, S.T., ANDERSON, D.R., BURNHAM, K.P. AND LAAKE, J.L. (1993) *Distance sampling: Estimating abundance of biological populations*. Chapman & Hall, London & New York. pp 446.

BURNHAM, K.P., ANDERSON, D.R., LAAKE, J.L. (1980) Estimating density from line-transect, sampling of biological populations. *Wildlife monographs* **72**, 1-102.

CARROLL, R.W. (1986) *The status, distribution, and density of the lowland gorilla (Gorilla g gorilla Savage + Wyman)), forest elephant (Loxodonta africana cyclotis) and associated dense forest fauna in south-western Central African Republic: Research towards the establishment of a reserve for their protection.* Thesis submitted for the degree of Ph.D. Yale University, Connecticut, USA.

FAY, J.M. (1989) Partial completion of a census of the lowland gorilla (Gorilla g gorilla) in the Central African Republic. *Mammalia* **53**, 203-215.

FAY, J.M., AGNAGNA, M. (1992) Census of gorillas in the northern Republic of Congo. *American Journal of Primatology* **27**, 275-284

JONES, C. AND SAVAGE-PI, J. (1971), Comparative ecology of Gorilla gorilla (Savage and Wyman) and Pan troglodytes (Blumenbach) in Rio Muni, West Africa. *Bib primatology* **13**, 1-96

MITANI, M., YAMAGIWA, J., OKO, R.A., MOUTSAMBOTÉ, J-M., YUMOTO, T., MARUHASHI, T. (1993) Approaches in density estimates and reconstruction of social groups in western lowland gorilla population in the Ndoki forest northern Congo. *Tropics*, **2(4)**, 219-229

OATES, J.F. (1996) Habitat alterations, hunting and the conservation of folivorous primates in the African forests. *Australian Journal of Ecology* **21**(1), 1-19.

TUTIN, C.E.G. AND FERNANDEZ, M. (1984) Nation-wide census of Gorilla (Gorilla g gorilla) and chimpanzee (Pan t. Troglodytes) in Gabon. *American Journal of Primatology* **6**, 313-336.

TUTIN, C.E.G., PARNELL, R.J., WHITE, L.T.J., FERNANDEZ, M. (1995) Nest building by lowland gorillas in the Lope reserve, Gabon: Environmental influences and implications for censusing. *International Journal of Primatology* Vol. 16, No.**1**, 53-75.

WHITE, L.J.T. (1994) Biomass of rainforest mammals in the Lope reserve, Gabon. *Journal of Animal Ecology* **63**, 499-512.

Chapter 5

Human impact on wildlife populations within a protected central African forest

Allard Blom[1,2,3], Robert van Zalinge[2], Eugene Mbea[1], Ignas Heitkonig[2] and Herbert H.T. Prins[2].

[1] Dzanga-Sangha Project, World Wildlife Fund, B.P. 1053, Bangui, Central African Republic
[2] Tropical Nature Conservation and Vertebrate Ecology Group, Wageningen Agricultural University, Bornsesteeg 69, 6708 PD, Wagenigen, The Netherlands.
[3] Department of Anthropology, State University of New York at Stony Brook, Stony, Brook NY 11794, USA
Corresponding author address: 43 Cove Drive, Sound Beach, NY 11789, USA, E-mail: allardblom@msn.com

Abstract

This paper presents the results of the monitoring of large mammals and evidence of human presence carried out on a monthly basis from January 1997 to August 1999 in the Dzanga-Ndoki National Park and adjacent Dzanga-Sangha Reserve in the Central African Republic.

Between 6 to 8 twenty kilometer-long permanent transect were walked on a monthly basis to assess large mammal populations as well as human intrusion. There were no obvious seasonal or monthly trends in elephant, gorilla or monkey densities. Although some significant differences were found between years in both gorilla and elephant populations (but not monkeys), the results were not conclusive and it is premature to reach a definite conclusion about population changes.

Elephants in particular were significantly less common in areas related to human use, but also other species such as monkeys showed lower densities closer to the main road and the town of Bayanga. Our study also shows that poachers use secondary (logging) roads to penetrate into the national park. Thus, increasing anti-poaching efforts along these roads could be an effective protection measure.

Introduction

As the human population continues to grow, human activities escalate and become increasingly widespread. In central Africa, as in many other areas in the world, several animal species have come under threat due to habitat loss and hunting. A recent study carried out in the central African forests highlighted that game resources are the limiting factor for human densities in these areas (Barnes & Lahm, 1997), and can be easily exploited beyond sustainable levels (Noss, 1995 & 1998). Even those areas with a legally protected status are not free from human disturbance. A recent assessment of the protected areas in the Central African Republic (Blom & Yamindou, in prep.) illustrates that human disturbance is an important threat to the basic survival of many of these protected areas. The effect of human disturbance vary greatly depending on its nature and intensity; thus studies which look at the results of human interaction with wildlife may prove essential for managing protected areas.

As Tutin et al. (1995) pointed out, survey data are essential for conservation and management of protected areas. It is important to estimate numbers, but it is probably even more important to monitor trends in order to establish whether populations are stable, declining or increasing over time. The objective of the study presented here is to determine the effect of local human populations on the distribution of wildlife within the Dzanga sector of the Dzanga-Ndoki National Park and the adjacent area of the Dzanga-Sangha Dense Forest Special Reserve in southwestern Central African Republic (Figure 1).

This study is part of ongoing ecological research set up by the Dzanga-Sangha Project to survey and monitor local wildlife populations (Blom, 1999; Blom, et al., in press; Almasi, et al., in prep.). The results of the initial surveys (i.e. density estimates) will be published separately (Blom, et al., in press; Almasi, et al., in prep.). This paper presents the results of the first 20 months of the monitoring data collection, spanning from January 1997 to August 1999.

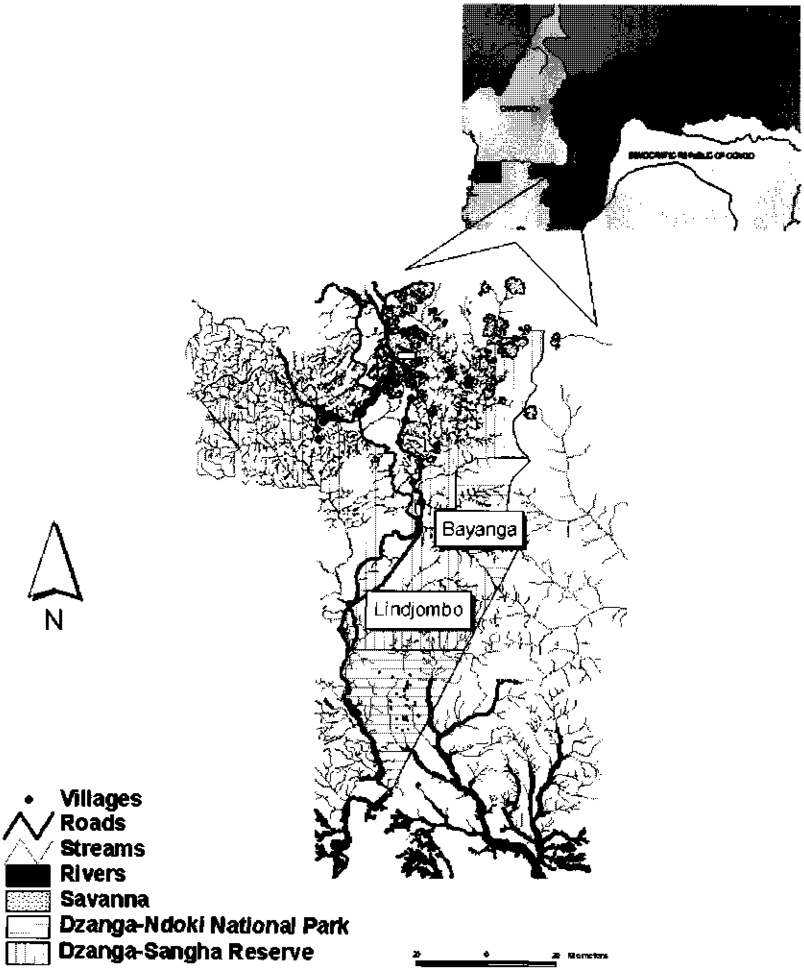
Past studies have analyzed species distribution by comparing regions with varying levels of human disturbance (Fitzgibbon *et al.*, 1995; Hall *et al.*, 1998; Oates, 1996; Prins & Reitsma, 1989; White, 1994), but few have actually tried to quantify the relationship in a more detailed manner (but see Barnes, et al., 1997 and Lahm, et al., 1998 for notable exceptions). By looking at the distribution of human activities as well as a range of different species we hope to obtain a better understanding of human impact in the Dzanga-Sangha protected area complex.

The surveys (Blom, et al., in press; Almasi, et al., in prep.) and the ecological monitoring program presented here concentrate on large mammals and human traces, as it is assumed that large mammals are good indicators of overall ecosystem health. Although it is realized this may not be sufficient, large mammals, such as monkeys, apes and elephants, do provide indicators for trends associated with hunting and other human activities (Barnes, *et al.*, 1991, 1993, 1995 a,b). As such they provide an appropriate indicator for the effectiveness of the protection program carried out by the Dzanga-Sangha project (Blom, 1999). Additional surveys and studies by the Dzanga-Sangha project, museums and other researchers on large and small mammals, birds, fishes and some insect families have and will continue to complement the large mammal surveys and the monitoring program (e.g. Blom, 1993 a,b; Rondeau & Blom, in prep; Lunde & Beresford, 1997; Beresford, 1999; Ray & Hutterer, 1996).

Study area

The Dzanga Sangha Special Dense Forest Reserve (3159 km^2) and the adjacent Dzanga-Ndoki National Park (sector Dzanga 495 km^2; sector Ndoki 727 km^2) together form the Dzanga-Sangha protected area complex, which lies in the south-western Central African Republic (CAR) (Figure 1). So far 105 species of non-volant mammals have been observed within the Dzanga-Sangha area (Blom, 1993a), including the species of large mammals that were the focus of our study. These species include elephants (*Loxodonta africana*), chimpanzees (*Pan troglodytes*) and gorillas (*Gorilla gorilla*), 9 species of monkeys (*Papio anubis, Cercocebus agilis, L. albigena, Cercopithecus nictitans, C. cephus, C. pogonias, C. neglectus, Colobus guereza and Piliocolobus oustaleti*) and five species of duikers (*Cephalophus monticola, C. nigrifrons; C. silvicultor, C. callipygus, C. dorsalis and C. leucogaster*). Besides a diverse rainforest flora and fauna (Fay, *et al.*, 1990; Blom, 1993 a,b; Harris, 1994; Rondeau & Blom, in prep.) the area contains one of the highest documented densities of western lowland gorillas (*Gorilla g. gorilla*) and forest elephants (*Loxodonta africana cyclotis*) in Africa (Carroll, 1986 a,b,c, 1988 a,b, 1997; Fay, 1989, 1991a,b; Blom, *et al.*, in prep.; Almasi, *et al.*, in prep.). The total forest area of southwest CAR covers approximately 6000 km^2 and lies along the northern limits of the Congo Basin rainforest (Carroll, 1997).

Figure 1 The Dzanga-Ndoki National park and the Dzanga-Sangha Dense Forest Special Reserve in the Central African Republic



The Dzanga-Sangha protected area complex is also part of a continuous protected forest block stretching into neighboring Congo (Nouabale-Ndoki) and Cameroon (Lac Lobeke), forming the so-called Sangha tri-national area.

The Dzanga-Ndoki National Park is a strictly protected area, allowing only limited access for research and tourism. The creation of the Dzanga-Sangha Dense Forest Special Reserve in 1990 introduced a new category of protected area into the Central African legislation, that of a multiple-use reserve. The reserve functions as a buffer zone for the national park by allowing the use of natural resources in a sustainable manner (Carroll, 1992). Forestry, safari hunting and traditional hunting and gathering are authorized, but mining is banned. The limits as well as the interior regulations of the protected areas were negotiated with the local population before their gazetting (Carroll, pers. comm.).

The human population density in this area is low at an estimated 1 person per km^2, based on a census carried out in 1995 by World Wildlife Fund (Gonda Ngbalet, 1995; Blom, unpublished data). Almost 60 % of the people live in the town of Bayanga (2,365 inhabitants in 1995). The rest of the population, roughly 2400 people, is largely distributed along the road leading from the northern limit of the Reserve to Lindjombo (720 inhabitants), the second largest settlement in the Reserve (Figure 1). The BaAka pygmies comprise the largest ethnic group in the area. Most people living in the area are dependent on wildlife as a source of daily protein.

Duikers and most other wildlife may be legally hunted within the reserve by the owners of licensed firearms or by traditional means such as nets and spears. Meat is then consumed directly, bartered, sold at the marketplace of Bayanga or transported to other villages. Transportation of meat and hides to markets outside of the reserve is illegal, but difficult to control. Protected species such as the apes and species for which hunting is closed, such as elephants can not be legally hunted. The use of cable snares, which kill indiscriminately, is prohibited though widely used by local hunters, whose range encompasses the entire Dzanga-sector. A recent study carried out in Dzanga Sangha confirmed that snare hunting alone is currently being practiced at unsustainable high levels for three species of duiker: *Cephalophus callipygus*, *C. dorsalis* and *C. monticola* (Noss, 1998).

From 1971 until the early eighties the logging company "Slovenia Bois" selectively logged a 1,000 km^2 area, largely within the area now encompassing the Dzanga-Sangha complex (Carroll, 1997), before going bankrupt. It briefly reinitiated activities to fail again within a year. In 1993 new owners revived and renamed the company "Sylvicole de Bayanga". Logging operations were restarted on a smaller scale, employing about 250 people. It closed once again in 1997 due to mismanagement. At present it is in the process of re-opening once again. The town of Bayanga grew rapidly during the heyday of Slovenia Bois, but the following cycles of boom and bust resulted in similar cycles of immigration and emigration. The result has been a highly mobile population with significant fluctuations in inhabitant numbers in Bayanga.

Most of the survey and monitoring presented in this study was undertaken in and adjacent to the Dzanga sector ($2^0 55'$N, $16^0 20'$E) of the Dzanga-Ndoki National Park (Figure 1). From 1971 until the 1985 this area was selectively logged for mainly two species of hardwood, sipo and sapeli (*Entandrophragma utile* and *E. cylindricum*)(Carroll, 1997).

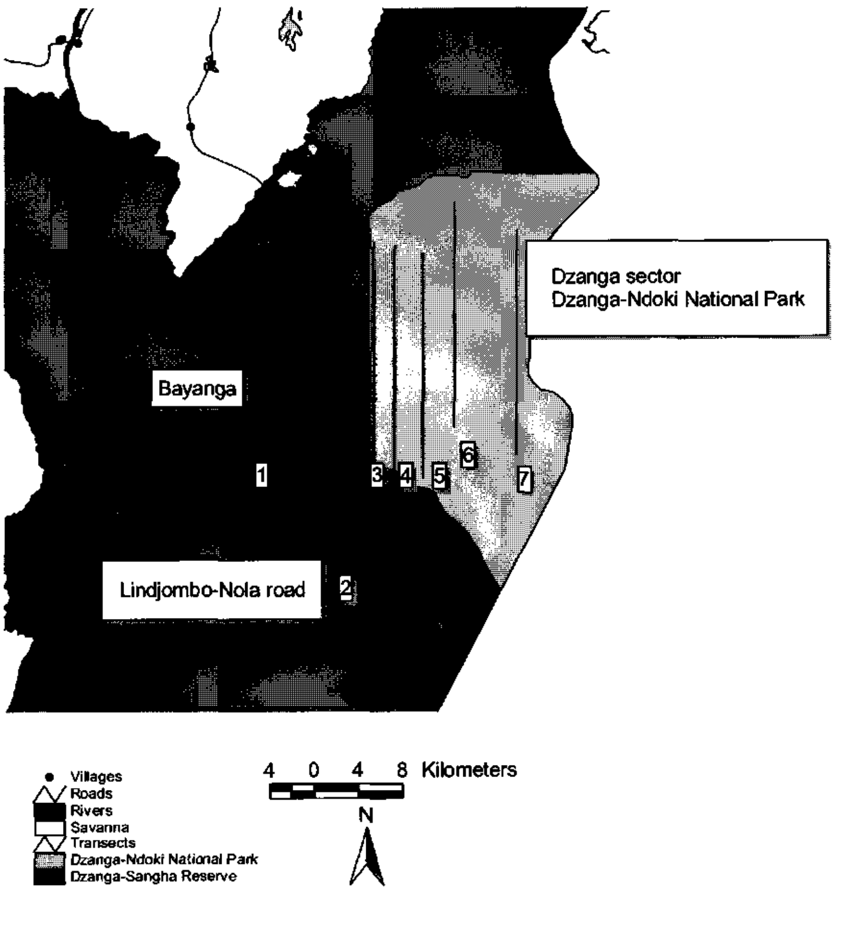
The forest structure in the study area is a patchwork of primary forest habitats, including stands of monodominant forest of *Gilbertiodendron dewevreii,* and secondary forest with large quantities of herbaceous undergrowth. Light gaps which are created by natural tree fall or elephant activity (Carroll, 1986c), represent almost 9.5% of the forest habitat (Almaši et al., in prep.). Also, selective logging created disturbed forest habitats and herbaceous plants are abundant along abandoned logging roads.

The climate is tropical and the year is characterised by a dry season of three months (December - February) and a long rainy season with a relative drier period in June-July. Mean annual rainfall is 1365 mm in Bayanga (Carroll, 1997). Temperature varies little over the year with an average of 26.4 °C. Mean monthly minimum temperatures vary from 20.6 °C to 22.9 °C, and mean monthly maximum temperatures from 28.4 °C to 35.7 °C (Carroll, 1997).

Methods

Initially 5 line-transects were placed in the Dzanga sector of the Dzanga-Ndoki National Park (Almaši et al., in prep.; Blom, et al., in press): transects 3,4,5,6 and 7 (Figure 2). To this was added the limit of the Dzanga sector of the national park, which is in the form of a transect. The transects were 20 km in length and were placed perpendicular to average drainage flow. In this way the variation in habitat was accounted for as much as possible. Thus, all transects also ran perpendicular to the Nola-Lindjombo Road and to all human settlements in the study area (Figure 2). The transects were spaced randomly, with the exception of the park limit. During March and April 1998 two additional transects: 1 and 2, were placed in the reserve.

Figure 2 The Dzanga sector of the Dzanga-Ndoki National Park with transect locations



From January 1997 to August 1999 monthly surveys focused on estimating distribution and relative abundance of wildlife and human disturbance. Each transect was walked by at least one researcher and two BaAka pygmy trackers, sometimes accompanied by one or two guards and additional trackers. The transects were walked every month (with the exception of 2 transects during March 1999) at an even pace and most of the time by the same experienced observers, as to minimise fluctuation in detection rates. An effort was made to remove all snares that were encountered, including those off the transect. Each of the pre-established transects of 20 km was divided into forty 500 meter blocks. Distances from the center point of each transect to the main road Nola- Lindjombo, as well as of each block to the nearest secondary (logging) road were measured using a satellite photo of the study area. To determine the effect of the main road on animal distribution our sample level was that of a transect, as the transects run perpendicular to the main road. For all other environmental variables the sample level was that of a block, allowing more detailed analysis. The percentages of the different habitat types found in each block were determined during the initial placement of the transects (Almasi, et al., in prep.). During the monthly surveys the observers noted the following signs for each 500 meter block:

- Number of elephant dung piles seen from the transect line
- Presence or absence of ape nest
- Presence of non-human primates: each species of monkeys (seen or heard) and/or apes (feeding remains, traces/tracks, seen or heard). Human presence and type of presence:
    - Hunting: snare, cartridge
    - Traditional hunting: net
    - Honey gathering: tree cut, open hive
    - Other: footprints, camps, trails, etc.

In April, May and June 1998 duiker distribution data was collected on monthly surveys through dung counts on specific strip transects. As the dung is of small size yet frequently encountered we did not count all dung piles, but placed a strip transect only 1 km long and 3m wide on each of the 20 km transects, within a mixed forest type of similar structural appearance. Due to the subjectivity possible in this procedure all strip transects were placed by one individual. Average travel speed along these strips was approximately 0.5 km per hour in order to get accurate counts. Two individuals would search for duiker dung while the other(s) would continue standard observations. Differentiation of the dung belonging to the various medium sized (red) duikers often proved difficult and so for analysis these were lumped together as a group. Thus we distinguished dung as belonging to either red duikers or the smaller Blue duiker, *Cephalophus monticola*. The red duiker group consists of Peter's duiker, *Cephalophus callipygus*; Bay duiker, *C. dorsalis*; White-bellied duiker, *C. leucogaster* and the Black-fronted duiker, *C. nigrifrons*. Dung of the larger yellow-backed duiker (*C. sylviclutor*) was only rarely encountered on any of the transects and was not taken into consideration here.

Besides leaving feeding remains of plants, lowland gorillas have been observed to frequently use the termites of the genus *Cubitermes* as a food resource in various study sites (Tutin & Fernandez, 1992; Carroll, 1997). Furthermore, though chimpanzees have been reported to feed on termites and other insects they seem to select other species than those eaten by gorillas (Tutin & Fernandez, 1992). Gorillas break termite mounds into fist sized pieces in order to shake out the termites (Carroll, 1997), thus leaving characteristic trace of their passage. Traces of chimpanzees other then nest sites were rarely encountered on transects and therefore not used for distribution analysis. The following species of monkeys were encountered: *Cercopithecus nictitans, C. cephus, C.pogonias, Lophocebus albigena and Cercocebus agilis.*

To analyse species distribution five habitat types were distinguished:

1. Mixed Forest: dense semi-deciduous forest with a wide variety of species. Structure of undergrowth varies from dense to relatively sparse, though always more dense than found in *Gilbertiodendron* type forest.

2. Gilbertiodendron Forest: *Gilbertiodendron dewevreii* tends to be found in monodominant stands, most often close to rivers and streams, but also in drier areas. Transition zones in which *Gilbertiodendron* is still dominant are also noted as such. Undergrowth is very sparse.

3. Disturbed Forest: found throughout the forest where the vegetation has not recovered from past logging operations or other forms of disturbance. Characterized by a dominance of saplings and young trees. In the lighter areas, where more sunlight penetrates the canopy, herbs such as *Marantaceae spp.* and *Affromomum spp.* occur in high densities.

4. Light Gaps: formed by treefalls. The increased light intensity encourages the development of a dense herb layer as can be found in disturbed forests, though light gaps are smaller in size.

5. Waterlogged and Exposed Habitats: forest along streams and rivers, bais (clearings) and swampy areas are included here.

Data analysis

The following statistical analysis methods were used:

- Linear regression and the F-test of significance (Sokal & Rohlf, 1995; SPSS, 1997) to analyse the impact of transect distance from the town of Bayanga and the main road
- Pearson correlation coefficient of significance (SPSS, 1997) to examine the way certain variables covary or were interdependent
- T-test for comparisons between means for trimestrial as well as the dry season versus wet season values (Sokal & Rohlf, 1995; SPSS, 1997)
- Paired samples t-test for comparisons between monthly means for years (SPSS, 1997).

We used SPSS 8.0 statistics software (SPSS, 1997) to analyse the data. Tests were either one-tailed or two-tailed depending on the hypothesis, with a 5 % level of significance. For the more detailed analyses of distribution from the encounter rate data collected per block on apes, duikers and various monkeys we used multivariate techniques. Multivariate techniques are a useful tool for exploring ecological relationships. To get an overview of the distribution of species in relation to each other and towards environmental variables we used a principal component analysis (PCA). Using the species abundance data set, PCA constructs components or axes, which will each reflect the maximum linear correlation between the species, which can still be found after the construction of a previous axis. All axes constructed are completely uncorrelated and thus can explain different relationships (Kent and Coker, 1994). Environmental gradients are subsequently regressed on to the principal components constructed to help interpret the ecological meaning of the axis.

Multiple linear regression was then applied in order to select those environmental variables which explain the greatest variation in species abundance. Necessary assumptions in applying linear regression to our data are that the dependant variable is normally distributed around any given value of the independent variables and that the variance around the regression line is constant (Sokal and Rohlf, 1995). To test for a normal distribution we used the Kolmogorov-Smirnov test on the residuals from the regression. Where regression could not be applied, Spearman's rank correlation test was used.

Predictions

We expected to find that human influence on wildlife distribution would be reduced within the boundaries of the Dzanga National Park and that there would be significant differences between species abundance in the park and in the reserve. Furthermore, based on previous studies (e.g. Barnes, et al., 1991) we predicted that elephant densities would increase with the distance from the main population center, the town of Bayanga and the main road. Likewise we expected higher densities of primates further away from the main road, but the opposite for human presence. We expected the same in relation to secondary roads, possibly to a lesser degree. As these roads are often not displayed on maps, they are not taken into consideration when data are used in extrapolations based on models using Global Information Systems (e.g. Michelmore, et. al., 1994). For the protection program carried out by the Dzanga-Sangha Project to be considered successful, populations of elephants and primates should not have declined during the study period due to increased poaching.

Results

As mentioned earlier, the ecological monitoring was carried out on a monthly basis from January 1997 until August 1999 for 6 of the 8 transects. The two transects closest to Bayanga were added in April 1998, but were not investigated in March 1999. Thus to show the monthly fluctuations in dung piles (Figure 2) and the number of blocks with elephant dung, ape nests or human sign (Figure 3) we could only used the first 6 transects that were monitored consistently from the beginning of the study.

Figure 2: Total number of elephant dung piles for the first 6 transects per months

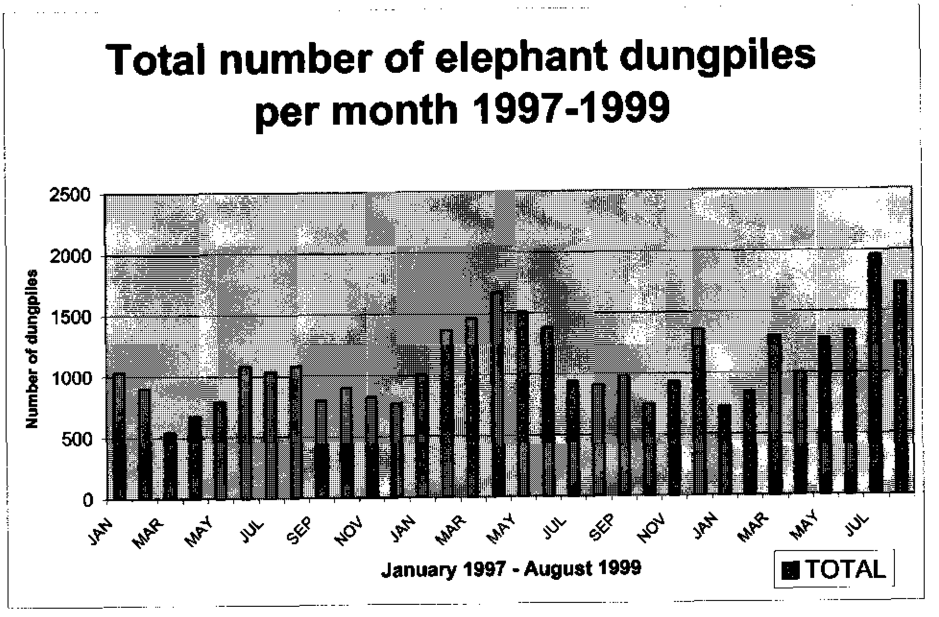
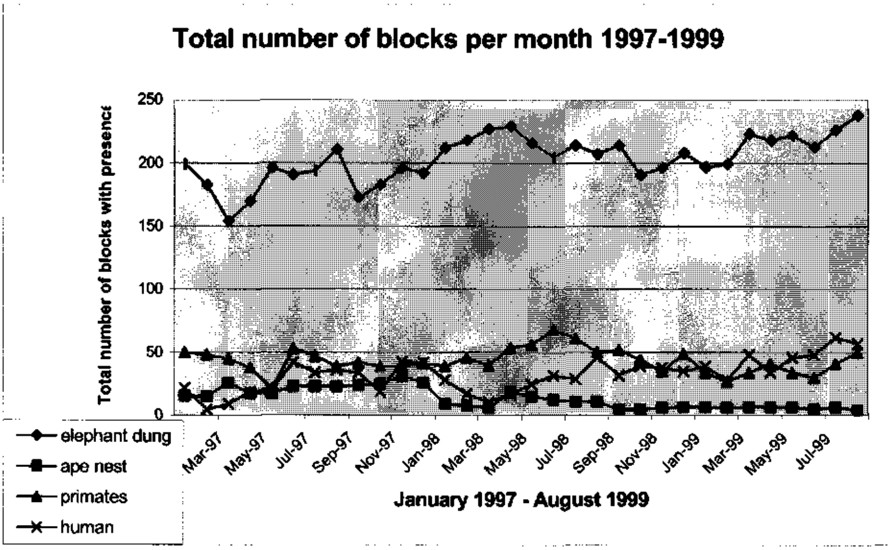


Figure 3: Total number of blocks with indicators (elephant dung piles, ape nests, non-human primates and human signs) for the first 6 transects per months



The data show that the total number of elephant dung piles per month on the first 6 transects was significantly higher in 1998 than in 1997 (paired samples t-test, two-tailed, df=11, t=-2.641, $p<0.05$). However no differences were apparent between the first 8 months of 1998 and 1999 (paired samples t-test, two-tailed, df=7, t= 0.039, NS). The same result was shown when we compared the number of blocks with elephant dung between 1997 and 1998 (paired samples t-test, two-tailed, df=11, t= -3.657, $p<0.005$), but likewise no differences were apparent between the first 8 months of 1998 and 1999 (paired samples t-test, two-tailed, df=7, t= -0.171, NS).

The number of blocks with ape nests per month shows the opposite, with 1997 being significantly higher than 1998 (paired samples t-test, two-tailed, df=11, t= 5.568, $p<0.001$) and again significantly higher in 1998 than in 1999 (paired samples t-test, two-tailed, df=7, t= 3.507, p=0.010). The number of blocks with human sign and the number of blocks with non-human primates did not show any significant differences between 1997 and 1998 (paired samples t-test, two-tailed, df=11, resp. t= -0.750, NS and t=-1.884, NS). The latter showed an almost significant trend (p=0.086), with 1998 being higher than 1997, but then the first of 8 months of 1999 were significantly lower then in 1998 (paired samples t-test, two-tailed, df=7, t=3.512 , p=0.010). Human sign significantly increased between 1998 and 1999 (paired samples t-test, two-tailed, df=7, t=-5.451 , p=0.001).

As illustrated in figure 3 there were no obvious seasonal or monthly trends in the number of blocks with elephant dung, ape nests, non-human primates or human presence.

No significant differences were found between any combination of quarters tested for all the years combined (t-test, two-tailed, df=16 for years combined first and second quarter to df=14 for year combined third and fourth quarter, NS). One exception could be noted, which was a significant difference between first and third quarter with an increase in human sign (t-test, two-tailed, df=15, t=-2.799, $p<0.05$). No significant differences were found between seasons (dry-wet) for all the years combined (1997-1999) or for the other years treated separately for any of the tested measures on the first 6 transects as illustrated in Table 1. The only exception was that the elephant dung piles seem to have been more numerous and present in more blocks in the dry season of 1999 than in the wet season of the same year. However it should be pointed out that the data for 1999 were incomplete.

Table 1: Seasonal differences between wet and dry season during the period 1997 – 1999

	t-value 1997-1999 combined	t-value 1997	t-value 1998	t-value 1999
Elephant dung piles	-0.870	0.365	0.399	-2.499 *
Blocks with elephant dung piles	-0.488	0.570	0.215	-3.998 **
Blocks with ape nests	-0.718	-1.490	-1.200	0.327
Blocks with human sign	-1.316	-0.619	-.0455	-2.043
Blocks with non-human primates sign	-0.525	1.109	-1.075	-1.075

(T-test, two-tailed, df=30 for years combined and df=10 for 1997, 1998 and df=6 for 1999 and * $p<0.05$, ** $p<0.01$ *** $p<0.005$. Equal variance is assumed in all cases, except for blocks with apes in 1998 where the Levene's test for equality of variances was significant (F= 5.481, $p<0.05$)).

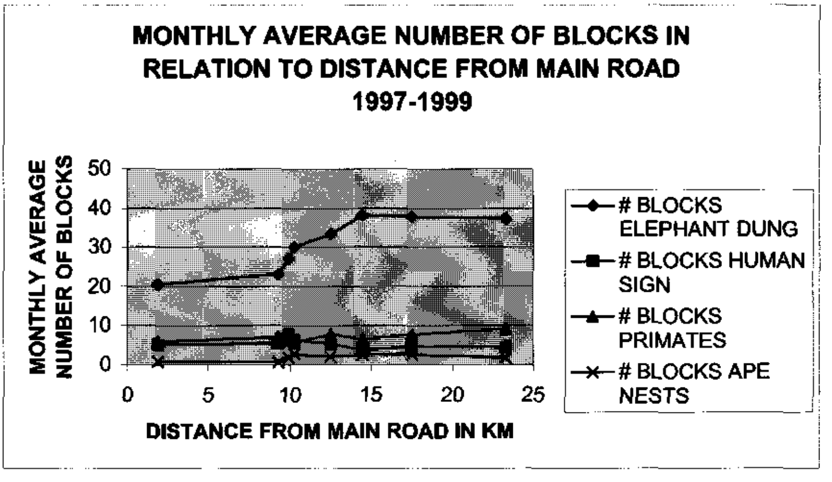
Table 2 indicates that the number of blocks with non-human primates present was clearly dependent on the distance from the main road, but only in 1998. The number of blocks (Figure 4) with dung piles and the total number of dung piles (Figure 5), showed a tendency to increase with distance from the main road, when all transects were taken into consideration.

Table 2: Regression between distance and dependant variables

	F-value 1997 (df=5)	F-value 1998 (df=5)	F-value April–Dec. 1998 (df=7)	F-value Jan.-Aug. 1999 (df=7)
Elephant dung piles – Distance from Main Road	2.044	1.144	6.578 *	8.890 *
Blocks with dung piles – Distance from Main Road	5.863	4.776	12.009 *	17.067 **
Blocks with ape nests – Distance from Main Road	0.267	0.268	4.155	0.558
Blocks with human sign – Distance from Main Road	4.108	2.772	1.330	4.602
Blocks with traditional hunting – Distance from Main Road	3.588	0.560	0.666	0.955
Blocks with hunting sign – Distance from Main Road	3.585	0.710	0.163	0.012
Blocks with non-human primates – Distance from Main Road	2.777	33.942 ***	72.559 ***	1.873

(ANOVA; * $p<0.05$, ** $p<0.01$ *** $p<0.005$)

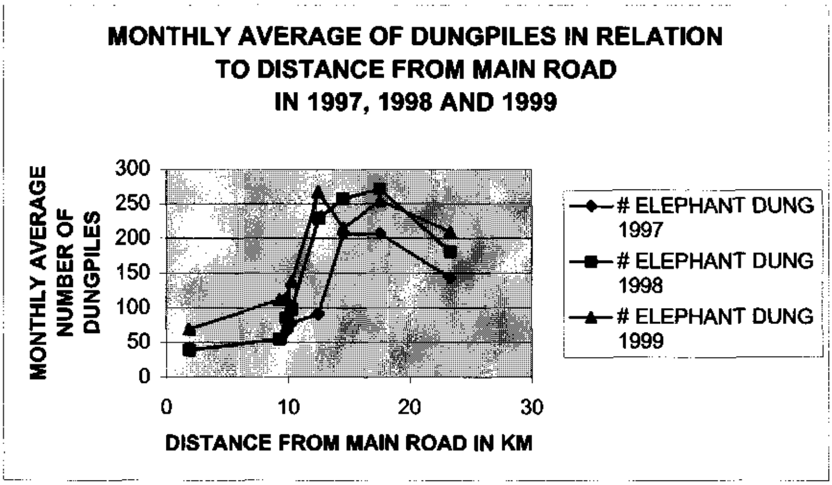
Figure 4: The relation between distance from the main road and dependant variables



(with n=32 for all transects, except the two closest to the main road n=16; blocks primates refers to signs of non-human primates presence: see methods)

As illustrated in Figure 4 and 5 the increase in elephants is not linearly related to the distance, but shows a sudden increase after about 10 km away from the main road. This increase is constant over the length of the study.

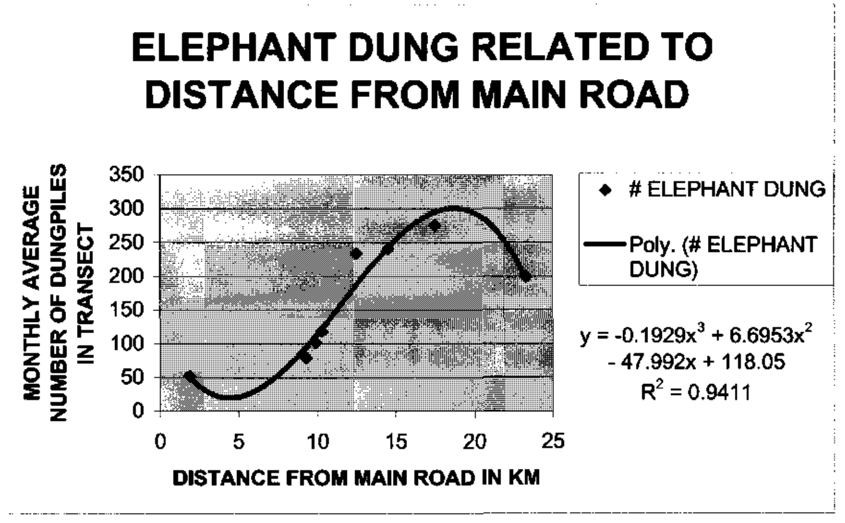
Figure 5: The relation between distance from the main road and average number of dungpiles per transect for 1997, 1998 and 1999.



(with n=12 for all transects in 1997 and 1998, except the two closest to the main road n=9; n=8 for all transect in 1999, except the two closest to the main road n=7)

The relation between the distance from the main road and the monthly average number of dung piles per transect can best be described as a regression with a polynomial trend of the third order (Figure 6)

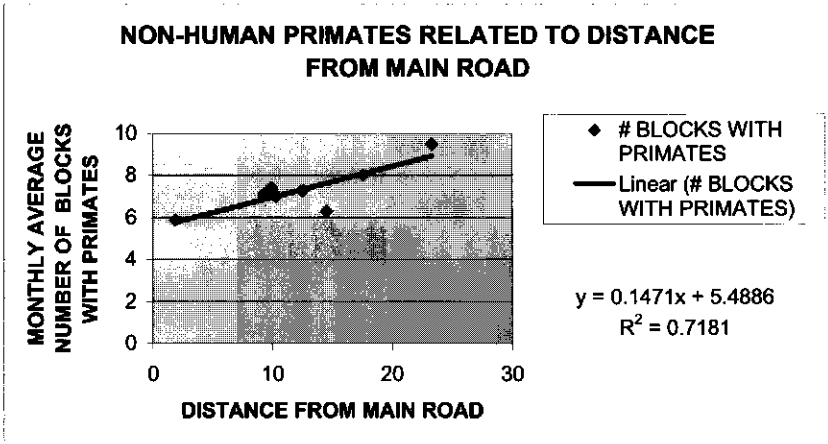
Figure 6: Regression between distance from the main road and the dependent variable: the monthly average number of dung piles per transect.



(polynomial trendline of the third order; only those months with all transect taken into consideration n=16 months)

The only other regression which showed some significant trend (table 2) was the relation between distance from the main road and blocks with non-human primates present. This relation, as illustrated in Figure 7, is best presented as a linear regression.

Figure 7: Regression between distance from the main road and the dependent variable: the monthly average number of blocks with non-human primates present per transect.



(only those months with all transect taken into consideration n=16 month; blocks primates refers to signs of non-human primates presence: see methods)

Contrary to our expectations, no relation was found between distance from the main road and human presence. Even when examining clear hunting signs (e.g. snares and cartridges) or traditional hunting (nets) and eliminating other traces from for example patrols and researchers, no relation was detected (Table 2).

The number of blocks with human sign showed a negative regression with the number of elephant dung piles in 1998 and 1999 and with the number of blocks with dung in 1997 and 1998 (Table 3). In 1998, these relations were no longer evident when the two additional transects were added. The number of blocks with ape nests and non-human primates present did not show any significant relation to the number of blocks with human evidence.

Table 3: Regression between human sign and dependant variables

	F-value 1997 (df=5)	F-value 1998 (df=5)	F-value April–Dec. 1998 (df=7)	F-value Jan.-Aug. 1999 (df=7)
# of dung piles – Human sign	3.837	14.539 *	2.959	7.184 *
Blocks with dung piles – Human sign	7.874 *	26.926 **	1.358	4.438
Blocks with ape nests – Human sign	0.179	0.004	0.099	0.185
Blocks with non-human primates – Human sign	3.644	1.240	0.555	0.137

(ANOVA; * $p<0.05$, ** $p<0.01$ *** $p<0.005$)

Although there was a significant negative regression of overall human presence and elephant dung piles, when looking specifically at hunting signs and elephant dung piles there is no relationship. In fact none of the expected dependant variables show any significant relation (Table 4).

Table 4: regression between hunting sign and dependant variables

	F-value 1997 (df=5)	F-value 1998 (df=5)	F-value April–Dec. 1998 (df=7)	F-value Jan.-Aug. 1999 (df=7)
# of dung piles – Hunting sign	1.344	3.799	0.044	0.552
Blocks with dung piles – Hunting sign	3.540	4.609	0.476	0.266
Blocks with ape nests – Hunting sign	0.009	0.107	0.864	1.067
Blocks with non-human primates – Hunting sign	2.586	0.032	0.564	0.407

(ANOVA; * $p<0.05$, ** $p<0.01$ *** $p<0.005$)

Detailed analyses of ecological relationships

Comparison of sectors

Table 5 gives the mean encounter rates per km for the species studied for different sectors. The rates were calculated from surveys in April-June 1998 by which time transects 1 and 2 had been placed in the reserve. The mean encounter rates for the Dzanga sector are based on transects 4, 5, 6 and 7, while transect 3 represents the park boundary. Tests for significant differences between sectors in the mean encounter rates per transect survey relied on the Mann-Whitney U-test. Unfortunately only one duiker survey could be carried out along the park boundary and in the reserve so little could be said on the significance of the differences found for the two groups of duikers (red and blue). Statistical strength was increased when the samples from both groups were used together (*Cephalophus* spp.). Differences between the park and other sectors then proved significant.

Table 5. Mean group encounter rates and the statistical significance of their differences for the three sectors. (t) = trace, (n) = nests, (d) = dung piles.

Species	Mean encouter rates			Z statistic of differences between sectors		
	Dzanga-sector	Park boundary	Reserve	Ds & Pb	Ds & R	Pb & R
Cercopithecus nictitans	0.3	0.18	0.18	-2.23*	-2.46*	-0.10
Cercopithecus cephus	0.08	0.06	0.05	-0.65	-1.37	-0.29
Cercopithecus pogonias	0.16	0.05	0.06	-2.19*	-2.18*	-0.30
Lophocebus albigena	0.25	0.05	0.03	-2.61**	-2.99***	-0.32
Cercocebus agilis	0.05	0.03	0.02	-0.59	-1.58	-1.07
Gorilla g. gorilla (t)	0.88	0.31	0.18	-1.95	-2.87**	-0.56
Gorilla g. gorilla (n)	0.04	0.02	0.01	-0.42	-1.18	-0.83
Pan t. troglodytes (n)	0.04	0.05	0.02	-0.50	-0.84	-0.27
Loxodonta a. cyclotis (d)	16.32	5.67	2.43	-3.16***	-3.37***	-2.20*
Cephalophus spp. (d)	0.17	0.03	0.03	-2.12*	-2.12*	0.00
C. monticola (d)	0.15	0.05	0.05	-1.33	-1.33	0.00
Red duikers (d)	0.19	0	0	-1.61	-1.61	0.00

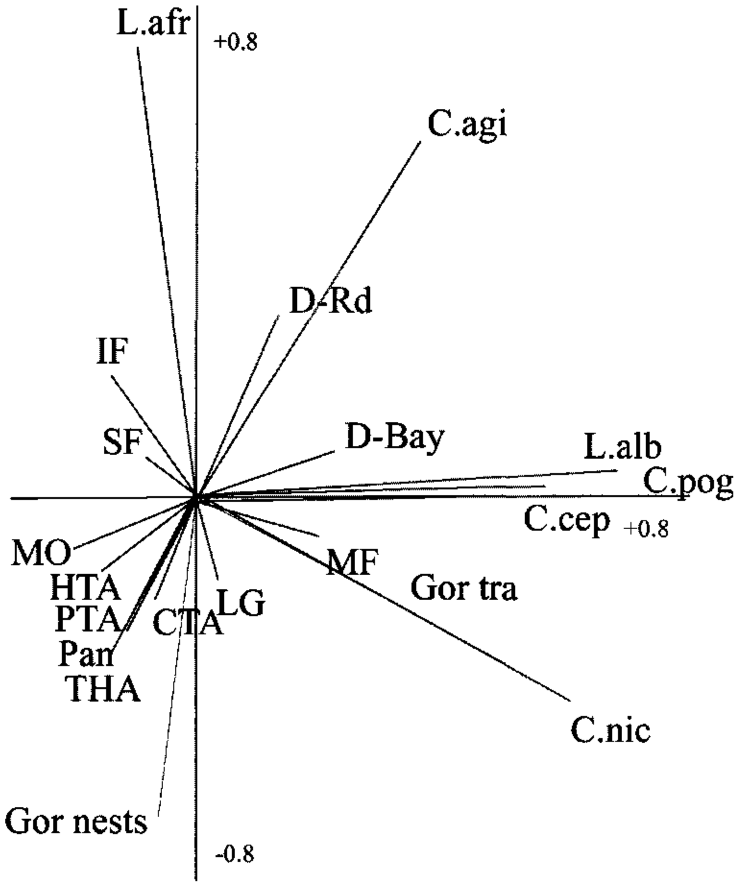
(with: * $p<0.05$, ** $p<0.01$ *** $p<0.005$)

Multivariate Analysis

Figure 8 shows the bi-plot produced from the PCA. The first and second axes have been taken as they show the highest correlation for most species. The length of the lines relative to the axis is a measure of the strength of the relationship between that variable and the axis.

All species of monkeys show a strong correlation with the first axis. The first axis is positively correlated with increasing distance from the village of Bayanga (on the main road) and mixed forest, while being negatively correlated with especially *Gilbertiodendron* forest. Forest elephants and agile mangabeys (*Cercocebus agilis)* are highly correlated with the second axis which is positively related to distance from secondary roads and inundated forest, but negatively related to human disturbance. Gorilla abundance had the best correlation with the third axis, which was positively related to mixed forest and distance from Bayanga while negatively related to distance from secondary roads.

Figure 8. Biplot of principal component analysis



L.afr = *Loxodonta a. cyclotis*, Gor tra = traces of *Gorilla g. gorilla*, Gor nests = gorilla nests, Pan = chimpanzee nests, L.alb = *Lophocebus albigena*, C.agi = *Cercocebus agilis*, C.nic = *Cercopithecus nictitans*, C.cep = *Cercopithecus cepus*, C.pog = *Cercopithecus pogonias*.

D-Rd = Distance from roads, D-Bay = Distance from village, HTA = Hunting trace, CTA = Collection trace, PTA = Passage Trace, THA = Total human trace, MF = Mixed forest, MO = *Gilbertiodendron* forest, LG = Light gaps, SF = Disturbed forest, IF = Waterlogged and Exposed Habitats.

Multiple linear regression

Applying the Kolmogorov-Smirnoff test showed that the residual variation from regression of species mean encounter rates on to most of the environmental variables did not have a normal distribution. By taking the natural logarithm of the mean encounter rates regression was possible for putt-nosed monkeys (*Cercopithecus nictitants)*, gorillas, elephants and grey-cheeked mangabeys (*Lophocebus albigena*). Using the natural logarithm gave a better fit of the regression line for the first three species. Transformation of the mean encounter rate for grey-cheeked mangabeys did not help explain distribution and no variables proved significant ($P<0.05$). Putty-nosed monkeys were significantly more abundant further away from Bayanga village and outside of blocks where waterlogged and exposed habitats were strongly represented (Sig. model<0.01, R^2=0.18). Gorilla trace was more frequently found in blocks further removed from Bayanga and with relatively more mixed forest (Sig. model<0.01, R^2=0.15). Finally elephant dung abundance was strongly related to increasing distance from Bayanga and blocks which had a lower occurrence of human trace during surveys (Sig. model<0.01, R^2=0.39).

Correlation of variables

Spearman's rank test was used to find correlations between environmental variables and between species mean encounter rates and environmental variables (table 6). Significant correlations exist between the environmental variables: hunting trace decreased as distance from roads (both main and secondary roads combined) increased. On the other hand collection trace and trails were found more often closer to the village. Monodominant stands of *Gilbertiodendron* were most frequently encountered nearer to Bayanga village, while the disturbed forest occurring in the national park was found further from Bayanga.

Table 6. Environmental variables, which are significantly, correlated ($p < 0.05$) with mean encounter rates of species in order of magnitude of correlation coefficient. (+) or (-) signs show the nature of the relationship.

Cercopithecus cephus	Secondary Roads (-)
Cercopithecus pogonias	Village (-)
Lophocebus albigena	Village (-); Secondary Roads (-); Hunting Trace (-); Human Trace (-)
Cercocebus agilis	Secondary Roads (-)
Gorilla g. gorilla (trace)	Waterlogged and Exposed Habitats (-); Mixed Forest (+); Village (-); Monodominant Forest (-)
Gorilla g. gorilla (nest)	Light Gap (+); Collection Trace (+)
Pan t. troglodytes (nest)	None
Loxodonta a. cyclotis (dung)	Secondary Roads (-); Village (-); Human Trace (-); Passage Trace (-); Hunting Trace (-); Collection Trace (-)
Cephalophus monticola (dung)	None
Red Duikers (dung)	Mixed Forest (+); Secondary Roads (-)

Table 7. Results of Spearman's Rank Correlations between environmental variables, showing the correlation coefficients (r_s) and their significance.

	Roads	Village	Hunting Trace	Passage Trace	Collection Trace	Human Trace	Mixed Forest	Monodominant Forest	Light Gaps	Disturbed Forest
Village	-0.039									
Hunting Trace	0.262**	0.086								
Passage Trace	0.149	0.282**	0.095							
Collection Trace	-0.068	0.042	-0.194	0.062						
Human Trace (Total)	-0.247*	0.286***	0.565***	0.745***	0.289***					
Mixed Forest	0.047	-0.099	-0.044	0.0298	-0.042	-0.01				
Monodominant Forest	-0.194	0.398***	-0.04	0.122	0.078	0.068	-0.409***			
Light Gaps	0.197*	-0.129	-0.024	0.092	-0.089	0.04	-0.096	-0.12		
Disturbed Forest	-0.027	-0.324***	0.073	-0.029	-0.099	0.013	-0.354***	-0.09	0.137	
Waterlogged and Exposed Habitats	-0.005	0.006	0.034	-0.189	0.019	-0.08	-0.385***	0.167	-0.05	0.14

(with: * $p<0.05$, ** $p<0.01$ *** $p<0.005$)

Discussion

The ecological monitoring results reveal that there were no obvious seasonal or monthly trends in elephant, gorilla or monkey densities. Elephant populations may have increased between 1997 and 1998, but no such increase was apparent between 1998 and 1999. It is too early to draw any conclusions relating this increase in elephant densities. Elephant densities increase with distance from the main Nola-Lindjombo road as both the total number of dungpiles per transect as well as the number of blocks with dungpiles per transect increases with distance from the main road (see also Barnes & Jensen, 1987; Barnes, *et al.*, 1991).

Gorilla populations appear to have decreased between 1997 and 1999, as the number of blocks with ape nest per transect decreased significantly between 1997 and 1998 and again between 1998 and 1999. This is surprising as there are no other indications – carcasses from either natural death or poaching, researcher observations at the Bai Hokou and Mongambe sites inside the Dzanga sector – supporting this decline. However further monitoring and research is essential before reaching any definite conclusions. Gorilla densities do not increase with distance from the main road, as the number of blocks with ape nests per transect did not change significantly with growing distance from the main road.

Monkey populations fluctuated between 1997 and 1999, as the number of blocks with primates per transect fluctuated between these years, showing an almost significant increase followed by a significant decrease. The decrease in 1999 might be related to a simultaneous significant increase in human sign. Monkey densities might increase with distance from the main road, as the number of blocks with non-human primates present per transect increased very significantly with distance from the main road in 1998, but did not do so in either 1997 or 1999. However, an alternative explanation is that as non-human primates presence was detected by either sound or sight it may be that in fact non-human primates are more cryptic near the main road as opposed to being at lower densities.

Human presence does not decrease with distance from the main road, as the number of blocks with human traces present per transect did not decrease significantly with distance. The possibility that this might be caused by the presence of patrols and researchers inside the Park and well away from the road did not seem to provide the answer. When we analyzed only clear signs of non-traditional hunting (snares and cartridges) or traditional hunting (nets) we still could not detect a decline with distance from the road. An alternative explanation is that the hunters compensate for the lower densities of prey near the roads and move further into the forest. It is also possible that anti-poaching patrols have led to a diffusion of human activities, as concentration of humans as well as long-term residency are likely to be detected by the patrols. This strategy by local hunters would indeed make it more difficult to detect them, which leads to the question if aerial surveillance might not be an appropriate answer to increase the chance of early detection of poachers. Elephant densities seem to decrease with increasing human presence, but not specifically with hunting pressure. Gorilla densities seem unaffected by human presence and hunting pressure. Monkey presence does not seem to decrease with increased human presence or hunting pressure.

The more detailed analyses of ecological relationships we carried out showed significant differences between the park and the reserve in the encounter rates for gorilla traces, duikers and 3 of the 5 species of monkeys. However by far the most interesting result from this analysis is the role of secondary roads. Several species are negatively correlated with these roads. In our original design of the monitoring program we had paid special attention to the main road, but not so much to the secondary roads. We had initially underestimated the influence of these roads, but also practical considerations played a role. No good maps existed of the secondary roads, as is often the case in other parts of central Africa. For future modelling using Global Information Systems the regression found here for both elephants and non-human primates in relation to the main roads is still an important result.

It appears that human activities negatively influence the distribution of large forest animals in Dzanga-Sangha considerably. There is much evidence of human intrusion into the park. The highest intensities of human trace were found just inside of the park boundary facing the village of Bayanga, but traces were found throughout the park. Hunting trace was most intensive within a band of 3 km from mostly secondary roads, but did not change much with varying distance from Bayanga. As these secondary roads (in contrast to the main road) are closed for vehicles this underlines the importance of hunting on foot in this area. Distances from the village and the main road as well as the distance from secondary roads appeared to be the most important variables measured, both influencing half of the number of species studied.

Elephants in particular were significantly less common in areas related to human use. Together with the location of roads, human trace explained 39% of their distribution within the national park, as shown by the regression results. This avoidance behavior has also been reported in Gabon (Barnes *et al*, 1991). Several authors have reported that elephants favor habitats where there is abundant ground vegetation (Barnes *et al.*, 1991; White, 1994). In this study we found no significant correlation with either light gaps or disturbed forest. Light gaps were found frequently near roads, which elephants generally avoid, but disturbed forest was more common deep within the park where there were also more elephants. This leads us to believe that elephants find enough herbaceous vegetation and other food resources such as fruit throughout the forest.

Western lowland gorillas use a wide variety of food resources, including insects (Carroll, 1986; Tutin and Fernandez, 1992). Fruit is a major component of their diet when it is readily available (Remis, 1994; Fay , 1997; Carroll, 1998; Goldsmith, 1996). Terrestrial herbaceous vegetation remains important especially in times of fruit scarcity and selection of habitats with large amounts of herbaceous vegetation has been reported frequently (Carroll, 1986; Tutin and Fernandez, 1984, 1993; Doran & McNeilage, 1998). We found no correlation between gorilla densities and habitat. This could be a result of the time period in which the detailed data was collected on gorilla feeding trace, being the first three months of the rainy season. This is probably the period with the highest fruit availability and fruit consumption by gorillas, when they leave relatively few terrestrial herbaceous vegetation feeding remains (Remis, 1994; Goldsmith, 1996). Feeding trace consisted mostly of broken termite mounds and little herbaceous vegetation. However, their preference for mixed forest could also reflect the ample availability of terrestrial vegetation within this habitat.

Although the monitoring data as expected showed that there is a strong relation between the distance from the main road and wildlife abundance, such as non-human primates and elephants, it was surprising to find no similar relation for ape nests. One possible explanation is that gorillas are not hunted often and thus co-exist in close proximity with humans, as they do around the hotel at park headquarters, the field camp at Salcapa and the Nouabale-Ndoki National Park headquarters, just across the border in Congo (Ruggiero, 2000; Quammen, 2000). However, increasing elephant numbers in Dzanga may lead to a decrease in gorilla numbers. Competition between the two species has been reported previously by Plumptre (1996) and displacement has been observed (Blom, pers. obs.). This potential change warrants close monitoring and further study in following years, especially because gorilla traces do not confirm this relation. We found a large difference between the correlations found for nest sites and feeding activity, which also may have implications for studies in which nest sites are used to determine distribution and habitat selection by gorillas and chimpanzees.

The grey-cheeked mangabey was significantly more common where human disturbance (particularly hunting) was low. Both putty-nosed and crowned monkeys were more abundant further away from the village and the main road. The distance from secondary roads influenced the moustached monkey and agile mangabey, but the distance to the main road did not influence them, so possibly they are only negatively influenced by human activity if it is in the form of hunting.

The results of this study show that even though it is officially a protected area, human incursions are frequent and traces of poaching are found deep within the park boundaries, affecting the distribution of animals significantly. Not only was there evidence of encroachment along the park boundary, it also became clear that secondary roads were being used to penetrate deep into the park, especially for hunting activities.

The observed avoidance of the village and roads by wildlife was not caused by variations in habitat but by human activities. Increasing anti-poaching patrols within a 4km band off roadsides could be an effective protection measure.

The results underline the vital importance of a monitoring program to detect changes in wildlife populations and their interrelationship with human activities and presence. This becomes especially relevant in light of the re-opening of the logging company in Bayanga. As this study demonstrates the existence of base line data as well as a well-established monitoring program may provide the opportunity to better understand the relation between logging, hunting and wildlife. A better understanding of this relation is vital for conservation in central Africa, where more and more of the forest is being invaded by logging companies, often closely followed by hunters.

Acknowledgement

This work was supported by the Dzanga-Sangha Project, specifically through funding from the World Wildlife Fund, Inc. and grants from the World Wide Fund for Nature – Germany and the United States Fish and Wildlife Service. Several students working on this program received student grants from the FONA Foundation, Lucie Burgers Foundation for Comparative Behaviour Research and the Wageningen Agricultural University Foundation. We would also like to thank the field team, consisting of the permanent field staff, students, volunteers and all the BaAka trackers. Thanks are also due to Chloe Cipolletta (Bai Hokou) and her staff for generous support and data sharing. We would like to thank Jeff Hall for letting us use his rainfall data from Bayanga. Furthermore we would like to thank Chloe Cipolletta, Arend Brunsting, Jefferson Hall, Lee White, Peter Walsh, Richard Carroll, Richard Barnes, Guy Rondeau, Lisa Steel, Gerrit Gort, Alfred Stein, Han Olff and Natasha Shah for their assistance and useful comments and suggestions. Finally, we would like to thank the entire Dzanga-Sangha Project staff and the WWF staff in Bangui, Washington and Frankfurt for their support.

References

Almaši, A., Blom, A., Otto, K., Knapou, J-B. and Prins, H.T.T. (in prep.) Survey of elephants (Loxodonta Africana) in the Dzanga-Sangha reserve, Central African Republic

Barnes, R.F.W., Agnagna, M., Alers, M.P.T., Blom, A., Doungoube, G., Fay, M., Masunda, T., Ndo Nkoumou, J.C., Sikubwabo Kiyengo, C. and Tchamba, T., (1993) Elephants and ivory poaching in the forests of equatorial Africa. *Oryx*, **27**, 27-34.

Barnes, R.F.W. & Barnes, K.L., (1992) Estimating decay rates of elephant dung-piles in forest. *African Journal of Ecology*, **30**, 316-321

Barnes, R.F.W., Barnes, K.L., Alers, M.P.T. and Blom, A., (1991) Man determines the distribution of elephants in the rain forests of northeastern Gabon. *African Journal of Ecology*, **29**,54-63.

Barnes, R.F.W., Beardsley, K., Michelmore, F., Barnes, K.L., Alers, M.P.T. & Blom, A. (1997) Estimating forest elephant numbers with dung counts and a geographic information system. Journal of Wildlife Management **61**, 1384-1393.

Barnes, R.F.W., Blom, A. and Alers, M.P.T., (1995a) A review of the status of forest elephants in central Africa. *Biological Conservation*, **71**, 125-132.

Barnes, R.F.W., Blom, A., Alers, M.P.T. and Barnes, K.L., (1995b) An estimate of the numbers of forest elephants in Gabon. *Journal of Tropical Ecology*, **11**, 27-37.

Barnes, R.F.W. and Jensen, K.L., (1987) How to count elephants in forests. *IUCN African Elephant & Rhino Specialist Group Tech. Bull.* **1**, 1-6.

Barnes, R.F.W. & Lahm, S.A. (1997) An ecological perspective on human densities in the central African forests. *Journal of Applied Ecology*, **34**, 245-260.

Beresford, P. (1999). Speciation in African forest robins (Stiphronis) : species limits, phylogentic relationships, and molecular biology. *American Museum Novitates*, 22 p. : ill. (some col.), map. American Museum of Natural History, New York.

Blom, A. (1993 a) List of the large mammals of the Dzanga-Sangha Dense Forest Reserve and the Dzanga-Ndoki National Park. World Wildlife Fund - CAR.

Blom, A. (1993 b) List of the birds of the Dzanga-Sangha Dense Forest Reserve and the Dzanga-Ndoki National Park. World Wildlife Fund - CAR.

Blom, A., (1999) Ten years Dzanga-Sangha project 1988 – 1999. Unpublished manuscript, WWF-CAR

Blom, A., Almasi, A, Heitkonig, I.M.A., Kpanou, J.-B. & Prins. H.H.T. (in press) A survey of the apes in the Dzanga-Ndoki National Park, Central African Republic. *African Journal of Ecology*

Blom, A. & Yamindou, J., in prep. Status of the protected areas and gazetted forests of the Central African Republic.

Carroll, R.W. (1986 a) Status of the lowland gorilla and other wildlife in the Dzanga-Sangha region of southwestern Central African Republic. *Primate Conservation* **7**, 38-41.

Carroll, R.W. (1986 b) The creation, development, protection, and management of the Dzanga-Sangha dense forest sanctuary and the Dzanga-Ndoki National Park in southwestern Central Africa Republic. Unpublished report. New Haven: Yale University.

Carroll, R.W. (1986 c) The status, distribution, and density of the lowland gorilla (Gorilla gorilla gorilla (Savage and Wyman)), forest elephant (Loxodonta africana cyclotis), and associated dense forest fauna in southwestern Central African Republic: research towards the establishment of a reserve for their protection. Unpublished report. New Haven: Yale University.

Carroll, R.W. (1988a) Relative density, range extension, and conservation potential of the lowland gorilla (Gorilla gorilla gorilla) in the Dzanga - Sangha region of southwestern Central African Republic. *Mammalia,* **52**, 309-323.

Carroll, R.W. (1988b) Elephants of the Dzanga-Sangha dense forest of southwestern C.A.R. *Pachyderm*, **10**, 12-15.

Carroll, R.W. (1992) The development, protection, and management of the Dzanga-Sangha Dense Forest Special Reserve and the Dzanga-Ndoki National Park in southwestern Central African Republic. Dzanga-Sangha Reserve Project and World Wildlife Fund, Washington.

Carroll, R.W. (1997) Feeding ecology of lowland gorillas (Gorilla gorilla gorilla) in Dzanga-Sangha Reserve of the Central African Republic. PhD thesis, University of Yale.

Doran, D.M. & McNeilage, A. (1998) Gorilla ecology and behavior. *Evolutionary Anthropology*, **6 (4):** 120-131

Fay, J.M. (1989) Partial completion of a census of the lowland gorilla (Gorilla g gorilla) in the Central African Republic. *Mammalia*, **53**, 203-215.

Fay, J.M. (1991a) An elephant (*Loxodonta africana*) survey using dung counts in the forests of the Central African Republic. *Journal of Tropical Ecology*, **7**, 25-36.

Fay, J.M. (1991b) Forest elephant populations in the Central African Republic and Congo: the Central African Republic. *Pachyderm*, **14**, 4-12.

Fay, J.M. (1997) The ecology, social organization, populations, habitats and history of the western lowland gorilla (Gorilla gorilla gorilla Savage and Wyman, 1874). PhD thesis, Washington University.

Fay, J.M., C.A. Spinage, B. Chardonnet and A.A. Green (1990) Central African Republic. In East, R. (ed.) *Antelopes global survey and action plans* (pp. 99-109) Gland: IUCN.

Fitzgibbon, C.D., Mogoka, H., Fanshawe, J.H. (1995) Subsistence hunting in Arabuko-Sokoke Forest, Kenya and its effects on mammal populations. *Conservation Biology*, **5**, 1116-1126.

Goldsmith, M.L. (1996). Ecological influences on the ranging and grouping behavior of western lowland gorillas at Bai Hokou, Central African Republic.

Gonda Ngbalet, M. (1995) Données démographique de Dzanga-Sangha. Rapport intermediare. Projet Dzanga-Sangha, Université de Bangui.

Hall, J.S., White, L.J.T., Inogwabini, B.I., Omari, I., Morland, H.S., Williamson, E.A., Walsh, P., Saltonstall, K., Sikubwabo, C., Bonny, D., Kiswele, K.P., Vedder, A., Freeman, K. (1998). A survey of Grauer's gorillas (Gorilla gorilla graueri) and chimpanzees (Pan troglodytes schweinfurthi) in the Kahuzi-Biega lowland sector and adjacent forest in eastern Zaire. *International Journal of Primatology*, **19 (2):** 207-235

Harris, D. (1994) Interim check-list to the vascular plants of the Dzanga-Sangha Project Area Central African Republic. Unpublished report. University of Oxford 31pp.

Kent, M., & Coker, P., (1994) Vegetation description and analysis: A practical approach. John Wiley & Sons, Chichester.

Lahm, S.A., Barnes, R.F.W., Beardsley, K. & Cervinka (1998). A method for censusing the greater white-nosed monkey in northeastern Gabon using the population density gradient in relation to roads. *Journal of Tropical Ecology*, **14**: 629-643.

Lunde, D. & P. Beresford (1997). Noteworthy records of bats from the Central African Republic. *Bat Research News*, **38 (2):** 19-20.

Michelmore, F., K. Beardsley, R.F.W. Barnes and I. Douglas-Hamilton, (1994) A model illustrating the changes in forest elephant numbers caused by poaching. *African Journal of Ecology*, **32**, 89-99.

Noss, A.J. (1995) Duikers, cables, and nets: a cultural ecology of hunting in a central African forest. PhD. dissertation. University of Florida. P. 415.

Noss, A.J. (1998) The impacts of cable snare hunting on wildlife populations in the forests of the Central African Republic. *Conservation Biology*, **12**, 390-398.

Oates, J.F. (1996) Habitat alterations, hunting and the conservation of folivorous primates in the African forests. *Australian Journal of ecology*, **21(1)**,1-19.

Plumptre, A.J. (1996) Modelling the impact of large herbivores on the food supply of mountain gorillas and implications for management. *Biological Conservation*, **75**, 147-155.

Prins, H.H.T. & Reitsma, J. (1989). Mammalian biomass in an African Equatorial rain forest. *Journal of Animal Ecology*, **58**: 851-861

Ray,J.C. & Hutterer,R. (1996). Structure of a shrew community in the Central African Republic based on the analysis of carnivore scats,with the description of a new sylvisorex (Mammmalia; Soricidae). *Ecotropica*, **1**: 85-97

Remis, J.M. (1994) Feeding Ecology and Positional Behavior of western lowland gorillas (Gorilla gorilla gorilla) in the Central African Republic. Ph.D. thesis Yale University, New Haven, CT

Rondeau, G. & Blom, A. (in prep.) The avifauna of Dzanga-Sangha, Central African Republic

Ruggiero, R. (2000). Phantom of the forest. *Wildlife Conservation*, **103 (5):** 50-55.

Sokal, R.R. & Rohlf, F.J. (1995) *Biometry*. Third edition. W.H. Freeman and company, New York.

SPSS (1997) *SPSS Base 8.0*, SPSS, Inc., Chicago

Tutin, C.E.G. and Fernandez, M. (1984) Nation-wide census of Gorilla (*Gorilla g gorilla*) and chimpanzee (*Pan t. troglodytes*) in Gabon. *American Journal of Primatology*, **6**, 313-336.

Tutin, C.E.G. & Fernandez, M. (1992) Insect eating by sympatric lowland gorillas (*Gorilla g. gorilla*) and chimpanzees (*Pan t. troglodytes*) in the Lopé Reserve, Gabon. *American Journal of Primatology*, **28:** 41-48.

Tutin, C.E.G. & Fernandez, M. (1993). Composition of the diet of chimpanzees and comparisons with that of sympatric lowland gorillas in the Lopé Reserve, Gabon - Composition du régime alimentaire des chimpanzés et comparaison avec celui des gorilles de plaine de la Réserve de la Lopé, Gabon. *American Journal of Primatology*, **30**, 195-211

Tutin, C.E.G., Parnell, R.J., White, L.T.J., Fernandez, M. (1995) Nest building by lowland gorillas in the Lope reserve, Gabon: Environmental influences and implications for censusing. *International Journal of Primatology*, **16**(**1**), 53-75.

White, L.J.T. (1994) Biomass of rainforest mammals in the Lope reserve, Gabon. *Journal of Animal Ecology*, **63**, 499-512.

Quammen, D. (2000). Megatransect. National Geographic, 198 (4): 2-29

Chapter 6

Behavioral responses of gorillas to habituation in the Dzanga-Ndoki National Park, Central African Republic

Allard Blom[1,2,3], Chloe Cipolletta[1], Arend M.H. Brunsting[2] and Herbert H.T. Prins[2,4]

[1] Dzanga-Sangha Project, World Wildlife Fund, B.P. 1053, Bangui, Central African Republic
[2] Tropical Nature Conservation and Ecology of Vertebrates, Dept. of Environmental Sciences, Wageningen University, Bornsesteeg 69, NL 6708 PD Wageningen, The Netherlands
[3] Department of Anthropology, State University of New York at Stony Brook, Stony, Brook NY 11794, USA
Corresponding author address: Zuivelweg 5B, 7255 XA, Hengelo (Gld), The Netherlands, E-mail: allardblom@msn.com
[4] Corresponding author

Abstract

Habituation of western lowland gorillas is the slow process by which gorillas become accustomed to the presence of humans in their proximity. Habituation of gorillas for tourism was undertaken in the Dzanga-Ndoki National Park, Central African Republic, with the aim to increase park revenue and to raise the level of benefits and employment for the local community. The aim of our study was to monitor the impact of habituation through changes in the gorillas' behavior during the habituation process. The study was undertaken in the Dzanga sector of the national park from August 1996 until December 1999. From August 1998 onwards we were able to focus the habituation process on one specific group, the Munye.

Over time, as habituation progressed, it became increasingly easier to locate and to remain with the gorillas. The gorillas' initial reactions of aggression, fear and vocalization upon contact with the observers were replaced increasingly by ignoring the observers. It seems that curious reaction was an intermediate stage in the habituation process. The way in which contacts with the Munye group ended also became more subdued over time. The average daily path length diminished over time, indicating that the Munye group was ranging further (avoiding the observers) in the beginning of the study.

Several factors have an impact on the gorillas' behavior during the habituation process. Regular daily contact seems more important than the number of contacts in a single day in promoting habituation. Likewise, contacting gorillas while they were in a tree or in dense forest seems to provide better results. Contacts within 10 meters and contacts without forewarning the gorillas (achieved in our study by tongue clacking) should be avoided, as these lead to more pronounced reactions.

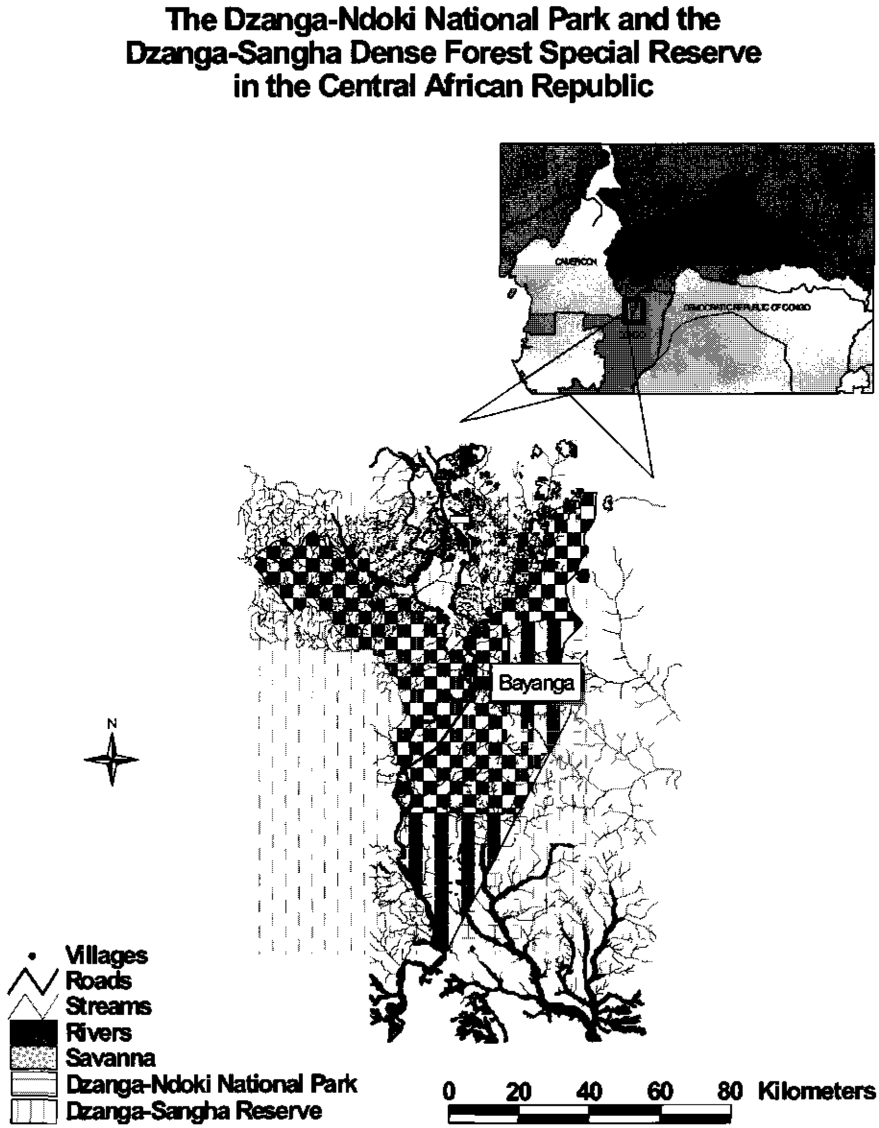
We judge that habituation is progressing well and that habituation of western lowland gorillas is feasible. However, the gorillas experience negative impacts during the habituation process, such as possibly an increase in ranging and disturbance in their behavior. Impacts do diminish over time. Given these and potentially other negative impacts, the decision to start habituating should not be taken lightly.

Introduction

The Central African Republic (CAR) has made tremendous efforts to preserve its natural heritage by setting aside large tracts of both savannas and forests as protected areas (Blom & Yamindou, in prep.). However, given that the CAR is among the poorest countries in the world (e.g. PNUD, 1995) the government is unable to maintain these protected areas. In fact the areas without outside foreign donor assistance have become "paper" parks, with little conservation value (Blom & Yamindou, in prep.). Furthermore the short-term objectives and funding cycles typical of foreign donor assistance make this type of dependence on outside funding an option that is not viable in the long-term. Alternative sources of revenues are essential to maintain the protected area system in the CAR. Tourism is seen as one of the potential revenue sources (TELESIS, 1991; TELESIS, 1993; Blom, in press; Blom, et al., in prep c).

The Dzanga-Sangha Protected area complex, consisting of Dzanga-Sangha Dense Forest Reserve (3159 km^2) and the Dzanga-Ndoki National Park (sector Dzanga 495 km^2; sector Ndoki 727 km^2) are located in the southwestern corner of the country (Figure 1). Dzanga-Sangha can offer the tourist a hundred percent guarantee to see forest elephants, and other fascinating dense rainforest wildlife, as well as the possibility of experiencing the rich BaAka pygmy culture. However, even these unique experiences are insufficient to draw enough visitors to Dzanga-Sangha to contribute substantial resources towards the management costs of the protected area (Blom, in press). By adding the possibility of observing western lowland gorillas (*Gorilla gorilla gorilla*) at close range, the Dzanga-Sangha Project hoped to place Dzanga-Sangha among the world's most prominent ecotourism sites and to increase its direct revenue as well as its impact on the local economy (Blom, in press; Blom et al, in prep. c).

Figure 1 The Danga-Ndoki National Park and the Dzanga-Sangha Dense Forest Special Reserve, Central African Republic



Habituation is the slow process by which gorillas become accustomed to the presence of humans in their vicinity. As gorillas become more and more used to people the distance between the gorilla and the observer can be reduced. Ideally habituation leads to the acceptance by wild animals of human observers as neutral elements in their environment (Tutin & Fernandez, 1991).

Even though mountain gorillas have been successfully habituated for both tourism as well as scientific pursuits (e.g. McNeilage, 1996; Fossey, 1983), the process has come under some recent well-founded criticism (Butynski & Kalina, 1998a; 1998b). Gorilla habituation carries certain risks for the groups being habituated (see McNeilage, 1996 for review of mountian gorilla tourism). Due to the presence of people in their home range, gorillas might change their daily path lengths, extend their home range or change their home range altogether (e.g. Butynski & Kalina, 1998a; 1998b: Goldsmith, 2000). Habituation might result in behavioral changes and ultimately even in lower reproduction (McNeilage, 1996). Other important risks may be the transmission of diseases (e.g. Kalema, 1998; Sholley, 1989; Wallis & Lee, in prep.; McNeilage, 1996) and parasites (e.g. Mudikikwa, 1998, Macafie, 1996) from visitor to gorilla and accidents caused by visitors. Even though this is a million dollar business and mountain gorillas are classified as vulnerable (Lee, et al., 1988; Harcourt, 1996) Butynski & Kalina (1998a) point out that little has been done to monitor the potentially disastrous impact of habituation on gorillas. Some recent initiatives on disease transmission issues (Cameron et al, 1997; Homsy, 1998; Cranfield, 1999) as well as behavioral ecology (Goldsmith, 2000; this study) might be mitigating this situation. The process of habituation of apes is rarely described (but see Tutin & Fernandez, 1991; Krunkelsven et al., 1999; Johns, 1996), as it is commonly regarded as a means to an end (Tutin & Fernandez, 1991). McNeilage (1996) recently reviewed some of these issues in the case of mountain gorilla ecotourism concluding that even in the case of the well studied mountain gorillas, there is as yet little information available to allow a full assessment of the effects of tourism on the mountain gorillas. He stresses the need to establish studies of the reactions of gorillas to tourists.

One aim of our study was to monitor human impact through changes in behavior during habituation. Monitoring will continue after the program has been opened for tourism. This will allow us to evaluate if gorillas are disturbed and if so which factors are causing the disturbance. We can then take mitigating actions based on concrete data. The second aim of the study was to analyze the factors influencing the process of habituation. Western lowland gorillas are notoriously difficult to habituate (Tutin & Fernandez, 1991) and a better understanding of the process could help future initiatives in habituation. This could be essential in those cases were habituation is carried out in a similar context of ecotourism development (e.g. Lope: Tutin et al., 1996; Tutin & Abernethy, 1997; Lossi: Aveling, 1996; Bermejo, 1997, 1999).

This paper presents the first results of the monitoring of gorilla behavior during the habituation process in Dzanga-Sangha. This research is part of a larger monitoring program, which includes monitoring of their home ranges and daily path length (Cipolletta, in prep.), disease transmission, as well as overall human impact on the national park (Almasi et al, in prep.; Blom, et al., in prep.c). In this paper we measure and evaluate the different factors influencing these behavioral changes as well as their development over time. We focussed on the first reaction of the gorillas, as this is probably the most stressful moment of the encounter and would give us an indication of the seriousness and the duration of stressful reactions to the observer. By monitoring the gorilla's responses during habituation we are looking at those factors most likely to provoke aggressive or fearful reactions, in an overall aim to prevent such reactions and preventing gorilla tourism from being detrimental to the animals themselves.

We expected that, over time, the gorillas would increasingly ignore the observers as a neutral element in their environment, as that is a sign of a successful habituation (Tutin & Fernandez, 1991). We also expected that if the process of habituation causes stress to the gorillas they would move away from the observers, increasing their daily path length and even shifting their home ranges. Both these factors would have serious impacts on the gorillas by increasing their energy expenditure, possible risk of predation and foraging effort.

Specifically we expected that after repeated exposure to the observers the gorillas would become less agitated and stressed. We expected that the time to find and contact the gorillas would decrease over the habituation period, while the duration of the contacts would increase during the same period. Additionally we expected that a previous encounter or even a previous day encounter (Fossey, 1983) would affect the behavior, making the gorillas more agitated. We expected that an increasing number of recontacts and a decreasing time between contacts would result in increasing excitement in the response. As gorillas seem to prefer denser habitat types (Fay & Agnagna, 1992; Carroll, 1997) we expected that they would feel more secure and show less agitated behavior in dense as compared to open habitat types.

Schaller (1963) described "tolerance distance" as an important factor in the gorilla's reaction to the observer. The possibility to avoid or escape and the distance between gorilla and observer all probably play a role in the behavioral response to an observer. We expected that contacts in trees, especially those higher up, would be experienced as more threatening due to poor escape possibilities as compared to contacts on the ground. Furthermore, we expected a shorter horizontal distance between the gorillas and the observers to be perceived as more threatening, and therefore expected the first reactions to be more agitated when observers were closer to the gorillas. Schaller (1963) also indicated that the response given depends on the suddenness of the contact. We expected suddenness of contact and agitation to be positively correlated. Last we expected that an increasing number of observers would result in an increasing agitated response.

Study area

This study was undertaken at Bai Hokou in the Dzanga sector ($2^0$55'N, $16^0$20'E) of the Dzanga-Ndoki National Park. From 1972 until the 1980s this area was selectively logged. Since the gazetting in 1990 of the Dzanga-Ndoki National Park no logging has taken place. The area is a strictly protected area, allowing only limited access for research and tourism. The Dzanga-Sangha Dense Forest Special Reserve functions as a buffer zone for the national park by allowing the use of natural resources in a sustainable manner. The human population density in this area is low at an estimated 1 person per km^2 (Gonda Ngbalet, 1995; Blom, unpublished data) and most people are concentrated in the town of Bayanga or along the main road outside of the national park (figure 1).

The Dzanga-Sangha complex contains high densities of western lowland gorillas (*Gorilla g. gorilla*) and forest elephants (*Loxodonta africana cyclotis*) (Carroll, 1986 a,b,c, 1988 a,b, 1997; Fay, 1989, 1991a,b, 1997; Blom, *et al.*, in press; Blom et al., in prep. a;

Almasi, *et al.*, in prep.). The flora and fauna of the area is very rich and diverse (Fay, *et al.*, 1990; Blom, 1993 a,b; Harris, 1994; Rondeau & Blom, in prep.), including some recently discovered endemic species (e.g. Lunde & Beresford, 1997; Beresford, 1999; Ray & Hutterer, 1996).

Duikers and some other wildlife can be legally hunted within the reserve, but not in the national park. Poaching is a serious problem both in the reserve and the national park (Blom, 1999; Blom, et al., in prep). Wire snares (illegal) are common (Blom, 1999) and the combined off take of hunting and poaching is known to be currently unsustainable for at least three species of duiker (Noss, 1998). Poaching of gorillas however, is a rare event, but snares do pose a risk for gorillas.

The forest structure in the Dzanga area is a patchwork of different habitat types with large quantities of herbaceous undergrowth. The forest is dominated by mixed forest and monodominant forest of *Gilbertiodendron dewevrei,* which has a very open understorey. Light gaps which are created by natural tree fall or elephant activity (Carroll, 1986c), compose almost 9.5% of the forest habitat (Almaši et al., in prep.). Past selective logging created disturbed forest habitats and herbaceous plants are abundant along abandoned logging roads.

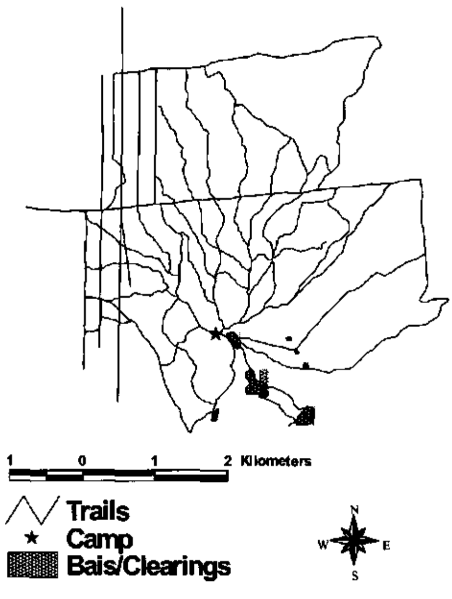
The climate is tropical and the year is characterised by a dry season of three months (December - February) and a long rainy season with a relative drier period in June-July. Mean annual rainfall is 1365 mm in Bayanga (Carroll, 1997). Temperature varies little over the year with an average of 26.4 °C (Carroll, 1997).

Methods

The data presented in this paper were collected from August 1996 until December 1999 in the Dzanga sector of the national park. By the end of 1999 progress was such that we decided to start habituating a second group of gorillas. Analyses of the data until that point would help us guide this second process of habituation.

During the initial phase (August 1996 – December 1997) the Bai Hokou study site was selected. From late 1997 onwards all the data were collected at this study site. In the study area a number of trails were marked using pre-established elephant trails, abandoned logging roads and survey transects. (Figure 2). An extensive trail system was thus established in an area of about 25 km^2 that allowed both for easy movement of the observers through the area as well as means to map the movements of the gorillas. The trails were mapped using a compass and topofil or pacing. The whole system was represented on a base map, which was later digitized using ArcView software (ESRI, 1998a).

Figure 2 The Bai Hokou study site



Each day a team of observers, usually consisting of 2 BaAka trackers and one researcher, went out along the trails until fresh tracks of gorillas were encountered. When feasible these tracks were followed until the gorillas were encountered. An effort was made to find the nest sites or to locate the gorillas at their nest sites and follow them all day to their new nest sites, as gorillas build a new nest every evening. On most days teams switched around mid-day and the second team would continue where the first team had left off.

We tried as much as possible to establish contact by making a tongue clacking sound. This sound was considered distinctive and loud enough for the gorillas to associate it with the researchers without being threatening. To create the least threatening situation, the gorillas were preferably contacted when at an acceptable distance (at least 10 meters) and when gorillas and researchers were able to observe each other. Observations were made on several groups and lone individuals. However, from August 1998 onwards it was possible to distinguish one particular group (called "Munye") and the habituation from then on focussed on this group. By that time we were able to distinguish this group based on its composition, its home range and its progressively calmer reaction to the observers. We were fortunate that the trackers were in many cases able to follow a trail from nest to the actual encounter and onwards without losing the gorilla's trail. Additionally, the process of habituation was aided by the fact that the Munye group almost exclusively used the core area of our study site, with only an occasional lone male wondering in. Encounters with other groups in this area were extremely rare and their reaction to us made it immediately evident that we were dealing with another group.

Encounters were defined as starting when at least one gorilla showed awareness of the observers' presence. Awareness was clearly demonstrated in the majority of cases by a gorilla responding to the observers by one of the behaviors defined in Table 1. In cases where gorillas did not respond to observers' presence ("ignore" in Table 1), awareness was judged subjectively by the observers when conditions of visibility and proximity meant that the gorillas could not be unaware of the observers' presence. The duration of the contacts was defined as the time when the first gorilla was aware of the observers until either the last gorilla left and/or the observers moved away. The duration of each contact was recorded rounded off to the closest minute. In most cases the end of the contact was clearly delimited, with either the observer leaving or the gorillas visibly moving away. However sometimes no visual clues were evident and the observer had to rely on auditory evidence of departure. If the gorillas were not heard for about 15 minutes, while the observers remained stationary, and there was no evidence of their continued presence, they were considered to have broken off contact at the last sign of them.

During a contact the observers would mostly remain seated in one area, although sometimes we would move to get a better view of the group. No attempt was made to follow the gorillas during a contact. If the gorillas broke off a contact, we waited at least 15 minutes and sometimes considerably more time before trying to follow their trail and locate them once again. The interval depended on the type of contact and the number of contacts made previously that day. If the contact had been calm, less time would be spent waiting (but minimum about 15 minutes) before trying to recontact them. On the other hand, especially later on during the habituation process, if we had already made several previous contact that day or the contact had been stressful, we would wait longer before starting tracking. An additional contact on the same day was defined as a same-day recontact. If we were able to follow the group over consecutive days, without interruption, the number of days of the follow were noted as were the subsequent number of contacts, called recontacts.

All fresh traces and nest sites were located on the base map and attributed to a specific group (Munye) or lone males whenever possible. We only attributed trails or nests to the Munye group when that nest or trail was directly connected to an encounter where we could make a positive identification. Likewise when in contact with the gorillas their position was mapped and each time a trail was crossed this was marked on the map. As the trails were marked every 100 meters and few trails were more then 500 meters apart the trail network allowed for fairly accurate positioning (within 100 x 100 meters) within the study area. This geographic information was later digitized onto the base map using ArcView software (ESRI, 1998a) and analyzed using the same software with the Spatial Analyst (ESRI, 1998b) and Animal Movement Analysis (Hooge & Eichenlaub, 1997) extensions.

For each encounter with gorillas, data were collected on the immediate reaction to the observers, the way the encounter ended and circumstances of the contact as outlined in tables 1 and 2. Only the initial responses of the first gorilla detecting the observers were considered. In most cases the gorillas would break off the contact in synchronous fashion. Usually the whole group would either run away or walk away. Otherwise, the reaction of the last individual leaving was taken. The reason that observers broke off the contact was mostly related to the fact that it was getting dark at the end of the day or that a change over of teams was made around mid-day. Furthermore the time of day, number of the contacts for that day, number of subsequent days of contact and group ID were noted. It was not always possible to collect all the data intended and so the number of observations varied as expressed with the N-value mentioned with each test.

Table 1. Behavioral data taken during contacts with gorillas

First reaction	**First response given after contact (in order of increasing disturbance):**
• IG	Ignore; no discernible response shown, while it is obvious that the observer has been noticed, by the fact that conditions of visibility and proximity meant that the gorillas could not be unaware of the observers' presence.
• CU	Curious; the gorilla moves to obtain a better view of the observer, or keeps looking at the observer with or without continuing the previous activity. On a few occasions followed by a non-threatening chest beat or hand clap.
• VO	Non-threatening vocalization ("bark" or "whoo")
• AV	Avoid; changing direction, descending tree or moving away
• FE	Fear; running away with or without screaming or screaming from position in tree with or without descending the tree
• AG	Aggressive; varying from a threatening "wraagh" vocalization without movement to a charge with direct physical contact
Way encounter ended	**Activity upon ending the contact**
• OL	Observer leaves
• WA	Gorillas walk away
• RA	Gorillas run away
• RV	Gorillas run away vocalizing

Our definition of curiosity included both the definitions of monitor as well as curiosity used by Tutin & Fernandez (1991). These authors also distinguished hide as an activity, by which the gorilla moves behind vegetation. Although this behavior was observed it was not a first reaction in Dzanga-Sangha. Overall, both the first reaction and the way the contact ended in Table 1 are ordered in a gradient of increasing stress. Although the gradient is not always directly stepwise, it is clear that a gradient is present.

Table 2 Data taken on the circumstances of the contact

Way	**Way of contact establishment**
• OC	Observer contacted; observer approaches undetected and makes his/her presence known
• OD	Observer detected; observers detected by gorillas before the observers could signal their presence
• RD	Reciprocal detection; abrupt detection in which gorilla and observer detect each other simultaneously
Distance	**Horizontal distance between gorilla (or tree with gorilla) at the moment contact established (in meters)**
• A	< 10
• B	10-20
• C	21-30
• D	> 30
Height	**Height above ground of gorilla at the moment contact established**
• GR	On the ground
• TR	In a tree at the following heights (in meters):
A	< 10
B	10-20
C	> 20

To monitor the effort needed to find the gorillas we noted time spent searching (time we left camp until the time we returned to camp) as well as the number of people in the team. As the type of habitat could have an influence on the detection distance as well as the subsequent reaction of the gorillas, we noted the habitat type in which the contact took place, ranked by relative visibility at ground level (Table 3).

Table 3 Habitat types

Type	Habitat type in which the gorilla was present at moment of contact (in order of increasing density of understory)
• OH	Open habitats; roads and clearings (open areas in forest, locally called "bais") (visibility >> 20 meters) as well as monodominant forest of *Gibertiodendron dewevrei* (visibility >> 20 meters), locally referred to as *Bemba* or *Malapa*, with sparse understory of mostly *Palisota sp*
• MO	Mixed forest with an open understory (visibility > 20 meters)
• MC	Mixed forest with a closed understory (visibility < 20 meters)
• DU	Dense understory forest with a mixed open canopy, locally called *Ebuka*. The canopy is discontinuous allowing light to penetrate to the forest floor. The resulting very dense understory is covered with dense herbaceous growth, which is dominated by *Haumania sp.* and other *Marantaceae* and *Zingerberaceae*. Thick liana tangles can be locally common. Also included in this habitat type were light gaps and secondary forest along roads and rivers (visibility < 10 meters)

Visibility is expressed as an estimate of the average distance at which a person dressed in dark colors can be seen standing still in an area that is typical for that habitat type.

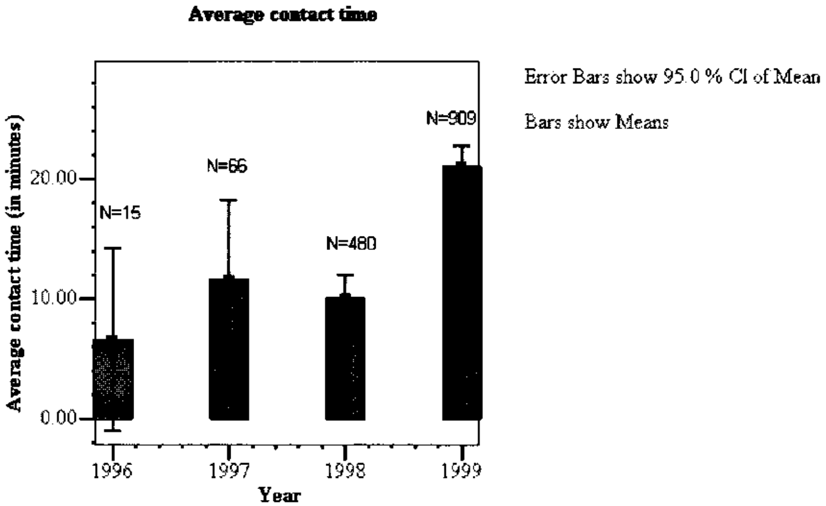
In order to detect any general trends in the data, the parameters were plotted against each other in a Spearman-correlation test using SPSS 8.0 software (SPSS, 1998). Parameters were ranked as presented in the above tables. Normally the classical method of Chi-square test is used for analyzing frequencies (Sokal & Rohlf, 1995; SPSS, 1998), while assuring that no more than 20% of the categories had expected frequencies of less than 5 (SPSS, 1998). In the case of very large sample sizes the Chi-square becomes inappropriate (Wonnacott & Wonnacott, 1977). Instead we used the recommended simultaneous 95 % confidence intervals, constructing a system of confidence intervals that are all simultaneously true. The error rate of 5 % is divided by the number of factors we are comparing (Wonnacott & Wonnacott, 1977). The resulting confidence intervals were calculated by using SPSS (1998). The results are presented as means with standard deviation. Our variables were in many cases not numerical, but merely ordered. Coding the variables and then proceeding with this new numerical variable will yield a more powerful test than Chi-square (Wonnacott & Wonnacott, 1977). The Levene's test for equality of variances was used to test for equal variances of samples before using the t-test for equality of means (Sokal & Rohlf, 1995; SPSS, 1998). To determine in which order the different factors related to the circumstance of the encounter (Table 2 and 3) influenced the gorillas first reaction as well as the way the contact ended we used the step-wise discriminant analysis (SPSS, 1998). In the step-wise discriminant analysis at each step the variable that minimizes the overall Wilks' Lambda is entered (SPSS, 1998).

Results

Duration

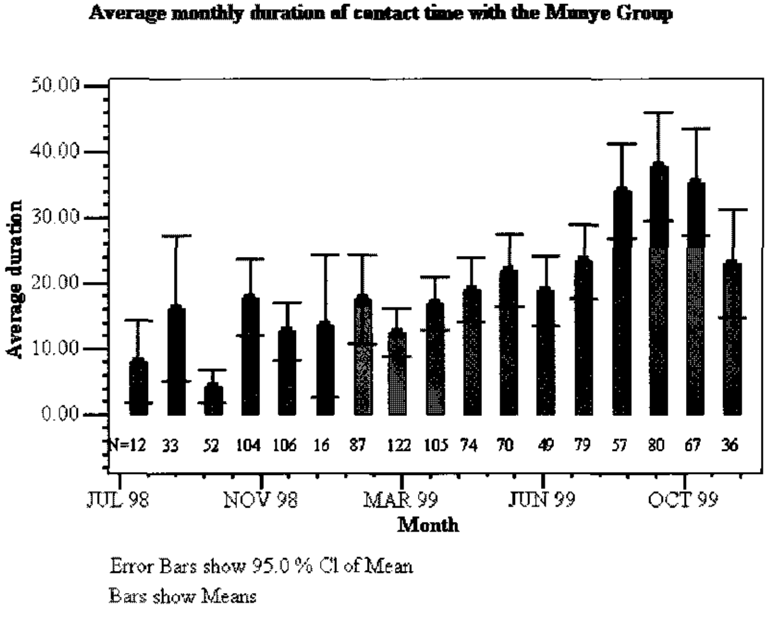
Between August 1996 and December 1999 data were collected on 1472 contacts with gorilla groups for a total of 24,859 minutes of contact time. Contacts varied in length from several seconds (rounded off to zero) to 180 minutes, but lasted almost 17 minutes on average (16.9; SD=25.5; N=1470). Average contact time increased over the years as illustrated in figure 3.

Figure 3 Average contact time over the years



The increase in average contact duration from 1998 to 1999 was significant (Levene's test for equality of variances F = 51.718, p<0.001 and t-test with equal variances not assumed t = -8.350, df=1189, p<0.001). The average contact with the Munye group, identified since August 1998, lasted 20 minutes (20.0; N=1148; SD=27.0) and increased over the study period (figure 4; Spearman correlation 2-tailed = 0.376, N=1148, p<0.01). This group was contacted 1,150 times for a total of 22,983 minutes.

Figure 4 Average contact time with the Munye group (N=1150)



<u>Effort</u>

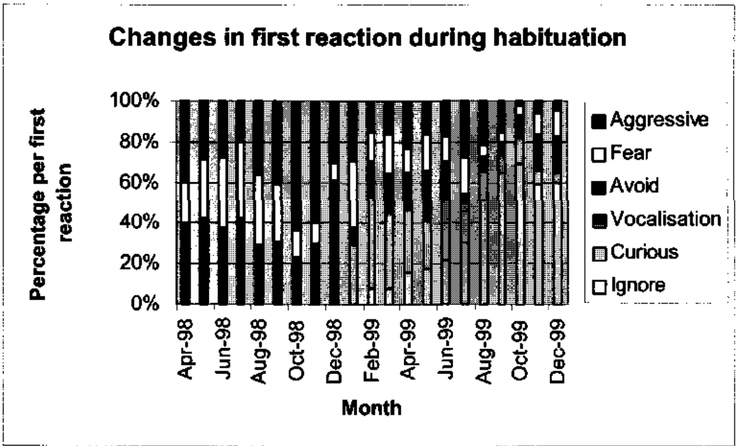
During the first full year (1997) a total of 3,085 hours were spent in the field searching for gorillas, during which time 64 encounters with gorillas took place, giving on average one contact about every 48 hours. In 1998 a total of 3,236 hours were spent in the field, with 467 gorilla contacts, giving on average about one contact every 7 hours. This decrease of average in the field time per contact continued in 1999, with a total of 4,160 hours in the field for 859 contacts, averaging about one contact every 5 hours.

There is a significant decrease of the average time in the field per contact from January 1997 to December 1999, excluding the month of November 1997, when no gorillas were encountered (Spearman Correlation 2-tailed: -0.861, N=35, $p<0.01$). Overall 1,472 contacts were made with gorillas in over 10,481 hours in the field. Of these 5,177 hours were spend tracking the Munye group, which was first recognized as such in August of 1998 resulting in 1,150 contacts with this group. The average tracking time per contact was over four hours. In fact also with the Munye group initially the average contact time did decrease, but we decided to limit the numbers of contacts after April 1999 (see discussion).

First reaction

First reactions of gorillas to observers were noted starting in April of 1998. As illustrated in figure 5 the behavior of the gorillas at contact changed over time.

Figure 5. Changes in first reaction during habituation



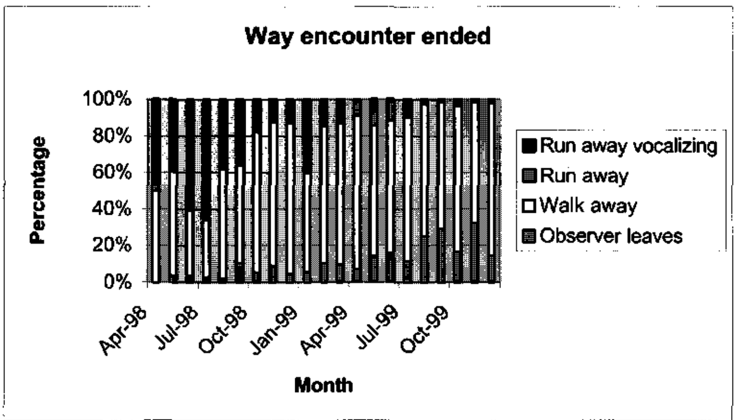
The percentage of aggressive first reactions seem to peak in October 1998, but overall showed a decrease over time (Spearman correlation 2-tailed -0,735, N=21, p<0.01). Fear (Spearman correlation 2-tailed -0,717, N=21, p<0.01), and vocalization reactions (Spearman correlation 2-tailed -0,614, N=21, p<0.01) both decreased over time. On the other hand, the percentage of "ignore" was absent during 1998 and showed an increase over time (Spearman correlation 2-tailed, 0.933, N=21, p<0.01). The "curious" reaction was only first noted in January of 1998. The curious reaction remained prominent for several months and then slowly diminished (Figure 5; Spearman correlation 2-tailed –0.951, N=12, p<0.01). Avoid did not show any significant correlation (Spearman correlation 2-tailed -0,385, N=21, NS)

In August of 1998 we started concentrating on the Munye group. Looking at the changes in the first reaction of this group, the process of habituation is clearly demonstrated. Initially aggression seems to increase, peaking in October in 1999 and then diminishing to low levels (Spearman correlation 2-tailed, 0.850, N=17, P<0.01). The percentages of first reaction fear and avoidance both tend to fluctuate more, but both do diminish over time (Spearman correlation 2-tailed, N=17, resp. -0.551 and -0.569, p<0.05). Both vocalization and curious as first reaction did not show any significant correlation (Spearman correlation 2-tailed, N=17, resp. -0.471 and 0.283, NS). However curious as first reaction did significantly decrease from its first occurrence in January 1999, (Spearman correlation -0.986, N=12, p<0.01). Finally the Munye group gradually ignored the observer (Spearman correlation 2-tailed, 0.968, N=17, p<0.01).

Way encounter ended

Another important factor in the evaluation of the habituation process is the way the encounter ended. As illustrated in Figure 6 the frequency of "run away", either vocalizing or not, diminished over time (Spearman correlation 2-tailed, N=21, -0.797 and –0.850 respectively, p<0.01). The gorillas rarely ran off during the last 5 months of the study, when they usually walked away calmly or the observers broke off the contact. Both these types of contact ending increased during the study period (Spearman correlation 2-tailed, N=21, 0.586 and 0.905 respectively, p<0.01).

Figure 6 Changes in the way the contact ended during habituation (N=1365)



During the whole period of habituation of the Munye group, the most common way in which the contact ended was the group walking away quietly. No significant changes in the percentage of this behavior was found over time (Spearman correlation 2-tailed, 0.065, N=17, NS). Over time, it became rare for the group to run away during contact (Spearman correlation 2-tailed, -0.482, N=17, NS, but p=0.05) and even rarer to do so while vocalizing, while these were common reactions in the beginning (Spearman correlation 2-tailed,.-0.492, N=17, p<0.05). At the end of the habituation period it became quite common for the contact to end by the observer leaving the gorillas (Spearman correlation 2-tailed, 0.700, N=17, p<0.01).

Recontacts

The success of tracking and contacting the Munye group varied over time. The number of consecutive contacts with the Munye group, or recontacts, slowly shifted to a higher percentage per month. However this trend was not significant (Spearman correlation, -0.015, N=1150, NS). The maximum number of subsequent contacts, without a day's interruption, was 109 over 17 days of continued follow. The maximum number of recontacts on the same day was 10 and the maximum number of days of continued follow was 28.

The number of recontacts on the same day became so high in February of 1999 that we decided by May that we would not try to recontact the gorillas more than 5-6 times in a day (see Discussion).

The number of times the Munye group was contacted in the same day did not seem to influence their first reaction to observers. We compared responses on the 1st (Mean=3.31, SD=1.95, N=339), 2nd (Mean=3.28, SD=1.95, N=274), 3rd (Mean=3.40, SD=1.93, N=202), 4th (Mean=3.28, SD=1.86, N=125) and more than 4th (Mean=3.45, SD=1.90, N=171) encounters for that day as illustrated in Table 3.

Table 3. Percentage of first reaction by subsequent contact with the Munye group on the same day (N=1110)

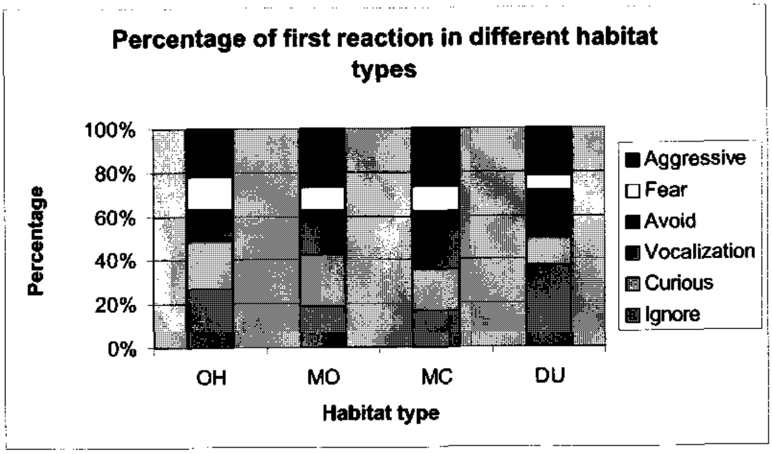
	Contacts on same day				
First reaction	1	2	3	4	>4
Ignore	27.5	25.9	22.3	21.6	20.5
Curious	14.5	17.5	18.3	20.8	19.3
Vocalization	16.3	17.2	18.8	20.0	16.4
Avoid	7.4	6.6	4.5	4.8	7.6
Fear	10.1	7.3	9.9	11.2	11.1
Aggressive	24.3	25.5	26.2	21.6	25.1
Total	100.0	100.0	100.0	100.0	100.0
N	338	274	202	125	171

Likewise, the way the contact ended did not seem to be influenced significantly by the number of contacts during the day (1st: Mean=1.97, SD=0.48, N=349; 2nd: Mean=1.91, SD=0.47, N=280; 3rd: Mean=2.00, SD=0.58, N=208; 4th: Mean=1.99, SD=0.54, N=128 and > 4th: Mean=1.96, SD=0.60, N=173). On the other hand, the number of days that the Munye group had been followed did significantly alter their first reaction to the observer (Spearman correlation -0.107, N=1111, $p<0.001$), but not the way the contact was ended (Pearson correlation -0.038, N=1138, NS). In fact, especially the percentage of aggressive first reactions seems to diminish with an increasing number of days that the group was followed (Spearman correlation –0.709, N=11, $P<0.05$).

Habitat

The type of habitat has an influence on the first reaction of the Munye group to observers. However as illustrated in figure 7 this difference in response does not seem to be related to how dense the vegetation is. In fact, the group's first reaction in the dense understory forest (Mean=2.96, SD=1.97, N=361) is significantly different from the reaction in mixed closed forest (Mean=3.59, SD=1.85, N=549), but the difference does not reach a significant level with mixed open forest (Mean=3.44, SD=1.92, N=155). No trend is evident with the open habitat, which shows a mean in between mixed forest and open habitats (Mean=3.20, SD=1.98, N=41).

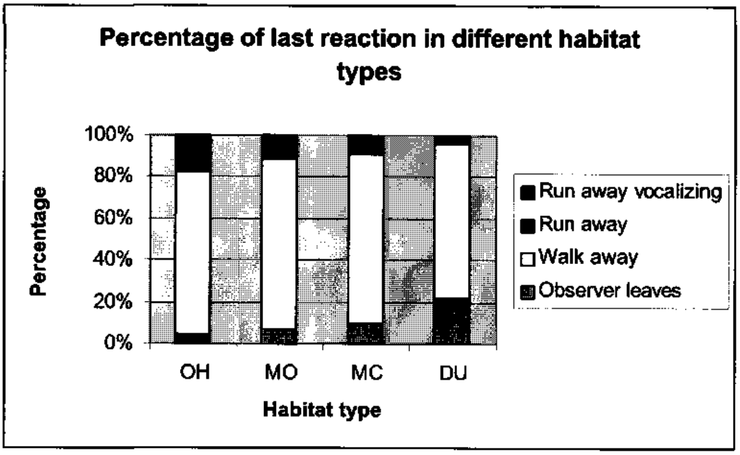
Figure 7 Percentage of first reaction in different habitat types (N=1106)



Habitat types: OH = Open Habitats; MO = Mixed Open; MC = Mixed Closed; DU= Dense Understory (see methods).

The way the contact ended with the Munye group differed significantly in the Dense Understorey (Mean=1.83, SD=0.53, N=379) from the other habitat types (Mixed Closed: Mean=2.02, SD=0.51, N=556; Mixed Open: Mean=2.06, SD=0.47, N=157 and Open Habitats: Mean=2.17, SD= 0.59, N=41). The chances of the group running away , diminished progressively as the habitat became denser (Figure 8).

Figure 8 Percentage of the way the contact ended in different habitat types (n=1133)



Position

Our results show that the Munye group's first reaction to observers was different when the gorillas were on the ground (Mean=3.61, SD=1.96, N=874) or in a tree (Mean=2.34, SD=1.39, N=233). The gorillas were a lot more tolerant in trees, showing a much higher percentage of curious and ignore behavior than when they were on the ground (Figure 9). They were also less likely to run away when in the trees versus on the ground (Figure 10; Ground: Mean=1.99, SD=0.53, N=893 and Tree: Mean=1.88, SD=0.49, N=240).

Figure 9 First reaction of gorillas in relation to their position

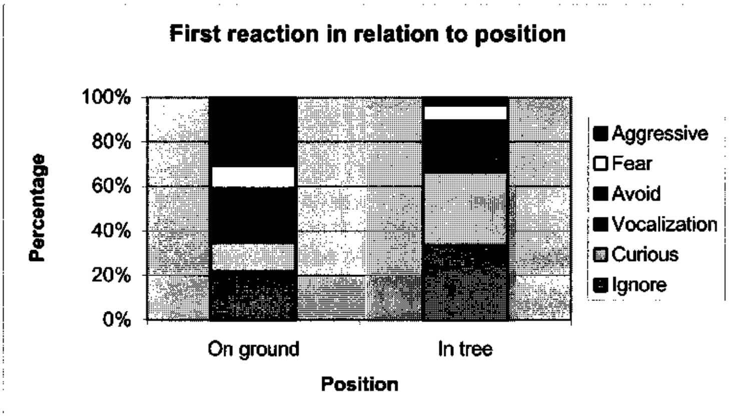
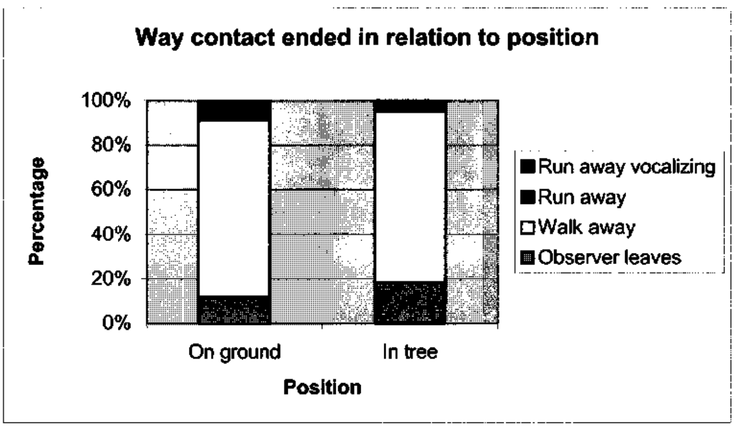


Figure 10 Way contact ended with the gorillas in relation to their position

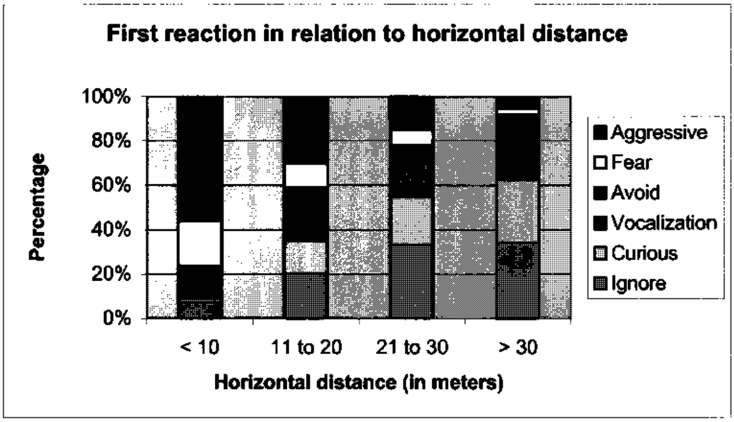


The height at which the gorillas were found in a tree at the moment of contact did not seem to significantly influence their first reaction (Height < 10 meter : Mean=2.49, SD=1.36, N=49; Height 10-20: Mean=2.37, SD=1.37, N=79; Height > 20: Mean=2.05, SD=1.19, N=83) or the way the contact ended (Height < 10 meter : Mean=1.94, SD=0.59, N=50; Height 10-20: Mean=1.88, SD=0.40, N=82; Height > 20: Mean=1.81, SD=0.45, N=84).

Horizontal distance

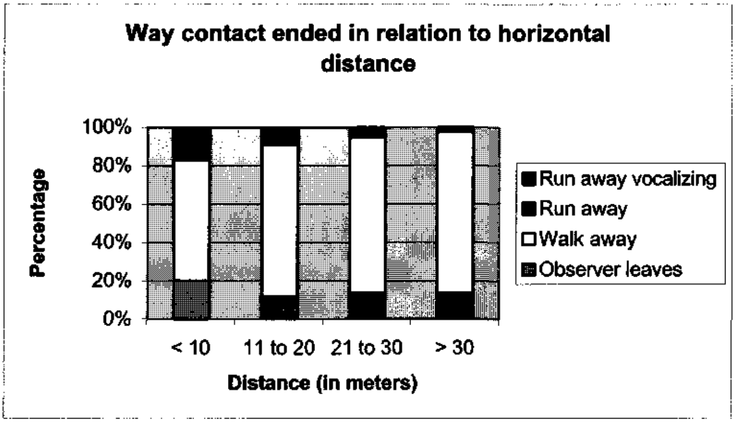
Horizontal distance between the Munye group (closest individual on the ground or distance to tree with closest individual) and the observer influenced the first reaction of the gorillas. The difference is significant between a distance of less than 10 meters (Mean=4.95, SD=1.56, N=109) and the next category up of between 10 and 20 meters (Mean=3.61, SD=1.94, N=505). Furthermore, the differences at that category is significantly different again from the next category up, which is between 20 and 30 meters (Mean=2.78, SD=1.79, N=333). Finally at the maximum distance of more than 30 meters do we no longer detect a significant difference, but the trend remains (Mean=2.36, SD=1.40, N=149). As illustrated in figure 11 there is a correlation between the first reaction and the distance between the observer and the gorillas (Spearman correlation 2-tailed –0.347, N=1096, P<0.01). The greater the distance to the observer the less pronounced is the first reaction of the gorillas to the observer's presence.

Figure 11 First reaction of Munye group in relation to the horizontal distance to the observers (N=1096)



Horizontal distance between the Munye group and the observer also influenced the way the contact ended. As illustrated in figure 12, again the greater the distance the less pronounced the reaction of the gorillas to the observers' presence (Spearman correlation 2-tailed -0.068, N=1124, p<0.05).

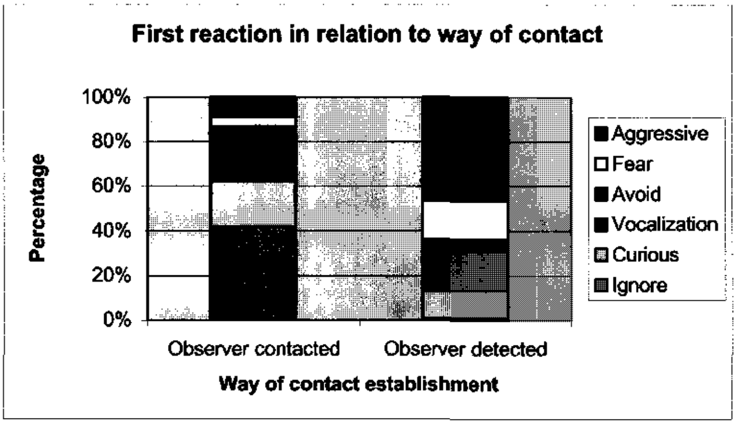
Figure 12 Way contact ended with the Munye group in relation to the horizontal distance between them and the observers (N=1124)



Way contact was established

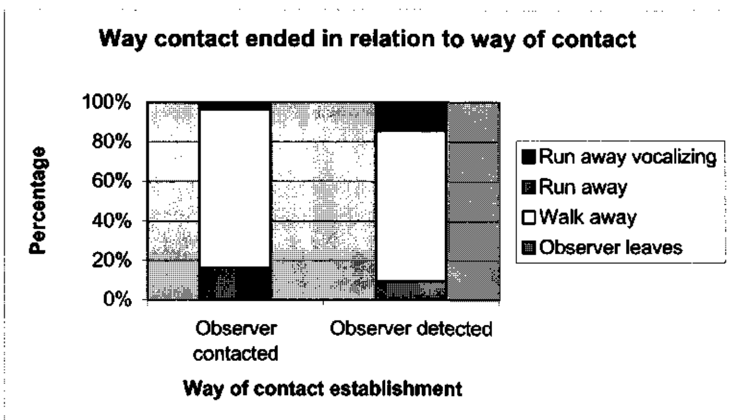
The manner in which a contact was established was correlated with the subsequent occurrence of the contact or contact number (Spearman correlation 2-tailed – 0.341, N=1149, $p<0.01$). The number of contacts in which the observer made his or her presence actively known (usually by clacking) increased over time. Both the first reaction and the last reaction were correlated with the way the contact was established (Spearman correlation 2-tailed resp. 0.579, N=1110, $p<0.01$ and 0.186, N=1137, $p<0.01$). Reciprocal detections were rare and happened in 14 cases with the Munye group or about 1 % of the contacts. In our analysis we combined the reciprocal detection with observer detected. Figure 13 illustrates that the first reaction differed significantly when the gorillas were contacted by the observer (Mean=2.38, SD=1.59, N=640) compared to encounters where the gorillas detected the observers first or simultaneously (Mean=4.65, SD=1.54, N=470). The Munye groups' first reaction was more positive when the gorillas were contacted by the observer as opposed to when the gorillas detected the observers first.

Figure 13 First reaction in relation to the way the gorillas were contacted



Similarly, the way the contact ended varied significantly with the way the contact was established. The gorillas were less likely to run away if they were contacted by the observers (mostly by the distinct clacking sound; Mean=1.89, SD=0.47, N=663) than if they noticed the observers before being forewarned (Figure 14; Mean=2.08, SD=0.57, N=474).

Figure 14 Way contact ended in relation to the way the gorillas were contacted



Observers

Our results did not show any significant correlation between the number of observers (varying between 1 and 7) and the first reaction of the gorillas (Pearson correlation 2-tailed –0.015, N=1111, NS). Likewise we could not detect any significant correlation between the number of observers and the way the contact ended (Pearson correlation 2-tailed –0.036, N=1138, NS). However it should be noted that in 99 % of the cases there were either 3 or 4 observers.

Most important factors

To evaluate which of the above analyzed factors were the most important in determining both the first reaction of the Munye group upon being contacted as well as the way in which the contact ended, we used the following variables in the analysis:

- Contact number, as a measure of time spend habituating
- Total number of recontacts
- Number of contacts on same day
- Number of subsequent days of contact
- Habitat type
- Position: on the ground or up in tree
- Horizontal distance between observer and Munye group
- Way contact was established
- Number of observers

Note that the number of contacts on same day and the number of observers previously did not show a significant relation with the first reaction of the gorillas.

The stepwise discriminant analysis showed that the following factors, in order of relative importance, played a significant role (all $P<0.001$ and N= 1081) in determining the gorillas' first reaction: contact number (Wilks' Lambda 0.646), way contact was established (0.479), distance (0.436), position (0.416), habitat type (0.404), total number of recontacts (0.396) and number of subsequent days of contact (0.377). In fact the resulting function with contact number and way contact was established as the largest absolute correlations explained 83.3 % of the variance.

In the case of the way the contact ended these were the significant factors (all $P<0.001$ and N= 1114): contact number (Wilks' Lambda 0.942), habitat type (0.911), way of contact (0.889) and distance (0.874). In this case the resulting first function uses contact number, way contact was established and habitat as the largest absolute correlation explaining 79.3 % of the variance.

Discussion

According to Tutin & Fernandez (1991) the ease of habituation of a particular population of primates appears to depend largely on the following factors:

1. The nature of any previous experience with humans
2. The behavior of the species when faced with an unfamiliar intruder into their environment
3. The structure of the habitat

Although it is impossible to assess the nature of previous experiences of the gorillas in the Bai Hokou area, it is important to note the area has been a study site intermittently since 1984 (Carroll, 1986a,c). Besides gorilla research (e.g. Carroll, 1997; Remis, 1994; Goldsmith, 1996), the site was also used to study other ecological aspects of the region (e.g. Klaus-Hugi, 1998; Klaus, 1998) and researchers have been present in the area for most of the time since the research camp was initially opened. Furthermore, poaching of gorillas was rare in Dzanga-Sangha during this study (January 1993-December 1999). Four cases of gorilla poaching were confirmed during that time, but none in the study area. Nevertheless the study site was never completely free of the presence of poachers, who were mostly after duikers and monkeys.

The increase in the duration of average contact time with gorillas and the fact that it took less and less time (effort) to locate gorillas both indicate that habituation progressed over the study period. In fact also with the Munye group the effort initially decreased, but we decided to limit the number of contacts to no more than 5-6 per day in order to avoid strong negative reactions. This decision was provoked by a physical contact on April 15, 1999 between the silverback and one of the trackers, in which the tracker was bitten in the arm. In the period preceding this incident habituation seemed to progress well and the number of contacts on a single day had increased up to 9. The exact cause of the attack on the tracker remains unclear, however our observations, ranging and nest data indicate that the group was going through social upheaval with members leaving the group (Cipolletta, in prep.). After this event more caution was taken approaching the gorillas and reducing the number of recontacts. No further physical contact occurred.

We ranked the gorillas' first reaction from ignore, curious through vocalization, avoid, fear and finally aggression, as a measurement of the stress involved. Although this is a somewhat subjective classification it also indicates the amount of energy spent by the gorillas on the encounter with the observers. It also is linked to the status of the habituation process. Gorillas that ignore the observer are per definition habituated, while unhabituated gorillas commonly show signs of fear, including diarrhea (Butynski & Kalina, 1998a; Blom & Cipolletta, pers. obs.) as well as charges and other aggressive displays, including biting (Fossey, 1983; Butynski & Kalina, 1998a; Blom & Cipolletta, pers. obs.). Initial reactions of aggression, fear and vocalization upon contact with the observers were replaced increasingly by ignoring the observers. It seems that a curious reaction was an intermediate stage in the habituation process.

The way in which the contacts ended also became much more subdued over time. In the last 5 months of the study, the Munye group rarely ran away once contacted and running away while vocalizing virtually disappeared. This way of ending a contact is also in sharp contrast with non-habituated gorillas. In the beginning of the study about half the contacts ended with the gorillas running away.

Progress in the habituation process was not only reflected by the change in reactions that the gorillas displayed upon the observers' arrival, but also in an analysis of their movement patterns. A simultaneous study of ranging patterns of the Munye group (Cipolletta, in prep) shows that the group's daily movements were significantly higher during the initial period of habituation, when the gorillas were avoiding, if not fleeing, the observers. As the gorillas' reactions changed with time, so did their daily movements, decreasing as they were becoming more habituated, and notably so when the 'Ignore' reactions became the most frequent reaction observed (Cipolletta, in prep.). On the other hand there was no decrease in home range size, which would have been expected if the gorillas would have been trying to avoid a disturbed area. Furthermore we could not detect any obvious shifts in the home range of the Munye group due to habituation, as has been observed in Bwindi (Butynski & Kalina, 1998b; Goldsmith, 2000). A possible reason for this apparent lack of correlation between home range size and progress in habituation could be the gorillas' strong attraction to a small area (the core of which was only about 4 km^2), or the high costs involved in moving to a different area (Cipolletta, in prep.). In fact, during most of the study period the Munye group seemed to use this small area almost exclusively, and very few encounters with, or traces of, other groups were recorded in this core area. This is in contrast to the prevailing situation in western lowland gorillas, where home ranges typically overlap to a high degree (Gabon: Tutin, 1996; Tutin & Abernethy, 1997; Congo: Olejniczak, 1996, 1997; Bermejo, 1997; Magliocca & Querouil, 1997; Magliocca, 1999; Magliocca et al., 1999). Even at Ndakan (Fay, 1997) and Mondika (Doran, pers. comm.), in the Ndoki sector of the park, as well as previously at the Bai Hokou site, several gorilla groups seem to overlap in their home ranges. For example Remis (1994) estimated that at least 5 groups and 5 lone silverbacks used her study area at Bai Hokou. Later Goldsmith (1996) estimated that 6 gorilla groups and at least 4 lone silverbacks were using the same Bai Hokou study area, which largely overlapped with our area although their area extended several kilometers further east. However, the differences observed in home range overlap, at least in the same study site, are likely to be influenced by the nature and the size of the sample of daily follows recorded (Cipolletta, in prep). As we were continuously following the Munye group, we obtained a clear picture of their home range and could detect no simultaneous use by other gorillas. However we can not entirely exclude home range overlap with different groups in areas used at different times. The fact that the Munye group was virtually the only group using the area made for much easier tracking of that specific group and thus probably facilitated the habituating process as well as identification of the group.

All these factors indicate that progress towards the habituation of the Munye group was made. Important for similar endeavors in habituating either in Dzanga-Sangha or elsewhere is to analyze factors that might have an impact on the behavior of the gorillas and how to mitigate possible negative factors as to allow for a smoother habituation process. The number of contacts on the same day did not seem to make much difference in the Munye group's first or last reaction. Even though we reduced the number of recontacts, this might not have been of major influence. On the other hand it did seem to matter how many days the group had been followed. Aggression was notably reduced when the group had been followed over a longer number of days. This indicates that it might be important to establish regular daily contact and to keep up with the gorillas. This might be more important than the number of contacts per day.

The type of habitat has a significant influence on both the first as well as last reaction of the Munye group. In the dense understory (*ebuka*) habitat the gorillas seem most likely to ignore the observer and less likely to run away. The more open the habitat, the more likely the Munye group ran away. Dense understory forest does provide more cover for the gorillas, which seems to reduce their level of stress when contacted by observers, resulting in less pronounced first and last reactions. This corresponds with the findings of Tutin & Fernandez (1991) for both gorillas and chimpanzees at Lope.

When in a tree the Munye group showed a higher percentage of curious and ignore behavior then when on the ground, but the height at which the gorillas were at the moment of contact did not seem to matter. Bonobos showed a similar reaction to observers, as they were more likely to react in a positive way when they were in a tree instead of on the ground. (Krunkelsven, et al., 1999). The gorillas were also less likely to run away when in a tree. This might be explained by the fact that the gorillas when coming down were getting closer to the observers and might have felt "trapped" in the tree, their escape route blocked by observers. Although this might indeed have occasionally happened, the observers were careful in avoiding treeing the gorillas. Also the calmer first reaction does not indicate that this is a major problem. A more likely explanation is that the gorillas did not want to expend the additional energy of leaving the tree in accordance with Tutin and Fernandez's cost hypothesis (Tutin & Fernandez, 1991). Tutin and Fernandez postulate that the cost of interrupting ongoing activities at any particular encounter may be important in determining the response of the apes. Johns' (1996) finding that chimpanzees were less likely to flee or charge when eating meat than when eating more readily available plants seem to confirm this hypothesis. Trees are favorite food patches, mostly consisting of fruits. On the ground on the other hand, such food patches with fruits are relatively uncommon. In contrast to our findings Tutin and Fernandez's (1991) found that both gorillas and chimpanzees responded with more alarm when contacted in trees.

The horizontal distance between the observer and the Munye group influenced response to observers: the greater the contact distance the less pronounced the first and last reaction of the gorillas. From the results it is clear that contacts within 10 meters should be avoided, as these lead to more pronounced reactions. Likewise in Lope all encounters at 5 meters or less caused fear and alarm (Tutin & Fernandez, 1991). Another good reason to avoid such close contacts is disease (e.g. Kalema, 1998; Sholley, 1989; Wallis & Lee, in prep.) and parasite transmission (e.g. Mudikikwa, 1998; Macfie, 1996).

Over time the observers were gaining experience and the frequency at which the gorillas were actively contacted (usually by clacking) increased. If the observer was detected before establishing contact by clacking the gorillas were much more likely to react with aggression or fear and run away than when they were contacted by the observer. Thus the clacking sound seems to be effective in reducing stress and making the contact more agreeable for both parties. An important factor for the potential of gorilla tourism development is the impact of the number of observers on the reaction of the gorillas. What is the maximum number of visitors possible without causing additional stress on a gorilla group? From the measurements we used to evaluate such stress, the first reaction and the way in which the contact ended, neither showed a significant difference. Care should be taken as most contacts (98.6 %) were with either 3 or 4 observers. It will be essential to continue monitoring the gorillas' behavior in relation to the number of observers. Johns (1996) found that up to 5 visitors had no impact on the chimpanzees' initial reaction and in cases in which up to 15 observers were permitted, the only significant change was increased vocalization rate. A prudent course of action in Bai Hokou would be to slowly increase the number of visitors while carefully monitoring the impact on gorilla behavior. Groups of up to 6 visitors including guides would be optimal.

In any event more than 8 visitors is not recommended. More than 8 visitors would decrease tourist satisfaction as well as security of gorillas and humans alike (see also Johns, 1996 for similar recommendations for chimpanzees).

Overall, based on the step-wise discriminant analysis of our results, it seems that time and the way the contact was established are the most important factors contributing to successful habituation. Persistence over time, while making the observers' presence known to the gorillas by clacking seem to be essential. Trying to keep a respectable distance and/or contacting the gorillas on the ground in the dense understory habitat contribute significantly to achieving habituation.

No measurement exists to evaluate if apes are fully habituated. Of course habituation is an ongoing process and apes will never be habituated to such an extent that they always ignore the observers. There will always be some surprise encounters in the dense forest. In fact with mountain gorillas in some cases the gorillas no longer ignore the observers, but rather interact with them in play or display (Blom, pers. obs; Doran, pers. comm.). It would be useful to obtain a measurement of progress in habituation to allow comparisons between sites and to be able to evaluate efforts and costs versus success. We suggest here that gorillas could be called habituated when more than 50 % of the time upon contacts with the observers they ignore the observers, and in less than 10 % of the cases they react in aggression and/or fear, or run away upon being contacted. If we apply this principal to our study group, the Munye group, we see that since August 1999 the group ignored observers more than 50 % of the time (Figure 6). However only for two of the last 5 months of the study did all the conditions apply, including less then 10 % of reactions with aggression and fear, and less than 10 % running away after contact. By this proposed standard it indicates that the Munye group is close to habituation.

In conclusion we judge that habituation is progressing well. The gorillas did experience negative impacts during the process of habituation, such as possibly an increase in ranging and disturbance in their behavior. However, impacts diminished over time. Several factors influence the process of habituation and should be taken into consideration in similar programs. We recommend the following specific actions based on our results:

1. Be persistent and try contacting the gorillas at least once every day
2. Try to avoid sudden contacts by making your presence known by clacking
3. Keep a distance of at least 10 meters at all times
4. Try establishing contact while gorillas are either in a tree or on the ground in dense vegetation

The decision to start habituating gorillas or any other primates for that matter, should not be taken lightly (e.g. Butinsky & Kalina, 1998a, b; Forthman, et al., 1996). There are several important issues to consider, including environmental impacts, poaching, behavioral changes, disease transmission, research opportunities and economical costs and benefits (Blom, et al., in prep. c; McNeilage, 1996). However this study, as well as other attempts elsewhere (Tutin & Fernandez, 1991; Bermejo, 1997; 1999; Doran, et al., 1996) show that it is feasible to, at least partially, habituate western lowland gorillas.

Acknowledgement

This research was supported by the Dzanga-Sangha Project, specifically through funding from the World Wildlife Fund, Inc. and grants from the World Wide Fund for Nature – Germany. We would like to thank the late Gunther Merz for his work on behalf of Dzanga-Sangha: his dedication to gorillas was instrumental in finding the funding to make the habituation program a reality. Several students working on this program received student grants from the FONA Foundation, Lucie Burgers Foundation for Comparative Behaviour Research and the Wageningen Agricultural University Foundation. We would like to thank the field team, consisting of the permanent field staff, students, volunteers and all the BaAka trackers. Data collected by Jean-Bosco Kpanou, Kenneth Otto, Pladele Godobo, Eugene Mbea, Jean Tetoungbou, Flavien Pani, Jason Fink, David Ritchie, David Greer, Franca Donati, Andrea Almasi, Claudia Sieler, Linda Haartsen, Robert van Zalinge, Sandra de Jong, Igor Dijkers, Birgit Janssen, Nasja Arends, Esther van der Wal, Pim Vugteveen, Guus Kruitwagen, Liesbeth Noor, Christine de Saint-Rat, Amalfaltino, Veronica Vecellio, Giulia Graziani and Brigitte Mbassangoa contributed significantly to this paper The first author would like to thank the State University of New York at Stony Brook for providing the opportunity to use their facilities. Furthermore we would like to thank Conrad Aveling, Richard Carroll, Diane Doran, Michele Fernandez, Jean-Marc Garreau, Michele Goldsmith, David Greer, Jefferson Hall, David Harris, Ignas Heitkonig, Annette Lanjouw, Han Olff, Guy Rondeau, Natasha Shah, Lisa Steel and Caroline Tutin for their assistance, comments and suggestions. Finally, we would like to thank the late Urbain Ngatoua, Director of the Dzanga-Sangha Project and his entire staff and the WWF staff in Bangui, Washington and Frankfurt for their support.

References

Almaši, A., Blom, A., Otto, K., Knapou, J-B. and Prins, H.H.T. (in prep.) Survey of elephants (Loxodonta Africana) in the Dzanga-Sangha reserve, Central African Republic

Almaši, A, Blom A, and Prins H.H.T. (1999) The Mongambe Research Camp, Dzanga-Ndoki National Park, Central African Republic. Gorilla Conservation News 13:5

Aveling, C. (1996) Update on gorilla news from the ECOFAC programme. Gorilla Conservation News 10:7-9

Beresford, P. (1999). Speciation in African forest robins (Stiphronis): species limits, phylogentic relationships, and molecular biology. American Museum novitates, 22 p.; ill. (some col.), map. American Museum of natural History, New York.

Bermejo, M. (1997) Study of western lowland gorillas in the Lossi forest of North Congo and a pilot gorilla tourism plan. Gorilla conservation news *11*:6-7

Bermejo, M. (1999) Update on the Lossi gorillas study and future sancuary of gorillas, 1998, Popular Republic of Congo. Gorilla conservation news *13*

Blom, A. (1993 a) List of the large mammals of the Dzanga-Sangha Dense Forest Reserve and the Dzanga-Ndoki National Park. World Wildlife Fund - CAR.

Blom, A. (1993 b) List of the birds of the Dzanga-Sangha Dense Forest Reserve and the Dzanga-Ndoki National Park. World Wildlife Fund - CAR.

Blom, A., (1999) Ten years Dzanga-Sangha project 1988 – 1999. Unpublished manuscript, WWF-CAR

Blom, A. (in press) The impact of tourism on protected area management and the local economy in Dzanga-Sangha (Central African Republic). Journal of Sustainable Tourism.

Blom, A., Almasi, A., Heitkonig, I.M.A., Kpanou, J.-B. & Prins, H.H.T. (in press) A survey of the apes in the Dzanga-Ndoki National Park, Central African Republic. African Journal of Ecology

Blom, A. & Yamindou, J. (in prep.). Status of the protected areas and gazetted forests of the Central African Republic.

Blom, A, Cipolletta, C. & Prins, H.H.T. (in prep. a) Potentials and pitfalls of gorilla beased tourism in the Dzanga-Sangha National park, Central African Republic.

Blom, A., Kpanou, J.-B., Otto, K., Mbea, E., Godobo, P. & Almasi, A. (in prep. b) Antelope survey of the Dzanga sector of the Dzanga-Ndoki National Park, Central African Republic

Blom, A.van Zalinge, R., Mbea, E., Heitkonig, I. & Prins, H.H.T. (in prep. c) Human impact on wildlife population within a protected central African forest.

Butynski, T.M. and Kalina, J. (1998a) Gorilla Tourism: A critical look Milner-Gulland, E.J. Mace, R. Conservation of biological resources. Oxford Blackwell Science 294-370

Butynski, T. and Kalina, J. (1998b) Is Gorilla Tourism Sustainable? Gorilla Journal, 16:15-19

Cameron, K., Cooper, J., Drciru, M., Falcon, A., Kalema, G., Mudakikwa, A., Nizeyi, J-B., Sherman, D., and Sleeman, J. (1997) Mountain gorilla PHVA workshop: health and disease working group final report, pp. 13 p

Carroll, R.W. (1986 a) Status of the lowland gorilla and other wildlife in the Dzanga-Sangha region of southwestern Central African Republic. *Primate Conservation* 7, 38-41.

Carroll, R.W. (1986 b) The creation, development, protection, and management of the Dzanga-Sangha dense forest sanctuary and the Dzanga-Ndoki National Park in southwestern Central Africa Republic. Unpublished report. New Haven: Yale University.

Carroll, R.W. (1986 c) The status, distribution, and density of the lowland gorilla (Gorilla gorilla gorilla (Savage and Wyman)), forest elephant (Loxodonta africana cyclotis), and associated dense forest fauna in southwestern Central African Republic: research towards the establishment of a reserve for their protection. Unpublished report. New Haven: Yale University.

Carroll, R.W. (1988a) Relative density, range extension, and conservation potential of the lowland gorilla (Gorilla gorilla gorilla) in the Dzanga - Sangha region of southwestern Central African Republic. *Mammalia*, **52**, 309-323.

Carroll, R.W. (1988b) Elephants of the Dzanga-Sangha dense forest of southwestern C.A.R. *Pachyderm*, **10**, 12-15.

Carroll, R.W. (1997) Feeding ecology of lowland gorillas (Gorilla gorilla gorilla) in Dzanga-Sangha Reserve of the Central African Republic. PhD thesis, University of Yale.

Cipolletta, C. (in prep.). Ranging patterns of a western lowland gorilla group during the process of habituation to humans, in the Dzanga-Ndoki National Park, Central African Republic.

Cranfield, M.R. (1999) Mountain gorilla veterinary project. MS :pp.8.

Doran, D.M. & McNeilage, A. (1998). Gorilla ecology and behavior. Evolutionary Anthroplogy, 6 (4): 120-129.

Doran, D., McNeilage, A., and Demmers, P. (1996) Mondika Research center, Central African Republic. Gorilla Conservation News 10:9

ESRI, 1998a. ArcView GIS, version 3.1. for Windows. Environmental Systems Research Institute, Inc.

ESRI, 1998b. ArcView Spatial Analyst, version 1.1. for Windows. Environmental Systems Research Institute, Inc.

Fay, J.M. (1989) Partial completion of a census of the lowland gorilla (Gorilla g gorilla) in the Central African Republic. Mammalia, 53, 203-215.

Fay, J.M. (1991a) An elephant (*Loxodonta africana*) survey using dung counts in the forests of the Central African Republic. *Journal of Tropical Ecology*, **7**, 25-36.

Fay, J.M. (1991b) Forest elephant populations in the Central African Republic and Congo: the Central African Republic. *Pachyderm*, **14**, 4-12.

Fay, J.M. (1997) The distribution, habitat, ecology, evolution, and origin of the Western Lowland Gorilla (Gorilla gorilla gorilla Savage and Wyman). PhD. thesis, Washington University

Fay J.M. and Agnagna, M., (1992) Census of gorilla in northern Republic of Congo. *American Journal of Primatology*, **27**, 275-284.

Fay, J.M., C.A. Spinage, B. Chardonnet and A.A. Green (1990) Central African Republic. In East, R. (ed.) *Antelopes global survey and action plans* (pp. 99-109) Gland: IUCN.

Forthman, D.L., Burks, K.D. and Maple, T.L. (1996) Letter to the editor: African great ape ecotourism considered. African Primates *2*:52-54.

Fossey, D. (1983) Gorillas in the mist. Boston: Houghton Mifflin Co.

Goldsmith, M.L. (1996) Ecological Influences on the ranging and grouping behaviour of werstern lowland gorillas at Bai Hokou, Central African Republic. Phd thesis. State University of New York at Stony Brook, New York

Goldsmith, M.L. (1999) Ecological constraints on the foraging effort of western lowland gorillas (Gorilla gorilla gorilla) at Bai Hokou, Central African Republic. International Journal of Primatology, 20 (1): 1-23.

Goldsmith, M.L. (2000) Effects of ecotourism on the behavioral ecology of Bwindi gorillas, Ugnada: preliminairy results. American Journal of Physical Anthropology *AAPA Abstracts Supplement 30:*161

Gonda Ngbalet, M. (1995) Données démographique de Dzanga-Sangha. Rapport intermediare. Projet Dzanga-Sangha, Université de Bangui.

Harcourt, A.H. (1996) Is the gorilla a threatened species - How should we judge? Biological Conservation 75:165-176

Harris, D. (1994) Interim check-list to the vascular plants of the Dzanga-Sangha Project Area Central African Republic. Unpublished report. University of Oxford 31pp.

Homsy J (1999) Consultancy on ape tourism and human disease. IGCP regional meeting. Rwanda.

Hooge, P.N. & Eichenlaub, B., 1997. Animal movement extension to arcview. Ver 1.1. Alaska Biological Science Center, U.S. Geological Survey, Anchorage, AK, USA.

Johns, B. (1999) Responses of chimpanzees to habituation and tourism in the Kibale forest, Uganda. Biological conservation 78:257-262.

Kalema, G. (1998) An outbreak of sarcoptic mange in free-ranging mountian gorillas (Gorilla gorilla berengei) in Bwindi Impenetrable National Park, South werstern Uganda. AAZV and AAWV joint conference, pp. 438.

Klaus, G. (1998) Natural licks and geophagy (soil ingestion) by large mammals in the rainforest of the Central African Republic, Universitat Zurich, Zurich

Klaus-Hugi, C.S. (1998) Home range, feeding behaviour and social organization of the bongo (Tragelaphus eurycerus) in the rainforest of the Central African Republic, Universitat Zurich, Zurich.

Krunkelsven, E. van, Dupain J., Elsacker L. van & Verheyen, R. (1999) Habituation of bonobos (Pan paniscus): first reaction to the presence of observers and the evolution of response over time. Folia Primatol 70:365-368

Lee, P.C., Thornback, J. & Bennett, E.L. (1988). Threatened primates of Africa: The IUCN red data book. Gland, Switzerland, IUCN.

Lunde, D. & P. Beresford (1997). Noteworthy records of bats from the Central African Republic. Bat Research News, 38 (2): 19-20.

Macfie, L. (1996) Case report on scabies infection in Bwindi gorillas. Gorilla journal :19-20

Magliocca, F. (1999) 1998 Update on the gorillas of the Odzala National Park, Popular Republic of Congo. Gorilla Conservation News 13:

Magliocca, F. & Querouil, S. (1997) Preliminairy report on the use of the Maya-Maya north saline (Odzala National Park, Congo) by lowland gorillas. Gorilla Conservation News, 11: 5.

Magliocca, F., Querouil, S., and Gautier Hion, A. (1999) Population Structure and Group Composition of Western Lowland Gorillas in North-Western Republic of Congo. American Journal of Primatology *48:*1-14.

McNeilage, A.(1996) Ecotourism and mountain gorillas in the Virunga Volcanoes. V. Taylor and N. Dunstone. The exploitation of mammal populations London Chapman and Hill. p: 334-344.

Mudakikwa, A.B. (1998) An indicator of human impact: gastrointestinal parasites of mountain gorillas (Gorilla gorilla berengei) from the Virunga volcanoes region, central Africa. AAZV and AAWV joint conference, pp. 436-437.

Noss, A.J. (1998) The impacts of cable snare hunting on wildlife populations in the forests of the Central African Republic. Conservation Biology, 12, 390-398.

Olejniczak, C. (1996) Update on the Mbeli Bai gorilla study, Nouabale-Ndoki National Park, Congo. Gorilla conservation news *10:*6-7

Olejniczak, C. (1997) 1996 update on the Mbeli Bai gorilla study, Nouabale-Ndoki national park, Congo. Gorilla conservation news *11:*7-10

PNUD (1995) Rapport mondial sur le developpement humain 1995. Paris: Economic

Ray, J.C. & Hutterer, R. (1996). Structure of a shrew community in the caentral african republic based on the analysis of carnivore scats,with the description of a new sylvisorex (Mammmalia; Soricidae). Ecotropica, 1: 85-97

Remis, J.M. (1994) Feeding Ecology and Positional Behavior of western lowland gorillas
(Gorilla gorilla gorilla) in the Central African Republic. Ph.D. thesis Yale University, New Haven, CT

Remis, M.J. (1997) Ranging and grouping patterns of a western lowland gorilla group at Bai Hokou, Central African Republic. American Journal of Primatology, 43, 111-133.

Rondeau, G. & Blom, A. (in prep.) The avifauna of Dzanga-Sangha, Central African Republic

Schaller, G.B. (1963) The mountain gorilla: ecology and behavior. Chicago: University of Chicago Press.

Sholley, C.R. (1989) Mountain gorilla update. Oryx :57-58.

Sokal, R.R. & Rohlf, F.J. (1995) *Biometry*. Third edition. W.H. Freeman and company, New York.

SPSS (1997) *SPSS Base 8.0*, SPSS, Inc., Chicago

TELESIS (1991) Sustainable economic development options for the Dzanga-Sangha Reserve, Central African Republic. USA: TELESIS, Inc.

TELESIS (1993) Supplementary study of the sustainable economic development options for the Dzanga-Sangha Reserve, Central African Republic. USA: TELESIS, Inc.

Tutin, C.E.G. (1996) Ranging and social structure of lowland gorillas in the Lope Reserve, Gabon. In: Great Ape Societies, ed: McGrew, W.C., Marchant, L.F. and Nishida, T. pp. 58-70. Cambridge University Press.

Tutin, C.E.G., and Abernethy, K.A. (1997) Station d'Etude des Gorilles et Chimpanzes, Reserve de la Lope, Gabon. Gorilla Conservation News 11:

Tutin,C.E.G., Abernethy, K.A. and Fontaine, F. (1996) Station d'Etude des Gorilles et Chimpanzes, Reserve de la Lope, Gabon - 1995. Gorilla Conservation News 10:4-5

Tutin, C.E.G. and Fernandez, M. (1991) Responses of wild chimpanzees and gorillas to the arrival of primatologists: behaviour observed during habituation: Primate responses to Environmental change.

Wallis, J. and Lee, D.R. (in prep.) Primate conservation: the prevention of disease transmission.: 27 p.

Waser, P. (1977) Feeding, ranging and group size in the Mangabey Cercocebus albigena. In TH Clutton-Brock (ed.): Primate Ecology, pp. 183-222

Watts, D.P. (1997) Long-term habitat use by mountain gorillas (Gorilla gorilla beringei). 1. Consistency, variation, and home range size and stability: International Journal of Primatology 19(4), August, 1998: 651-680, Illustr.

Wonnacott, T.H and Wonnacott, R.J. (1977). Introductory Statistics (3th ed), John Wiley & Sons, New York.

Chapter 7

The monetary impact of tourism on protected area management and the local economy in Dzanga-Sangha (Central African Republic).

Allard Blom

World Wildlife Fund, BP 1053, Bangui, Central African Republic
Correspondence address: Zuivelweg 5B, 7255 XA, Hengelo (Gld), The Netherlands

(Journal of Sustainable Tourism, 8(3): 175-189)

Summary

This paper analyses the premise that revenues from tourism can provide economic sustainability for the management of both the Dzanga-Sangha Special Dense Forest Reserve and the Dzanga-Ndoki National Park. Second, the paper examines the impact of tourism on the local economy.

The results demonstrate that the present form of tourism has so far been unable to become self-financing. Especially if investments and depreciation are taken into account it becomes evident that private commercial financing of similar investments is unlikely to be viable. Tourism alone provides insufficient revenue to cover the operating costs of the Park and Reserve.

The impact of tourism on the local economy is substantial. Revenue from tourism contributed to the acceptance of the Dzanga-Sangha Project by the local population and, although impossible to quantify, has probably contributed to the increase in effectiveness of law enforcement.

The Dzanga-Sangha Project tourism program has at least been partially successful in providing an alternative economic option to more environmentally destructive activities, but needs to raise additional revenue. The Project should also persue alternative funding mechanisms, such as trust funds, and generate additional income through gorilla tourism, safari hunting and sustainable forestry.

Introduction

The Central African Republic (CAR) is among the poorest countries in the world (PNUD, 1995). The CAR government has made a substantial effort to preserve the country's natural heritage by setting aside large tracts of both savanna and forest as protected areas. However, in the present economic setting, it is unrealistic to expect that the government will be able to support financially the management of these areas.

In central Africa, protected area management depends heavily on external financial assistance (Culverwell, 1998; Wilkie & Carpenter, 1998). Yet, both government and foreign funding agencies realize that dependence on international assistance is not a viable long-term option and that alternatives are required (Telesis, 1991 and 1993; Blom, 1996; Culverwell, 1998; Wilkie & Carpenter, 1998).

This lack of long-term economic sustainability is a fundamental problem in the management of protected areas, particularly in central Africa (Blom, 1996; Culverwell, 1998; Wilkie & Carpenter, 1998). However experience has shown (e.g. Rwanda, Kenya, Costa Rica, Belize), tourism can be highly lucrative and can partially finance the protection of important ecosystems in several countries. It has provided employment opportunities to and increased the income of local people, as well as raising public awareness of nature conservation issues at the national level, such as with gorilla tourism (McNeilage, 1996; Butynski & Kalina, 1998; Lanjouw, 1999).

Tourism is often seen as an alternative economic option to more environmentally destructive activities such as poaching, diamond mining, and logging. Direct benefits are mostly in the form of employment, fees and souvenir sales. Indirect income is generated though the sale of local products and services to hotels, to people employed in the tourism sector, etc.

This paper examines the potential of tourism revenue to contribute to the long-term management of the Dzanga-Sangha protected area complex, as well as its direct impact on the local economy. Although studies have been carried out in other parts of Africa, particularly in Kenya (e.g., Norton-Griffiths & Southey, 1995), Zimbabwe (CAMPFIRE), Zambia (ADMADE) and Namibia (LIFE), the central African context is quite different. Relatively low prices, stable economic and political systems, and a much higher volume of tourism in east and southern Africa contrast with the situation typical for central Africa. Most countries in central Africa have been plagued by high costs, especially of transport, high turnover of Governments, strive, and civil war. This paper contributes to on-going discussions on protected areas and their economic impact and sustainability in central Africa (Blom, 1996; Culverwell, 1998; Wilkie & Carpenter, 1998).

Study area

The Dzanga-Sangha Special Dense Forest Reserve and the Dzanga-Ndoki National Park, in the southwestern region of the Central African Republic (CAR) (Figure 1) have been recognized as protected areas of international importance. Besides diverse rainforest flora and fauna (Fay, *et al.*, 1990; Blom, 1993 a,b; Harris, 1994), the area contains one of the highest documented densities of western lowland gorillas (*Gorilla g. gorilla*) and forest elephants (*Loxodonta africana cyclotis*) in Africa (Carroll, 1986 a,b,c, 1988, 1996; Fay, 1989, 1991; Blom, *et al.*, in prep. a,b,c).

The Dzanga-Sangha National Park (sector Dzanga 495 km^2; sector Ndoki 727 km^2) is a strictly protected area, allowing only limited access for research and tourism. The creation, in 1990, of the Dzanga-Sangha Special Dense Forest Reserve (3159 km^2) introduced a new category of protected area into the country's legislation, that of a multiple-use reserve. The reserve functions as a buffer zone for the national park by allowing the use of natural resources in a sustainable manner. Sustainable forestry, safari hunting and traditional hunting and gathering are authorized, but mining is banned. The limits as well as the interior regulations of the protected area were negotiated with the local population. As no local structure existed to represent the interests of local inhabitants, the Project stimulated the creation of a local Non Governmental Organization (NGO), the Bayanga Development Committee.

The human population density in this area is low at an estimated 1 person per km^2, based on a census carried out in 1995 by World Wildlife Fund (Gonda Ngbalet, 1995; Blom, unpublished data). Almost 60 % of the people live in the town of Bayanga (2365 inhabitants in 1995). The rest of the population is largely distributed along the road leading from the northern limit of the Reserve to Lindjombo (720 inhabitants), the second largest settlement in the Reserve (Figure 1). The BaAka pygmies comprise the largest ethnic group in the area.

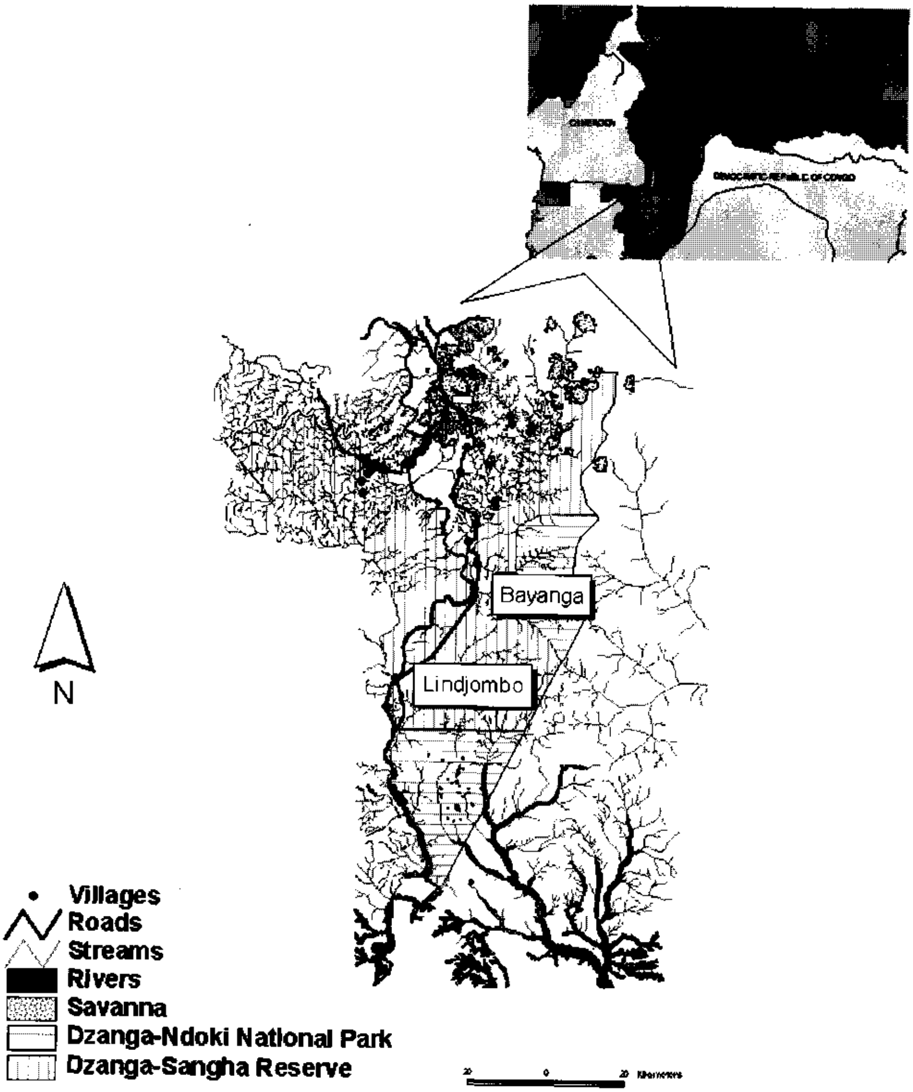


Figure 1 The Dzanga-Ndoki National park and the Dzanga-Sangha Dense Forest Special Reserve in the Central African Republic

From 1972 until the early eighties the logging company "Slovenia Bois" selectively logged a 1,000 km^2 area, largely within the Dzanga-Sangha area, before going bankrupt. It briefly reinitiated activities to fail again within a year. In 1993 new owners revived and renamed the company "Sylvicole de Bayanga". Logging operations were resumed on a much smaller scale, employing about 250 people. It closed once again in 1997 due to mismanagement. The town of Bayanga grew rapidly during the heyday of Slovenia Bois, but the following cycles of boom and bust resulted in similar cycles of immigration and emigration. The result has been a highly mobile population with significant fluctuations in inhabitant numbers in Bayanga.

Since their gazetting, both the Park and the Reserve have been managed by the Dzanga-Sangha Project. The Project is a collaborative effort of the Central African Government, the World Wildlife Fund (WWF), and LUSO Consult (for the German Technical Cooperation – GTZ), with financial and technical assistance provided by the Governments of Germany and the United States, and by the World Bank, as well as by several private organizations and donors.

The objective of the Dzanga-Sangha Project is the sustainable development, protection, and management of the Dzanga-Sangha Dense Forest Special Reserve and Dzanga-Ndoki National Park. The Project includes a wildlife protection program, tourism development, research and education, rural development, and initiatives to ensure the cultural integrity of the BaAka Pygmies of the region. The Dzanga-Sangha area is managed in an integrated manner, similar to the Biosphere Reserve model, allowing limited traditional hunting, agroforestry development and commercial logging in buffer zones, as well as total preservation of the natural forest ecosystem in the core area, the national park (Carroll, 1992). To achieve this objective the Project is, during this phase (1998-2000), putting an emphasis on:

- Improving and extending the law enforcement system
- Reducing the negative impact of logging on the ecosystem
- Increasing revenues from sustainable activities into the local economy
- Increasing tourism revenue
- Improving the internal organization of the local population to permit better participation
- Improving the management of research
- Improving overall Project administration

The Project possesses a management structure working in 4 different domains: conservation, rural development, tourism and administration. The Conservation Department is responsible for law enforcement and supervises the tourist guides. The Rural Development Department, in close collaboration with local partners, implements a variety of activities, including adult literacy, pre-school preparation for BaAka children, mobile health clinics, agroforestry, fish farming and technical assistance and training for local initiatives and NGO's. The Tourism Department is comprised of Doli Lodge[1], which will be privatized through a contractual arrangement in the future. The Administration Department is responsible for all support activities, including staff management, accounting and logistics. The Direction or senior management structure overseeing these Departments and related activities consists of a national director, representing the Government, and two principal technical advisors, one from each of the two implementing agencies, LUSO and WWF.

The Project's objectives related to tourism are two-fold:

1. To provide a viable option to achieve economic sustainability of both the Dzanga-Sangha Special Dense Forest Reserve and the Dzanga-Ndoki National Park.
2. To provide alternative economic activities in place of more environmentally destructive activities such as poaching, diamond mining and logging.

The first tourist visits were organized only after the start of the Project in 1988. Dzanga-Sangha offers many opportunities to observe wildlife as well as the possibility of engaging in activities such as fishing, palm wine "tapping", river boat trips, and, accompanied by local BaAka pygmies, forest hikes, medicinal plant gathering and net hunting. The area is renowned for its elephant viewing at the Dzanga Clearing as well as the opportunity to catch a glimpse of the rapidly disappearing traditional lifestyle of the BaAka. The Project has recently initiated a primate habituation program, focusing on lowland gorillas, with the aim of providing an additional and lucrative tourist attraction. A feasibility study (Telesis, 1991, 1993) and visiting international tour operators both underlined the area's potential for tourism, but also indicated some major existing obstacles. Most prominent among these were the lack of suitable accommodation and basic infrastructure in the region. Since then investments in tourism have increased, culminating in the construction of Doli Lodge (US$ 250,000) and a visitor center (US$ 50,000). Both structures as well as an international publicity campaign have raised the profile of Dzanga-Sangha as a tourist destination.

Methodology

In this paper, a cash flow analysis of the in-country costs and revenue of tourism was used. Direct revenue as well as employment data come from Project records. The Project employs three types of personnel directly associated with tourism. Tourist <u>guides</u> are responsible for the visitor center and for guiding visitors during their tour of the Park and Reserve. BaAka pygmies, with their extraordinary knowledge of the forest accompany guides and tourists as <u>trackers</u>. The third category is comprised of <u>Doli Lodge staff</u>. Salary figures for Project staff should include base salary and any additional bonuses and paid overtime. However, the data from the Sylvicole de Bayanga logging company only includes the base salary and the legally required bonus for long term employees. At the time of closure, the only period for which data are available, the company was not paying any overtime or any normally attributed bonuses. Additionally several months of wages were outstanding at the moment of closure.

It is difficult to estimate other financial benefits such as indirect employment opportunities and local purchases made by tourists, such as food and beverages. A separate study is analyzing these and other aspects, such as the relative distribution of costs and benefits between different ethnic and age/sex groups (R. Hardin, pers. comm.). The present study concentrates on the analysis of direct cash flows.

Data on revenue and the number of visitors come from the Project accounting system. Fees are collected at the visitor center against official receipts. Likewise expenses are made against vouchers, allowing for accurate tracing of both income as well as expenditure. Project revenue derives from three main sources:

A) Park entrance fees are charged for each visitor. The fee at the beginning of this study in 1993 was $ 10 for tourists, $ 1 for nationals, $ 2 for cars and $ 6 for lorries. On July 1, 1996, the fee for tourists was raised to $ 16, for cars to $ 8 and for lorries to $ 16. The fees for nationals remained the same. Reductions apply for groups, children and students. Park entrance fees are divided as follows:

- 40 % goes directly to a local NGO representing the interest of the local community. Funds are used for community activities, such as road maintenance, provisions for health care and drinking water and small-scale commercial development.
- 50 % is allocated to the management of the Park and Reserve.
- 10 % goes into a national forestry and tourism fund, which helps finance conservation activities in other parts of the country.

B) Souvenir sales include local handicrafts, which are sold at cost price by the Project (all profit going to local producer) and other souvenirs such as calendars, post-cards and T-shirts on which a small profit is made. Souvenirs are sold at the lodge, but no specific marketing effort is made.

C) Car/boat rental, guide services, and other revenue generating activities are presented here as revenue; investment costs are not taken into consideration. No effort was made to market the rental of vehicles or boats, as it was never the intention of the Project to provide these services. The Project has offered its vehicles for rent while awaiting privatization of Doli Lodge. The guide service fee initiated in 1995 is included in this source of revenue. Other revenue includes earnings made from Doli Lodge. The lodge was opened in April 1996 under a private management lease contract. The private operator canceled this lease in April 1998 and since then the Lodge has been managed by the Project. Salaries and operational costs of the lodge are now paid directly out of its revenue.

Although the Project started in 1988, a more or less complete financial record of tourism revenue has only been maintained since January 1993. Until the end of 1994, the salaries of trackers and some running costs were paid from the park entrance fees. From 1995 onwards these salaries have been paid out of the guide service fees. A guide fee of $ 10 /visitor/day was levied from July 1995 onwards to recover these costs. All revenue is collected by the Project and in the case of the park entrance fees, the Project is responsible for its distribution.

The Project collaborates with local fishermen and BaAka pygmies in certain tourist activities such as palm wine "tapping", medicinal plant gathering and net hunting. For these services these local collaborators are paid from Project income on rentals and services.

Data on employment come from the Project payroll and data on expenditure from accounting records. These data do not take into account the technical assistance provided by expatriates or investments in infrastructure. These expenses, although significant, are not considered part of the basic operating costs of the Project. Besides the salaries, no other costs were directly related to tourism, although many costs such as road maintenance costs and infrastructure could be partially attributed to tourism. However, this infrastructure would have to be maintained regardless of tourism, so as to keep the analysis simple and straightforward, I only took into consideration permanent and clearly attributable costs. In the analysis an emphasis is put on employment and expenditure records for 1998, as this year not only presents the latest data available but also showed the highest revenue from tourism obtained in any single year.

In the context of this paper, I consider the local economy as the economy of Bayanga and its immediate surroundings. The population of this area is estimated at about 4,500 people for 1998, based on the country's average annual increase of about 2.5 % and the census of 1995 (Gonda Ngbalet, 1995, pers. comm.; Blom, unpublished data). This is equivalent to about 820 households.

Results

The number of paying visitors reached a high of 1090 in 1994 (Figure 2). Based on information provided by guides and guards, who have worked in Dzanga-Sangha since the beginning of the Project, the number of tourists gradually increased from 1988 until 1992. The decline since 1994 is attributed to political unrest in the capital Bangui.

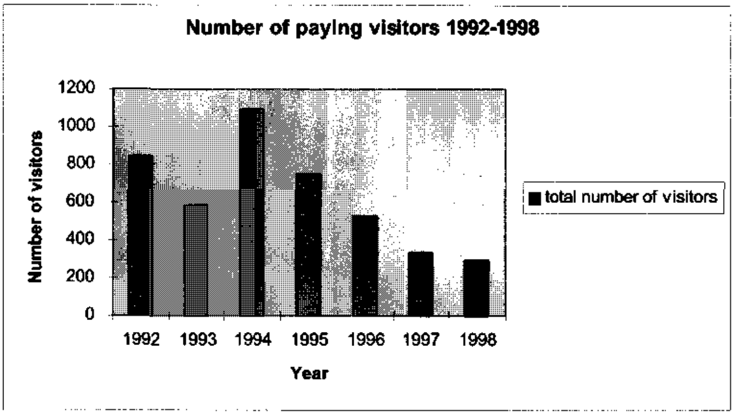


Figure 2: Number of paying visitors to Dzanga-Sangha per year

Cash flow analysis

1. Expenditure

a) Employment:

The Project has employed between 75 and 150 people annually. In December 1998, the Project employed 113 permanent staff, not including expatriate staff and roughly 15 temporary workers. The total amount of salaries and benefits (taxes, social security and medical) averaged US$ 20,270 per month in 1998 (Table 1). Of these employees, 13 permanent staff and 3 temporary trackers were directly involved in tourism, representing a monthly average of US$ 2,330 in salary and benefits for the permanent staff and US $ 220 for the temporary trackers (Table 1). The remaining 100 project staff and 12 temporary workers were mainly involved in law enforcement, rural development and administration. Salary and benefits for the eleven employees of Doli Lodge average US $ 2,420 per month. The staff of Doli Lodge is paid directly from Lodge income.

Table 1: Project local (Bayanga) expenditure in US$ (1US$ = 500 FCFA) for 1998

Type of expense[a]	Total	Average per month
Tourism staff salaries	27,960	2,330
Trackers salaries	2,620	220
Other staff salaries	212,660	17,722
Other local costs	277,030	23,090
TOTAL	520,270	43,360

Local expenses are all Project expenses excluding those made outside the Project activity zone, such as expatriate salaries and capital equipment
Note: [a] Salaries include benefits; other staff are Project staff not directly involved with tourism, such as law enforcement and rural development staff; other local costs are all operational costs other than salaries and benefits and include for example, office supplies, spare parts, fuel and infrastructure maintenance.

b) Other costs:

In 1998, Project expenditures in the Dzanga-Sangha area (excluding investments, expatriate salaries, and spare parts and supplies from Bangui) was US$ 520,270. Salaries and benefits represented 47 % of these costs (Table 1). Accounting records do not provide sufficient information to estimate exactly what additional costs, such as transport and office supplies, are attributable to the tourism program. However, as guides do not use Project vehicles, these costs are limited and can be roughly estimated to be about $ 2,600 / year by 1998, or the equivalent of 10% overhead over salaries and benefits.

2. Revenue

As illustrated in Table 2, revenue has increased dramatically from 1993 to 1998, more than eight-fold. Although the number of visitors has decreased (Figure 2), the revenue per visitor has increased. This growth is attributed to the increase in park fees, the introduction of a guide fee, and the opening of Doli Lodge. Visitors also tend to stay longer than in the past. However, the revenue increase has not reached all intended beneficiaries to the same extent. The Project has clearly benefited most from the increase. The local NGO and the forestry fund benefit solely from park entrance fees however, and they only saw an increase from 1993 to 1995. After that, fee revenue declined to stabilize in 1997 at just under US$ 5,000 (Table 3). As the number of tourists has declined since 1995, so has the amount to be distributed from entrance fees.

Table 2: Total annual revenue from entrance fees, rentals, guide services and souvenir sales in Dzanga-Sangha in US$ (1US$ = 500 FCFA).

Year	Entrance Fees	Rentals & Services[a]	Souvenirs Sales	Total
1993	2,764	680	643	4,087
1994	5,952	5,931	998	12,881
1995	7,695	10,689	-1,386	16,998
1996	7,383	12,054	771	20,208
1997	4,785	27,094	244	32,123
1998	4,970	29,996	1,262	36,228

Note: [a] Rentals & services since 1995 have included a guide fee

Table 3: Distribution of revenue per year in US$ (1US$ = 500 FCFA).

Year	Project	Local NGO (CDB)	Forestry Fund (FDFT)	Total
1993	2,705	1,105	276	4,087
1994	9,904	2,381	595	12,881
1995	13,150	3,078	769	16,998
1996	16,516	2,953	738	20,208
1997	29,730	1,914	479	32,123
1998	33,743	1,988	497	36,228

The income of local service providers, such as the BaAka net hunters and the palm wine "tappers", per year is presented in table 4

Table 4: Estimated income of local service providers (local fisherman and BaAka pygmies that collaborate in tourism activities) per year in US$ (1US$ = 500 FCFA)

Year	Estimated income
1993	1,298
1994	2,422
1995	1,664
1996	2,126
1997	1,397
1998	3,075

The premise that tourism would contribute to the self-financing of the Park and Reserve requires a close examination. At the very least income from tourism should cover its direct costs. These costs, mainly salaries and benefits, were in 1995 US$ 13,800. If we look at the income figure for 1995 of US$ 13,150 (Table 3) revenues almost covered the costs of staff salaries and benefits (excluding expatriates). By 1998, income was US$ 33,743 and salaries and benefits had risen to US$ 28,011, resulting in a small margin of US$ 5,732. However, we have to take into consideration trackers salaries and additional costs or overhead (mostly transport costs and office supplies), leaving only about US$ 514 as profit (Table 5).

Table 5: Income from Tourism in relation to its direct costs for 1998.

	Amount
Income	33,743
Salaries and benefits	-28,011
Trackers salaries	-2,618
Overhead	-2,600
Balance	514

(Amount in US$; US$ 1 = 500 FCFA)

Discussion

A. The relevance of tourism in relation to the self-financing of the Project

In 1995, for the first time, the Project was able to recover salary costs of guides from tourism revenue. Taking only local costs into consideration, it was not until 1998 that the Project made a profit, albeit negligible. At present, tourism is only self-financing at the local level. If present trends in increase in revenue continue, tourism should be able to generate sufficient revenue to be able to cover the additional costs of imported goods and technical assistance, guaranteeing its sustainability without further foreign subsidies.

However, tourism's contribution to a funding mechanism for the Park and Reserve is likely to remain nominal, especially if infrastructure investment and depreciation is factored into calculations. Total investment in infrastructure has been, as mentioned above, in the order of US$ 300,000. Evidently, there has been a negative rate of return on initial investments. Fortunately, donors do not expect a repayment of this capital investment. However, it demonstrates that private commercial financing of similar infrastructure is unlikely to be viable.

It has been estimated that for the Project to keep a complete protection, guide service, and support program going, roughly US $ 800,000 per annum is needed (Blom, 1996). This does not take into account any rural development program or support for outside technical assistance, just the basic operational costs of both the Park and Reserve. If projected costs are compared to actual revenue for 1998 we see that at present only 4 % of this budget is covered from revenue from tourism.

Although visitor numbers have declined in recent years (Figure 2), the client base is more stable and provides greater revenue (Table 1). Factors contributing to an increase of revenue per visitor include the apparent fact that the overseas tourists in general are willing to spend more money for access to and also spend more time in Dzanga-Sangha. In earlier years, most visitors were expatriates living in Bangui, sometimes accompanied by visiting relatives or friends; these numbers declined during and past the civil unrest years. Due to the opening of the lodge and a greater marketing effort overseas, the majority of visitors now come from Europe, travelling through Cameroon in order to avoid possible unrest in Bangui. According to the largest travel agency, reservations are on the increase and it is expected that visitor numbers will rice as the memory of civil unrest in Bangui fades (Ivory Tours, pers. comm.).

Clearly, present levels of tourism cannot cover Project operating costs. Other options must be investigated to insure the continuation of the Project. One option is the development of high revenue generating tourism based on habituated gorillas, as practiced successfully in Rwanda, the Democratic Republic of Congo (ex-Zaire), and Uganda (e.g. Harcourt, 1986; Aveling and Aveling, 1989; Shackley, 1995, McNeilage, 1996). There tourists pay between $ 100 and $ 120 per visit (Shackley, 1995). This means that if Dzanga-Sangha wanted to cover its operations from "gorilla tourism" alone, it would need 8,000 visitors a year. Although the Project's gorilla habituation program is progressing, it is unlikely that the capacity for gorilla visits will surpass 1,500 visitors in the foreseeable future.

Options for increasing income from tourism are principally:

1. Gorilla tourism
2. Raising the park entry fee.

Raising the park entry fee could generate substantial additional revenue. Tour operators indicate a willingness to pay higher park fees by their clients, if these fees contribute directly to conservation and rural development. However the fact remains, as illustrated here, that political instability can easily disrupt tourism. Even when revenue might dramatically increase, it is unlikely to be a reliable source of self-financing in the long-term.

As these additional revenue-generating activities will not be able to cover the Project's operating costs on any long-term basis, an overseas endowment conservation trust fund may be the best long-term financial mechanism for Dzanga-Sangha. It is estimated that an endowment of $ 10,000,000 would generate enough funds to maintain operations, with additional income from tourism providing investment opportunities and financing rural development (Blom, 1996). Several donors have reacted positively to these initiatives and some have made their present funding conditional on the establishment of such long-term financial mechanisms.

B. The impact of tourism on the local economy

A survey carried out in 1994 showed that 53 % of the men in Bayanga were formally employed by various employers and received a regular salary (Garreau, 1996a). Formal employment is therefore a very important economic factor in the region. The same survey showed that of those employed in the formal sector, 34 % were employed by the Project.

The biggest employer in the region during the time of the survey was the French logging company "Sylvicole de Bayanga". At the time of closure in September 1997, they were employing 251 permanent staff, with a monthly payroll of $17,128. Taking this as a base line, the annual payroll would be in the order of US $ 205,500.

In September 1997 the Dzanga-Sangha Project was the second largest employer, with 89 permanent staff and a monthly payroll of US $ 11,880. At present the logging company is closed, making the Project the only major employer in the region with an average 110 permanent employees in 1998 and an annual payroll, including benefits of US$ 243,240. The logging company is expected to reopen in 1999, however.

Tourism employs 13 Project staff directly, with an annual total expenditure for salaries and benefits of $ 27,960. To this we can add the staff (11 people) of Doli Lodge, with an annual $ 29,040 in salaries and benefits. This makes the total number of employees in the tourist sector represent roughly 17 % of permanent employment for Bayanga as a whole, but likely substantially more in terms of salaries and benefits. Furthermore, there is additional employment from temporary work and from spill-over effects in the informal economy.

Of park fees, 40 % goes directly to a local NGO and into the local economy through its community activities. As shown in Table 3, this reached a maximum of US$ 3,078 in 1995. The total direct economic benefits from tourism can be estimated to have been US $ 18,500 for 1995 (Table 6). This might not seem to be much, but in relation to the official minimum wage of $ 1.70/day it does represent over 10,000 working days a year directly coming from tourism. It translates in the same period to over $ 24 per household per year, when yearly income was estimated to be $ 40.88 per year for the average BaAka net hunter's household (Noss, 1995).

Table 6: Estimated direct economic benefits to the local community from tourism in US$ (1US$ = 500 FCFA) for 1995.

	Amount
Park fee contribution	3,078
Direct income	1,600
Employment	13,800
Total	18,478

Although the income from park fees for 1998 was lower than for 1995 (US$ 2,000, Table 3), the total amount entering the local economy of US$ 64,695 was in fact higher. This was due to the increase in the amounts obtained from tourist activities and from direct employment, respectively US$ 3,075 (Table 4) and US$ 59,620 (Table 1 plus Doli Lodge). As minimum wages were not changed, this total amount represents over 38,000 working days a year coming directly from tourism. Even with the increase in population, from an estimated 740 households in 1995 to 820 household in 1998, it would represent over US$ 78 per household per year. Furthermore, taking into consideration that additional economic benefits are related to tourism, such as construction work, bar and restaurant services, it becomes clear that tourism provides important benefits to the region.

It is too early to assess if increased income and employment has resulted in a shift towards less environmentally destructive activities. However, revenue from tourism has contributed to Project acceptance and a greater willingness to collaborate on conservation-related activities. This is illustrated by the fact that the NGO that receives the revenue from park fees is seen as an important stakeholder in the region. During an evaluation of the NGO, which surveyed 350 people, 2/3 of the persons interviewed underlined the importance of the NGO in the resolution of conflicts and also desired that the NGO put more effort into the protection of natural resources (Garreau, 1996b). The effectiveness of law enforcement has also improved dramatically, with an increase in the confiscation of snares (895 %) and illegal arms (200 %) from 1993 to1998 (Blom, in prep.). This increase can be partly attributed to a growing willingness of community members to provide the Project with information on illegal activities. Overall, revenue sharing is seen as positive from both the local community as well as the donors' side.

Conclusions

In summary the following conclusions can be drawn:

- The present form of tourism has so far been unable to become self-financing, except at the local level.
- If present trends in increase in revenue continue, tourism should be able to generate sufficient revenue to be able to cover the additional costs of imported goods and technical assistance, guaranteeing its sustainability without further foreign subsidies.
- Private commercial financing of similar investments is unlikely to be economically viable.
- Tourism in its present form contributes nominally to Project operating costs and is unlikely to play a significant role in the long-term self-financing of the Park and the Reserve management.
- Tourism is a significant source of employment in the region.
- Tourism plays an increasingly important role in the local economy.
- Revenue from tourism has contributed to the greater acceptance of the Project among local populations and correspondingly improved law enforcement.

Although tourism has become an important economic activity for the region, it is evident that it will not or at least not in the near future, provide a solution for the self-financing of protected area management in Dzanga-Sangha, and other options need to be developed. An increase in Park fees should be considered as a willingness to pay on the part of the visitor might be present if well informed about the reasons for this increase. Even so the Project needs to consider establishing alternative sources of funding, such as trust funds, and generating additional income from gorilla tourism, safari hunting and sustainable forestry.

From a purely commercial point of view, the development of tourism in Dzanga-Sangha is economically questionable, certainly in view of the high risk associated with investments in central Africa. However, donors and the Project were interested in more than commercial viability. The Project's major goal, supported by its donors, was clearly two-fold. The first objective, financial sustainability of operations, is unlikely to be achieved in the present situation. However, the second objective, substituting environmentally destructive activities with more conservation-friendly economic activities, may have been at least partially achieved.

Acknowledgements

I would like to thank the World Wildlife Fund, Inc. and the different Government agencies for supporting this research; and Urbain Ngatoua and all the staff of the Dzanga-

Sangha Project for their collaboration. I'm particularly grateful to Herbert Prins, Ignas Heitkonig, Jean-Marc Garreau, Andrea Almasi, Lisa Steel, Natasha Shah and four anonymous reviewers for their constructive comments on the manuscript.

Note:

1. Doli Lodge has 32 beds in four wooden bungalows on stilts. Each bungalow is divided into two units, each with connecting rooms – a bathroom, one large master bedroom and one small room for children. The Lodge also has a campsite, bar/restaurant on a large terrace overlooking the river, a reception/shop and several service buildings. It was build and is owned by the Dzanga-Sangha project, although its management has been privatized. The Lodge caters for high-level international tourism

References

Aveling, C. & Aveling, R. (1989) Gorilla conservation in Zaire. *Oryx* 23, 64-70.

Blom, A. (1993 a) List of the large mammals of the Dzanga-Sangha Dense Forest Reserve and the Dzanga-Ndoki National Park. World Wildlife Fund - CAR.

Blom, A. (1993 b) List of the birds of the Dzanga-Sangha Dense Forest Reserve and the Dzanga-Ndoki National Park. World Wildlife Fund - CAR.

Blom, A. (1996) Proposal for the creation of an environment trust fund for Dzanga-Sangha. World Wildlife Fund - CAR.

Blom, A. (in prep.) Ten years Dzanga-Sangha Project: 1988 – 1999. World Wildlife Fund – CAR.

Blom, A., Kpanou, J.-B., Otto, K., Mbea, E., Godobo, P. & Almasi, A. (in prep. a) Elephant surveys of the Dzanga sector of the Dzanga-Ndoki National Park, Central African Republic

Blom, A., Kpanou, J.-B., Otto, K., Mbea, E., Godobo, P. & Almasi, A. (in prep. b) Antelope survey of the Dzanga sector of the Dzanga-Ndoki National Park, Central African Republic

Blom, A., Kpanou, J.-B., Otto, K., Mbea, E, Godobo, P. & Almasi, A. (in prep. c) A survey of the diurnal primates in the Dzanga-Ndoki National Park, Central African Republic.

Butynski, T.M. & Kalina, J. (1998) Gorilla tourism: a critical look. In Milner-Gulland, E.J. & Mace, R. (eds) *Conservation of biological resources* (pp. 294-370). Oxford: Blackwell Scientific Publications,

Carroll, R.W. (1986 a) Status of the lowland gorilla and other wildlife in the Dzanga-Sangha region of southwestern Central African Republic. *Primate Conservation* 7, 38-41.

Carroll, R.W. (1986 b) The creation, development, protection, and management of the Dzanga-Sangha dense forest sanctuary and the Dzanga-Ndoki National Park in southwestern Central Africa Republic. Unpublished report. New Haven: Yale University.

Carroll, R.W. (1986 c) The status, distribution, and density of the lowland gorilla (Gorilla gorilla gorilla (Savage and Wyman)), forest elephant (Loxodonta africana cyclotis), and associated dense forest fauna in southwestern Central African Republic: research towards the establishment of a reserve for their protection. Unpublished report. New Haven: Yale University.

Carroll, R.W. (1988) Relative density, range extension, and conservation potential of the lowland gorilla (Gorilla gorilla gorilla) in the Dzanga - Sangha region of southwestern Central African Republic. *Mammalia* 52, 309-323.

Carroll, R.W. (1992) The development, protection, and management of the Dzanga-Sangha Dense Forest Special Reserve and the Dzanga-Ndoki National Park in southwestern Central African Republic. Dzanga-Sangha Reserve Project and World Wildlife Fund, Washington.

Carroll, R.W. (1996) Feeding ecology of lowland gorillas (Gorilla gorilla gorilla) in Dzanga-Sangha Reserve of the Central African Republic. PhD thesis, University of Yale.

Culverwell, J. (1998) Long-term recurrent costs of protected area management in Cameroon: monitoring of protected areas, donor assistance and external financing, ecological and management priorities of current and potential protected area system. P.-75. WWF-Cameroon/MINEF, Yaounde, Cameroon.

Fay, J.M. (1989) Partial completion of a census of the lowland gorilla (Gorilla g. gorilla (Savage and Wyman)) in southwestern Central African Republic. *Mammalia* 53, 203-215.

Fay, J.M. (1991) An elephant (Loxodonta africana) survey using dung counts in the forests of the Central African Republic. *Journal of Tropical Ecology* 7: 25-36.

Fay, J.M., C.A. Spinage, B. Chardonnet and A.A. Green (1990) Central African Republic. In East, R. (ed.) *Antelopes global survey and action plans* (pp. 99-109) Gland: IUCN.

Garreau, J-M. (1996a) Enquete socio-economique sur quelques productions de la ville de Bayanga. Non-published report. Projet Dzanga-Sangha. pp. 17.

Garreau, J-M. (1996b) Demarche de développement rural au sein du PCDI Dzanga-Sangha. Non-published report. Projet Dzanga-Sangha.

Gonda Ngbalet, M. (1995) Données démographique de Dzanga-Sangha. Rapport intermediare. Projet Dzanga-Sangha, Université de Bangui.

Harcourt, A.H. (1986) Gorilla conservation: anatomy of a campaign. In Bernischke, K. (ed.) *Primates: the road to self-sustaining populations*. New York: Springer-Verlag,

Harris, D. (1994) Interim check-list to the vascular plants of the Dzanga-Sangha Project Area Central African Republic. Unpublished report. University of Oxford 31pp.

Lanjouw, A. (1999) Tourisme aux gorilles en Afrique centrale. *Canopée* 13, 25-26.

McNeilage, A. (1996) Ecotourism and mountain gorillas in the Virunga Volcanoes. In Taylor, V. & Dunstone, N. (eds.) *The exploitation of Mammal*, London: Chapman and Hall.

Northon-Griffiths, M. & Southey, C. (1995) The opportunity costs of biodiversity conservation in Kenya. *Ecological Economics* 12, 125-139.

Noss, A.J. (1995) Duikers, cables, and nets: a cultural ecology of hunting in a central African forest. PhD. dissertation. University of Florida. P. 415.

PNUD (1995) Rapport mondial sur le développement humain 1995. Programme des Nations Unies pour le Développement (PNUD), Paris: Economica

Shackley, M. (1995) The future of gorilla tourism in Rwanda. *Journal of Sustainable Tourism* 3(2), 61-72.

Telesis (1991) Sustainble economic development options for the Dzanga-Sangha Reserve Central African Republic, Telesis USA, Inc.

Telesis (1993) Supplementary study of the sustainable economic development options for the Dzanga-Sangha Reserve Central African Republic, Telesis USA, Inc.

Wilkie, D.S. & Carpenter, J.F. (1998) The under-financing of protected areas in the Congo Basin: so many parks and so little willingness-to-pay. *Biological Conservation* (in review)

Chapter 8

Synthesis: Potentials and pitfalls of tourism in the Guinean-Congolian Forest Region.

Introduction

According to Wilson (2000) the planet is going through a bottleneck caused by a massive die out of species. He argues that biodiversity may be salvageable depending on the attention that is given to sustainable management of the environment, including protection of biodiversity. This could be accomplished by protection of priority areas identified by conservation experts, such as those that gathered in Libreville in February 1999 for the Guinean–Congolian forest region (Blom et al., in prep.). In many cases these priority areas already contain gazetted protected sites, but many gazetted areas are ineffectively managed, not managed at all or managed largely by foreign assistance. A case study of the Central African Republic (CAR) clearly demonstrates this problem. Although the country has an impressive total of 15 protected areas, covering about 10.9 % of its territory, only 32 % of the protected areas are adequately managed (Chapter 2). All of these areas are managed with substantial foreign assistance. Several underlining causes, such as lack of institutional capacity, civil war and poverty, can be mentioned to account for this failure of the governments of the region to manage the protected area network.

However the fundamental problem in the management of protected areas, particularly in the developing countries of the Congo Basin, is the lack of long-term economical sustainability (Chapter 2; Chapter 7; Blom et al., in prep.; Spergel et al., in prep.; Wilkie et al., in press). Although these countries spend about the same percentage of their national budgets on protected areas as do wealthy European and North American nations (Wilkie et al., in press.), this is clearly insufficient to manage their national protected area systems (Chapter 2). Leakey (2000) once again called upon the world's richest nations to provide funding to the poorest nations to help conserve the world's biodiversity. However there seems to be little willingness to pay and the under-funding of the management has seriously affected the integrity of many protected areas in the Guinean-Congolian region (Wilkie et al., in press; Chapter 2).

The actual cost of effective management forms a basis for an estimation of maintaining the present network of protected areas (Blom, in prep.; Wilkie et al., in press). Protected areas are a net cost to local and national economies (Wilkie et al., in press), as they do not generate significant revenue in contrast to landscapes with, for example, agriculture and logging (Spergel et al., in prep.). The countries in the region already carry this economic burden and are unlikely to be able to generate substantial additional funding for protected area management from their limited national budgets (Blom, in prep.; Wilkie, et al., in press). As it is assumed that protected areas are an essential component of biodiversity conservation and donor countries seem unwilling to finance this, it leaves only the prospects of user fees as a realistic option for sustainable funding of protected areas (Spergel et al., in prep.).

Among these user fees, those involving tourism play a leading role (Spergel et al., in prep.). The role of tourism as a long-term sustainable funding source for biodiversity protection has been discussed for many parts of the world (e.g. Boo, 1990; Brandon, 1996;

Cater and Lowman, 1994; Conservancy, 1995; Durbin, 1996; Inskeep, 1992; Langholz, 1996; Lindberg, 1991; Navrud and Mungatana, 1994; Tobias and Mendelsohn, 1991; Wells, 1996). The situation in Dzanga-Sangha provided us with unique opportunities to carry out a case study into the potential and pitfalls of tourism. The Dzanga-Sangha protected area complex is located in the southwest of the CAR, a country that has a history of limited tourism which still retains some of this potential (Plumier, 1992; UN, 1998). Tourism was seen as the best option for sustainable development for the Dzanga-Sangha area (TELESIS, 1991; TELESIS, 1993). The managers felt that ape-viewing could relatively easily complement the unique wildlife viewing and accessible BaAka (pygmy) culture in the Dzanga-Sangha area. Tourism based on close range observations of apes has been a major revenue and public awareness generator in other parts of Africa (Aveling and Aveling, 1989; Butynski and Kalina, 1998a; Butynski and Kalina, 1998b; Harcourt, 1986; Lanjouw, 1991; Lanjouw, 1999; McNeilage, 1996; Shackley, 1995). It seems that under the right circumstances ape-viewing tourism has substantial potential, but it also carries with it certain risks (Butynski and Kalina, 1998a; Butynski and Kalina, 1998b; Goldsmith, 2000; Kalema, 1998; McNeilage, 1996; Macfie, 1996; Mudakikwa, 1998; Sholley, 1989; Wallis and Lee, in prep.). In this chapter, based on the Dzanga-Sangha case studies, I review the potential and pitfalls of ape-viewing tourism. I analyze the role that this and other forms of tourism could play in financing biodiversity conservation in the Guinean-Congolian Forest Region.

The existing protected area system of the Guinean-Congolian Forest Region

The Guinean-Congolian Forest Region is a vast area of over 2 million km^2 consisting of 14 different ecoregions, not including the Congo side of the Rift valley (Blom et al., in prep.). Ecoregions are relatively large areas delineated by biotic and environmental factors that regulate the structure and function of ecosystems within them. Table 1 gives an overview of the ecoregions contained within the Guinean-Congolian Forest Region.

Table 1. The ecoregions of the Guinean-Congolian Forest Region

Ecoregion	Approximate size of area (in km^2)	Approximate total size of area under protection (in km^2) with (the percentage of the ecoregion under protection)
Nigerian Lowland Forest	67,300	1,522 (2.3 %)
Niger Delta Swamp Forest	14,400	0 (0 %)
Cross-Niger Transition Forest	20,700	0 (0 %)
Cross-Sanaga-Bioko Coastal Forest	52,200	6,431 (12.3 %)
Atlantic Equatorial Coastal Forest	189,700	26,778 (14.1 %)
Mount Cameroon and Bioko Montane Forest	1,100	0 (0 %)
Cameroonian Highlands Forest	38,000	1,469 (3.9 %)
Sao Tome and Principe Moist Lowland Forest	1,000	0 (0 %)
Northwestern Congolian Lowland Forest	434,100	30,793 (7.1 %)
Western Congolian Swamp Forest	128,600	0 (0 %) *
Eastern Congolian Swamp Forest	92,700	0 (0 %)
Central Congolian Lowland Forest	414,800	36,560 (8.8 %)
Northeastern Congolian Lowland Forest	533,500	31,256 (5.9 %)
Central African Mangroves	29,900	0 (0 %)
TOTAL	**2,018,000**	**134,809 (6.7 %)**

* Lac Tele and Likouala-aux-Herbes have been designated as a Ramsar site (4389.6 km^2), but their IUCN status is unclear. See Blom et al., in prep. for detailed information on protected areas
(Data on size of ecoregion from Blom et al., in prep.; data on protected areas modified from IUCN, 1998; UN, 1993; Chapter 2 and Blom, unpublished).

The region is globally outstanding for containing large intact blocks of lowland and swamp forest (Blom et al., in prep.). The area of forest remaining per capita is the highest in Africa (data in Wilks and IUCN Tropical Forest Programme, 1990). Species richness is high, with for example an estimated 6000 vascular plants for Gabon alone (Wilks and IUCN Tropical Forest Programme, 1990). Over 10,000 species of plants are known from Democratic Republic of Congo and that country has at least 409 species of mammals, 1086 species of birds, 80 of amphibians and 400 species of fish (Sayer, 1992). Approximately 400 species of birds have been recorded for the forest of CAR (Carroll, 1987; Green and Carroll, 1991). Cameroon has 29 species of primates in its forests (Gartlan, 1992) and Gabon 19 (Blom et al., 1992).

Endemism is high in many ecoregions and thus far over 42 species of ecoregion endemic birds and over 29 species of endemic mammals have been found in these forests (Blom et al., in prep.). All these figures are underestimates as this is one of the least studied and surveyed areas in the world, with major gaps in our knowledge (Blom et al., in prep.). However, the most striking aspect of the Guinean-Congolian forest block is that it is one of the last great wilderness areas remaining on the planet, where large mammals still dwell under natural regimes of population fluctuations and migrations.

Overall the potential for biodiversity conservation is exceptionally good. However this situation is changing rapidly, mostly under influence of the logging industry. Although selective logging usually does not cause significant habitat conversion, it is the main driving force behind the habitat degradation and fragmentation. The infrastructure developed by logging and other industries seriously fragments the forest and provides markets, transport and access for bushmeat hunters. The depletion of the fauna, the so-called bush meat crisis, is considered the number one threat to biodiversity conservation in this part of Africa (Blom et al., in prep.).

A vision for an effective protected area network

I define as an effective protected area network for the Guinean-Congolian Forest Region as follows (from Blom, in prep.):

1. A network based on protected areas, as defined by IUCN (1994) as areas of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means. This excludes gazetted forests defined in Chapter 2 as areas of land especially dedicated to the sustainable production of forestry products and/or protection of such resources on which this production is based.
2. A network which is based on representation. At least 10 % of each ecoregion should be gazetted as a protected area.
3. A network based on well-managed protected areas.

As shown in Table 1 the total area under official protection represents at present 134,809 km^2 or only about 6.7 % of the total area of the Guinean-Congolian Forest Region. Even more troublesome is that only half of the ecoregions contain any protected area at all. In fact only two ecoregions reach the suggested level of 10 % gazetted (Table 1 and Blom, et al., in prep.). Different scenarios are possible to mediate this situation and to ensure that at least 10 % is protected under law in each and every ecoregion (Blom, in prep.). Although there might be slight differences depending on the scenario, the following table gives a rough breakdown of the additional protected area needed per country to reach the objective of minimum 10 % gazetted per ecoregion.

Table 2. Existing extent per country of protected areas and additional area needed in the Guinean-Congolian Forest Region

Country	Area gazetted (in km^2)	Additional area to be gazetted (in km^2)	Total area needed (in km^2)
Cameroon	19,480	3,477	22,957
Central African Republic	4,725	2,366	7,091
Congo	9,156	13,394	22,550
Democratic Republic of Congo	67,816	40,323	108,139
Equatorial Guinea	800	10	810
Gabon	25,845	6,576	32,421
Nigeria	6,987	9,764	16,751
Sao Tome and Principe	0	100	100
TOTAL	134,809	76,010	210,819

(data from Blom, in prep.)

I consider an area well managed when it maintains its species assemblages, except for natural changes. This is especially critical in multiple use reserves, where extraction occurs. Any manager must assure that viable minimum populations are maintained (Blom, in prep.). In practice it is impossible to monitor all species and it might be too expensive to monitor even a range of taxa (Blom, pers. obs.; see also Balmford and Gaston, 1999). However it might be possible to use indicator groups (Howard et al., 1998), which also makes economic sense (Balmford and Gaston, 1999). According to Robinson (1993) protected areas are critical for the conservation of large mammals. Many of these species are wide-ranging and migratory and are prime targets for professional hunters. Depletion of the large fauna is considered the main short-term threat to biodiversity in the Guinean-Congolian forest region (Blom et al., in prep.). Monitoring the human impact on a selected group of large mammals would provide a mean to judge the effectiveness of management relative to costs. That is why I suggested in chapter 5 that monitoring human presence as well as large mammals might be an indicator for the overall "health" of a particular protected area, without having to monitor all or even many taxa.

In the case study area of Dzanga-Sangha I developed such a cost-effective monitoring system (Chapter 5). The preliminary results showed that elephants in particular were significantly less common in areas with heavy human use and that also other species such as monkeys showed lower densities closer to the main road and the town of Bayanga (Chapter 5). However although the results did show differences over time, it was yet too early to conclude that these trends were important and if the monitoring program was indeed effective. Nevertheless the preliminary results were encouraging and they also showed that poachers use secondary (logging) roads to penetrate into the national park, leading to the management policy recommendation to increase anti-poaching efforts along these roads (Chapter 5).

The costs of an effective protected area network

For the Guinean-Congolian Forest Region to be able to maintain a minimum presence in the existing protected areas system of about 135 thousand km^2 will require roughly 1,350 staff and a total budget of $ 7.4 million a year (Blom, in prep.). This option would result in increasing conflicts with local communities, as no funding would be available to compensate local communities for lost opportunities. No technical assistance or investments would be available which would lead to serious degradation of the protected area network. It would result in irreversible loss of biodiversity in the Guinean-Congolian Forest Region.

On the other hand, the above outlined vision for biodiversity conservation through a system of effectively managed protected areas in the Guinean-Congolian Forest Region would require an additional 76 thousand km^2 to be gazetted and an investment of over $ 1.3 billion in the next ten years. After these initial ten years I assume that a total of roughly $ 100 million a year would be sufficient to maintain this system (Blom, in prep.).

Total spending by the governments of the region is unlikely to reach even half of what is needed to maintain a minimum presence. Staffing levels are even more problematic. The needed increases in staff levels, up to 6,300 for full implementation of the vision, are especially crucial against the pressures by the International Monetary Fund that the governments in the region are to reduce the civil service. Privatization of the protected areas might circumvent this restriction (Blom, in prep.)

Furthermore, overall donor expenditure in the present protected area network is probably less than $20 million per year. Assuming that governments of the region will carry the national opportunity cost and that both the national governments as well as the donor community will maintain present levels of funding, approximately one billion dollars will have to be found elsewhere.

Gorilla based tourism in Dzanga-Ndoki

The potential of developing a gorilla viewing based type of tourism was considered to be good in the Dzanga-Ndoki National Park. Based on an economic feasibility study (TELESIS, 1991, 1993) the Dzanga-Sangha Project had developed the essential infrastructure (Blom, 1999). Our survey of the area (Chapter 4) reconfirmed that gorillas were still present in similar high densities as they were in the past (Carroll, 1986; Carroll, 1988; Carroll, 1997). Furthermore this survey combined with the ongoing monitoring program (Chapter 5), helped us identify that the best place to carry out the habituation would be at Bai Hokou. Bai Hokou had been, intermittently since 1984, the site of gorilla research (Carroll, 1988; Carroll, 1997; Goldsmith, 1996; Goldsmith, 1999; Remis, 1995; Remis, 2000; Remis, 1993; Remis, 1994; Remis, 1997a; Remis, 1997b; Remis, 1999), as well as other research on geology and bongos (Klaus, 1998; Klaus et al., 1998; Klaus-Hugi, 1998). Additionally data on gorilla ecology were available from other nearby research sites in the southern part of the park (Doran et al., 1996; Doran and McNeilage, 1998; Fay, 1989; Fay, 1997).

Although it is possible in some locations to observe gorillas while they visit forest clearings (Magliocca, 1999; Magliocca and Querouil, 1997; Magliocca et al., 1999;

Olejniczak, 1996; Olejniczak, 1997), in general it is necessary to habituate them to allow for regular observations by tourists (e.g. Fossey, 1983; McNeilage, 1996). Habituation is a process by which wild animals become accustomed to the presence of humans in their vicinity until humans are considered a neutral element in the animals environment (Tutin and Fernandez, 1991). Gorilla habituation carries certain risk and should be monitored (Butynski and Kalina, 1998a; Butynski and Kalina, 1998b; Tutin and Fernandez, 1991; McNeilage, 1996). Besides the obvious risk of direct transmission of diseases (e.g. Kalema, 1998; Sholley, 1989; Wallis and Lee, in prep.) and parasites (e.g. Macfie, 1996; Mudakikwa, 1998) there is also the risk of stress. The gorillas might change their daily path length, change or extend their home range and experience other stress-induced behavioral changes (e.g. Butynski and Kalina, 1998a; Butynski and Kalina, 1998b; Goldsmith, 2000). To monitor these potential negative impacts, the Dzanga-Sangha Project initiated an extensive monitoring program. This program will not only assist the on-going habituation process, but will also provide valuable input into similar habituation programs for tourism purposes carried out elsewhere (Aveling, 1996; Bermejo, 1997; Bermejo, 1999; Tutin and Abernethy, 1997; Tutin et al., 1996). The results from the health monitoring are not yet available, but the first results of the behavioral monitoring are (Chapter 6; Cipolletta, in prep.). The results summarized here cover the period of January 1998 until December 1999, when the group named Munye, which was first identified as such in August 1998, was at least partially habituated. Increase in the duration of the average contact time and an initial decrease in the time to locate the gorillas both indicate that the habituation is progressing (Chapter 6). The gorilla's initial reactions of aggression, fear and avoidance were gradually replaced by curious reaction and finally increasingly by ignoring the observers (Chapter 6). During the last 5 months of this study period the Munye group rarely ran away after a contact was made, in sharp contrast to early on in the study (Chapter 6). We did not detect any obvious shifts in the home range due to habituation, although the home range size was still increasing at the end of the study (Chapter 6; Cipolletta, in prep.). On the other hand it did seem that the average daily path length diminished as the habituation progressed (Chapter 6; Cipolletta, in prep.). Overall the average daily path lengths were similar to those found by Remis (1994) and Goldsmith (1996) at the same study site.

The results so far indicate that although habituation might temporarily impact the gorilla's behavior, these influences seem to decrease over time. Although habituation of western lowland gorillas is notoriously difficult (Tutin and Fernandez, 1991), our results summarized here, as well as other recent initiatives (Bermejo, 1997; Bermejo, 1999) show that it can be done successfully.

Potential and pitfalls of tourism

As mentioned above we have shown that western lowland gorillas can be habituated for tourism purposes and the program has now opened for limited experimental visits. The excellent tracking skills of the BaAka assistants as well as the fact that the Munye group seem to have been the only group extensively using the Bai Hokou study site certainly contributed to the circumstances that made habituation possible. I estimate that it takes about 2 years to habituate a group of gorillas for tourism in these circumstances. As experience is gained it might be possible to reduce this amount of time considerably. Nevertheless it is clear that habituating gorillas is a time consuming and expensive endeavor. The original three-year budget for our program was $ 463,800. Although the exact expenditure is not known it is safe to assume that it will costs at least $250,000 over a two-year period to habituate a group of gorillas under similar circumstances. This is probably an underestimate if I consider that we did not take into account any health monitoring in this estimate (carried out on a separate budget), which should form part of the overall monitoring.

Prior to the gorilla viewing program in Dzanga-Sangha tourism was unable to become self-financing (Chapter 7). Even though revenue was increasing and should be able to cover its recurrent costs, similar private commercial financing is not economically viable. Likewise, given the substantial investment needed to develop gorilla tourism and present numbers of visitors, I do not expect that this type of tourism to be viable from a purely commercial point of view. However the donors financing this program are not only interested in commercial viable enterprises. Tourism is an important local industry, both as a source of revenue as well as employment and gorilla habituation is a significant contribution to that economy. The additional jobs and revenue have improved local attitudes towards the national park and reserve and facilitated law enforcement (Chapter 7).

Although tourism has become an important economic activity in Dzanga-Sangha, at present levels it cannot cover the protected area management costs. Gorilla viewing is potentially a high revenue-generating type of tourism (e.g. (Aveling and Aveling, 1989; Harcourt, 1986; McNeilage, 1996; Shackley, 1995) thought to be able to substantially raise the existing level of revenue in Dzanga-Sangha. Given the fact that tourists are willing to pay fees of $100 and more per visit (Shackley, 1995), it would take about 8,000 visitors per year to cover the Dzanga-Sangha recurrent management costs (Chapter 7). Although the contributions from the gorilla habituation program in covering the recurrent costs could be significant it is unlikely to approach the levels of funding needed, as the gorilla viewing capacity will not surpass 1,500 visitors a year in the near future (Chapter 7).

Dzanga-Sangha provides great potentials for ecotourism, with its combination of visible megafauna and BaAka culture. Although isolated, it does have its own airstrip, making access to this area relatively easy and certainly comparable to most other protected areas in the Guinean-Congolian Forest Region. Overall Dzanga-Sangha certainly provides one of the best opportunities for a successful ecotourism venture in the Guinean-Congolian Forest Region. Even so, and even though tourism has become an important local industry, it is evident that it will not provide a solution for the self-financing of the protected area management in Dzanga-Sangha. Based on this case study in one of the potentially best opportunity sites for ecotourism in the Guinean-Congolian Forest Region, I conclude that the role of tourism in generating revenue for protected area management is limited at best in this part of the world. This case study illustrates the fact that although some user fees have the potential to generate substantial revenue for protected areas in the Guinean-Congolian Forest Region these fees will be far from sufficient to manage the proposed protected area system (see also Spergel et al., in prep.; Wilkie and Carpenter, 1999a; Wilkie and Carpenter, 1999b; Wilkie et al., in press).

In the case of Dzanga-Sangha, the development of its tourism program, including the gorilla viewing, are economically questionable, especially in the light of the high risks associated with investments in tourism in Central Africa. Furthermore the risk of serious disturbances to the gorillas make this option more than only economically questionable. The tourism in Dzanga-Sangha has certainly increased local revenue as well as employment opportunities and as such has helped mitigated some of the local opportunity costs and improved local perceptions of the park and reserve. Those are important gains, but managers have to carefully weigh these advantages against the background of risky economics of tourism and the apes' well being (chapter 6 and 7).

If the international donor community is serious about biodiversity conservation and willing to help implement the vision outlined above it will need to change current funding strategies. They should stop demanding that protected area systems in the Guinean-Congolian Forest Region become auto financed in the foreseeable future. Rather than invest at best in risky alternative economic ventures, such as ecotourism, donors should invest their money in establishing mechanisms, such as trust funds, for stable and sustainable source of revenue to finance the considerable recurrent costs of the proposed protected area system.

User fees, including safari hunting and nature tourism, have the potential to generate substantial revenue for protected areas, but only in a limited number of cases in the Guinean-Congolian Forest Region. Even under the best of circumstances, these fees will be far from sufficient to manage even the existing protected area system. The simple fact remains that if the international community values the biodiversity of the Guinean-Congolian Forest Region it is going to have to pay the costs. I recommend that this should be achieved by establishing environmental trust funds for individual areas, managed by (semi)-private national institutes, possibly in a larger national or regional framework. The source of capital is most likely to come from multilateral donors, especially under pressure of a potential clean development mechanism (CDM) within the Kyoto protocol, bilateral donors or private organizations. However, the potential of private sector corporation contribution or corporate sponsoring should be further investigated.

Acknowledgments

I would like to thank the World Wildlife Fund, Inc. (USA) and the World Wide Fund for Nature (Germany), and the different Government agencies for supporting this research. The late Urbain Ngatoua and all the staff of the Dzanga-Sangha Project were essential in making this happen. I thank Chloe Cipolletta and all the staff and students at Bai Hokou for their collaboration. I would like to acknowledge the State University of New York at Stony Brook for providing the opportunity to use their facilities during the writing of this paper. I am grateful to Herbert Prins, Arend Brunsting, Ignas Heitkonig, David Wilkie and Natasha Shah for their constructive comments on the manuscript.

References

Aveling C (1996) Update on gorilla news from the ECOFAC programme. Gorilla Conservation News *:* (10): 7-9.

Aveling C, and Aveling R (1989) Gorilla conservation in Zaire. Oryx *23:* (2): 64-70.

Balmford A, and Gaston KJ (1999) Why biodiversity surveys are good value. Nature *:* (398): 204-205.

Bermejo M (1997) Study of western lowland gorillas in the Lossi forest of North Congo and a pilot gorilla tourism plan. Gorilla conservation news *11:* 6-7.

Bermejo M (1999) Update on the Lossi gorillas study and future sancuary of gorillas, 1998, Popular Republic of Congo. Gorilla conservation news *13:* .

Blom A (1999) Ten years Dzanga-Sangha Project: "Dzanga-Sangha Project". Bangui, RCA: Dzanga-Sangha Project, pp. 17.

Blom A (in prep.) An estimate of the recurrent costs of biodiversity conservation through a system of protected areas in the Guiena-Congolian Forest Region. World Wildlife Fund .

Blom A, Alers MPT, Feistner ATC, Barnes RFW, and Jensen KL (1992) Notes on the current status and distribution of primates in Gabon. Oryx *:* (26): 223-234.

Blom A, Kamdem Toham A, D'Amico J, O'Hara D, Abell R, and Olson D (in prep.) Assessment of biological priorirties for conservation in the Guinean-Congolian Forest Region. Washington, DC: World Wildlife Fund..

Boo E (1990) Ecotourism: the potentials and pitfalls. Washington: World Wildlife Fund.

Brandon K (1996) Ecotourism and Conservation: A Review of Key Issues. Environment Department Papers, Biodiversity Series, World Bank *:* (33): 69.

Butynski T, and Kalina J (1998a) Is Gorilla Tourism Sustainable? Gorilla Journal *:* (16): 15-19.

Butynski TM, and Kalina J (1998b) Gorilla Tourism: A critical look. In EJ Milner-Gulland and R Mace (eds.): Conservation of biological resources. Oxford: Blackwell Science, pp. 294-370.

Carroll RW (1986) The Status, Distribution , and Density of the Lowland Gorilla (Gorilla gorilla gorilla (Savage & Wyman)), forest elephant (Loxodonta africana cyclotis, and associated dens forest fauna in the southwestern Central African Republic: research towards the establishment of a reserve for. New Haven: Yale University School of Foresatry and ENvironmental Studies, pp. 82.

Carroll RW (1987) Birds of the C.A.R. Malimbus 10 *:* (10): .

Carroll RW (1988) Relative density, range extention,and conservation potential of the Lowland gorilla (Gorilla gorilla gorilla in the Dzanga-Sangha region of southwestern Central Africa Republic. Mammalia *52:* (3): 310-323.

Carroll RW (1997) Feeding ecology of the western Lowland Gorillas (Gorilla gorilla gorilla) in the Central African Republic, Yale University, New haven.

Cater E, and Lowman GE (1994) Ecotourism: a sustainable option? (p.1-101). Wiley: Chichester: Wiley.

Conservancy TN (1995) Compatible Economic Development: Ecotourism: The Nature Conservancy.

Doran D, McNeilage A, and Demmers P (1996) Mondika Research center, Central African Republic. Gorilla Conservation News *:* (10): 9.

Doran DM, and McNeilage A (1998) Gorilla ecology and behavior. Evolutionary Anthroplogy *6:* (4): 120-129.

Doumenge C, Garcia Juste J-E, Gartlan S, Langrand O, and Ndinga A (in prep.) Conservation de la biodiversite foretiere en Afrique atlantique: le reseau d'aires protegees est-il adequat? table of MS *:* .

Durbin JC (1996) Can tourism make a major contribution to conservation of protected areas in Madagascar? Biodiversity and conservation *:* (5): 345-353.

Fay JM (1989) Partial completion of a cencus of the western Lowland gorilla (Gorilla g. gorilla (Savage and Wyman)) in southwestern Central Africa Republic. Mammalia *53:* (2): 203-215.

Fay JM (1997) The ecology, social organization, populations,habitat and history of the Western Lowland Gorilla (Gorilla gorilla gorilla Savage and Wyman, 1847), Washington University.

Fossey D (1983) Gorillas in the mist. Boston: Houghton Mifflin Co.

Gartlan S (1992) Cameroon. In JA Sayer, CS Harcourt and NM Collins (eds.): The conservation of tropical forests: Africa. Hants: IUCN, Macmillan Publishers Ltd, pp. 110-118.

Goldsmith ML (1996) Ecological influences on the ranging and grouping behaviour of werstern lowland gorillas at Bai Hokou, Central African Republic., State University of New York at Stony Brook, New York, Stony Brook.

Goldsmith ML (1999) Ecological constraints on the foraging effort of werstern lowland gorillas (Gorilla gorilla gorilla) at Bai Hokou, Central African Republic. International Journal of Primatology *20:* (1): 1-23.

Goldsmith ML (2000) Effects of ecotourism on the behavioral ecology of Bwindi gorillas, Ugnada: preliminairy results. American Journal of Physical Anthropology *AAPA Abstracts Supplement 30:* 161.

Harcourt AH (1986) Gorilla conservation: anatomy of a campaign. In K Ernischke (ed.): Primates: the road to self-sustaining populations. New York: Springer-Verlag.

Howard P, Viskanic P, Davenport T, Kigenyi F, Baltzer M, Dickinson C, Lwanga J, Matthews R, and Balmford A (1998) Complementarity and the use of indicator groups for reserve. Nature *394:* 472-475.

Inskeep E (1992) Achieving sustainable tourism development. WTO-News. *:* (6): 4-6.

IUCN (1994) abstract on definitions from: Guidelines for protected areas management categories. Cambridge, UK and Gland, Switzerland: IUCN.

IUCN (1998) 1997 United Nations list of protected areas. Gland & Cambridge:: WCMC/IUCN.

Kalema G (1998) An outbreak of sarcoptic mange in free-ranging mountian gorillas (Gorilla gorilla berengei) in Bwindi Impenetrable National Park, South werstern Uganda. AAZV and AAWV joint conference, pp. 438.

Klaus G (1998) Natural licks and geophagy (soil ingestion) by large mammal species in the rainforest of the Central African Republic, Universitat Zurich, Zurich.

Klaus G, Klaus-Hugi C, and Schmid B (1998) Geophagy by large mammals at natural licks in the rainforest of teh Dzanga National Park, Central African Republic. Journal of Tropical Ecology *:* (14): 829-839.

Klaus-Hugi CS (1998) Home range, feeding behaviour and social organization of the bongo (Tragelaphus eurycerus) in the rainforest of the Central African Republic, Universitat Zurich, Zurich.

Langholz J (1996) Ecotourism impact on independantly owned nature reserves in Latin America and Sub-Saharan Africa. The Ecotourism Equation: Meausuring the Impacts. Yale F&ES Bulletin *:* .

Lanjouw A (1991) Tongo Chimpanzee Conservation Project: an experiment in long-term conservation. Understanding Chimpanzees Symposium.

Lanjouw A (1999) Tourism aux gorilles en Afrique centrale. Canopée *13:* 25-26.

Leakey R (2000) Extinctions past and present. Time *155:* (17): 35.

Lindberg K (1991) Policies for maximizing nature tourism's ecological and economic benefits: World Resource Institute, pp. 37pp.

Macfie L (1996) Case report on scabies infection in Bwindi gorillas. Gorilla journal *:* (13): 19-20.

Magliocca F (1999) 1998 Update on the gorillas of the Odzala National Park, Popular Republic of Congo. Gorilla Conservation News *:* (13): .

Magliocca F, and Querouil S (1997) Preliminairy report on the use of the Maya-Maya north saline (Odzal National Park, Congo) by lowland gorillas. Gorilla Conservation News *:* (11): 5.

Magliocca F, Querouil S, and Gautier Hion A (1999) Population Structure and Group Composition of Western Lowland Gorillas in North-Western Republic of Congo. American Journal of Primatology *48:* (1): 1-14.

McNeilage A (1996) Ecotourism and mountain gorillas in the Virunga Volcanoes. In V Taylor and N Dunstone (eds.): The exploitation of mammal populations. London: Chapman and Hill, pp. 334-344.

Mudakikwa AB (1998) An indicator of human impact: gastrointestinal parasites of mountain gorillas (Gorilla gorilla berengei) from the Virunga volcanoes region, central Africa. AAZV and AAWV joint conference, pp. 436-437.

Navrud S, and Mungatana ED (1994) Environmental valuation in developing countries : the recreational value of wildlife viewing. Ecological Economics *11:* (2): 135-151.

Olejniczak C (1996) Update on the Mbeli Bai gorilla study, Nouabale-Ndoki National Park, Congo. Gorilla conservation news *10:* 6-7.

Olejniczak C (1997) 1996 update on the Mbeli Bai gorilla study, Nouabale-Ndoki national park, Congo. Gorilla conservation news *11:* 7-10.

Plumier JF (1992) Nature conservation in the northern region of the Central African Republic. Tropicultura. *10:* (4): 163-165.

Remis M (1995) Effects of body size and social context on the arboreal activities of lowland gorillas in the Central African Republic. American Journal of Physical Anthropology *97:* (4): 413-433.

Remis M (2000) Preliminary assessment of the impact of human activities on gorilla (Gorilla gorilla gorilla) and other wildlife at Dzanga-Sangha Reserve, Central African Republic,. Oryx *34:* (1): .

Remis MJ (1993) Nesting Behavior of Lowland Gorillas in the Dzanga-Sanga Reserve, Central Africa Republic: Implications for Population Estimates and Understanding of Group Dynamics. Tropics *2:* (4): 245-255.

Remis MJ (1994) Feeding ecology and positional behaviour of western lowland gorillas (*Gorilla gorilla gorilla*) in the central African Republic, Yale University, New Haven.

Remis MJ (1997a) Ranging and Grouping Patterns of a Western Lowland Gorilla Group at Bai Hokou, Central African Republic. American Journal of Primatology *:* (43): 111-133.

Remis MJ (1997b) Western Lowland Gorillas (Gorilla gorilla gorilla) as Seasonal Frugivores: Use of Variable Resources. Am. Journ. of Prim. *:* (4): 87-109.

Remis MJ (1999) Tree structure and sex differences in arbreality among western lowland gorillas (Gorilla gorilla gorilla) at Bai Hokou, Central African Republic. Primates *40:* (2): 383-396.

Robinson JG (1993) Limits to caring: sustainable living and the loss of biodiversity. Conservation Biology *7:* 20-28.

Sayer JA (1992) Zaire. In JA Sayer, CS Harcourt and NM Collins (eds.): The conservation of tropical forests: Africa. Hants: IUCN, Macmillan Publishers Ltd, pp. 272-282.

Shackley M (1995) The future of gorilla tourism in Rwanda. Journal of Sustainable Tourism. *3:* (2): 61-72.

Sholley CR (1989) Mountain gorilla update. Oryx *:* (23): 57-58.

Spergel B, Wilkie DS, and Blom A (in prep.) Prospects for sustainable financing of protected areas in the Congo Basin through user fees. *:* .

TELESIS (1991) Sustainable economic development options for the Dzanga-Sangha Reserve, Central African Republic. USA: TELESIS, Inc.

TELESIS (1993) Supplementary study of the sustainable economic development options for the Dzanga-Sangha Reserve, Central African Republic. USA: TELESIS, Inc.

Tobias D, and Mendelsohn R (1991) Valuing ecotourism in a tropical rain-forest reserve. Ambio. *20:* (2): 91-93.

Tutin CEG, and Abernethy KA (1997) Station d'Etude des Gorilles et Chimpanzes, Reserve de la Lope, Gabon. Gorilla Conservation News *:* (11): .

Tutin CEG, Abernethy KA, and Fontaine F (1996) Station d'Etude des Gorilles et Chimpanzes, Reserve de la Lope, Gabon - 1995. Gorilla Conservation News *:* (10): 4-5.

Tutin CEG, and Fernandez M (1991) Responses of wild chimpanzees and gorillas to the arrival of primatologists: behaviour observed during habituation. In B H.O. (ed.): Primate responses to environmental change. New York: Chapman and Hall, pp. 187-196.

UN (1993) 1993 United nations List of National parks and protected areas. www.wcmc.org.uk/cgi-bin/pa_paisquery *:* .

UN UNDPWTO (1998) Plan directeur pour le développement du tourisme, république Centrafricaine, volune 1: diagnostics et orientations: "United Nations Development Program & World Tourism Organization, Madrid". Madrid: United Nations Development Program & World Tourism Organization.

Wallis J, and D.R. L (in prep.) Primate conservation: the prevention of disease transmission. *:* 27 p.

Wells MP (1996) Economic Perspectives on Nature Tourism, Conservation and Development. Environment Department Papers, Environmental Economics Series, World Bank *:* (5): 54p.

Wilkie DS, and Carpenter JF (1999a) Can nature tourism help finance protected areas in the Congo Basin? Oryx *33:* (4): 332-338.

Wilkie DS, and Carpenter JF (1999b) The potential role of safari hunting as a source of revenue for protected areas in the Congo Basin. Oryx *33:* (4): 339-345.

Wilkie DS, Carpenter JF, and Zhang Q (in press) The under-financing of protected areas in the Congo Basin: so many parks and so little willingness-to-pay. Biodiversity and Conservation *:* .

Wilks C, and IUCN Tropical Forest Programme. (1990) La conservation des ecosystèmes forestiers du Gabon. Gland, Suisse: UICN l'Alliance mondiale pour la nature : Commission des Communautés européennes.

Wilson EO (2000) Vanishing before our eyes. Time *155:* (17): 29-34.

Summary

The Guinean-Congolian Forest Region is one of the last great wilderness areas remaining on the planet, where large mammals still dwell under natural regimes of population fluctuations and migrations. In general, the potential for biodiversity conservation in this region is exceptionally good, although only 6.7 % of the landscape is protected under law, and many of these conservation areas are protected only on paper. The international conservation community envisions the creation of an effective managed system of protected areas covering about 135,000 km^2 in the Guinean-Congolian Forest block, an increase of 76,000 km^2. Given the fact that even the existing protected area is severely under-financed, this would require an estimated investment of over $1.3 billion in the next ten years, with an additional $100 million needed each year after that to cover recurrent costs.

In this study, we critically examined the status of protected areas and gazetted forests in one of the countries of this region, the Central African Republic (CAR). The CAR has 15 protected areas covering about 10.9 % of the country, with an additional 1.0 % set aside as gazetted forests. The gazetted forests are mainly intended for the sustainable production of forest resources. Our analysis shows that only 32 % of the protected areas and only 2 of the 47 gazetted forests are adequately managed. Poaching poses the largest threat to biodiversity conservation, and in none of the protected areas was law enforcement sufficient to entirely control poaching.

We monitored how human activities affected large mammals in one relatively well-managed protected area of the CAR, the Dzanga-Sangha Protected Area Complex. The Dzanga-Sangha complex consists of two separate sectors of the Dzanga-Ndoki National Park, and the Dzanga-Sangha Dense Forest Special Reserve, which functions as a buffer zone for the national park. Monthly monitoring of large mammals and human signs from January 1997 to August 1999 confirmed that poaching remains a problem in this protected area. Elephants and monkeys were significantly less common in areas regularly used by humans, such as close to the main roads. Our study also found evidence that poachers used secondary (logging) roads to penetrate into the national park. The main reason that law enforcement is insufficient here, and elsewhere in the CAR, is lack of sustainable funding.

Tourism, especially involving ape viewing, has been promoted as a viable option to generate significant revenue for protected areas. We tested this hypothesis in Dzanga-Sangha, an area with one of the best opportunities for a successful ecotourism venture in the Guinean-Congolian Forest Region. We carried out surveys of the diurnal primates in the Dzanga sector of the park in order to estimate gorilla and chimpanzee densities. Based on the line transect survey method we estimated a density of 1.6 weaned gorillas/km^2. This estimate confirmed the importance of the area for western lowland gorilla (*Gorilla gorilla gorilla*) conservation and underlined the potential of developing a tourism venture based on gorilla viewing.

Gorilla habituation, which was part of this study, was initiated in the Dzanga sector of the national park in August 1996 and is still ongoing. Data on the habituation process from August 1996 to December 1999 are presented here. From August 1998 onwards, we were able to focus the habituation process on one specific gorilla group, the Munye. During this part of the study, our aim was to monitor the impact of the habituation process on the gorillas through changes in the gorillas' behavior. As habituation progressed, it became easier to locate and to remain with the gorillas. Upon being contacted, the Munye group

increasingly ignored the observers rather than exhibiting the initial reactions of aggression, fear, and vocalization, which were more common early in the habituation process. The way in which contacts with the Munye ended also became more subdued over time. However, habituation did initially have negative impacts on the gorillas: ranging data indicate that the average daily path length of the Munye group diminished over time, indicating that the group was ranging further (avoiding the observers) at the beginning of the study. From our results, we conclude that the gorillas experience negative impacts during the habituation process, but that these impacts do diminish over time. Although habituating gorillas to allow tourists to view these animals is feasible, it requires a substantial investment in time and money and is not without risks.

Our experience with the Munye group also provides several specific recommendations for the habituation process. Regular daily contact seems to be an important factor in promoting habituation. Likewise, contacting gorillas while they are in a tree or in dense forest seems to provide better results. On the other hand, contacts within 10 meters and contacts without forewarning the gorillas (achieved in our study by tongue clacking) should be avoided.

Our analyses of the monetary impact of tourism in Dzanga-Sangha on the protected area management and the local economy demonstrate that prior to the gorilla-viewing option, tourism was unable to become self-financing. Tourism, with or without gorilla viewing, is unlikely to provide sufficient revenue to cover the operating costs of the park and the reserve. On the other hand, the impact of tourism on the local economy is substantial and facilitates the relations between the conservation project and the local community. Even though this type of tourism can bring important gains to the region, such as revenue and employment, managers have to carefully weigh these advantages against the apes' well being and the risky economics of tourism in Central Africa before deciding on habituating these apes.

Given the fact that Dzanga-Sangha provides one of the best opportunities for this type of tourism in the Guinean-Congolian Forest Region and that even here the economic success is highly questionable, it is unlikely that nature tourism will be a realistic option in but a few exceptional places in this part of the world. This case study clearly demonstrates that although some user fees have the potential to generate substantial revenue for protected areas in the Guinean-Congolian Forest Region, these fees will be far from sufficient to manage the proposed protected area system.

Thus, if the international donor community is serious about biodiversity conservation, they need to change their funding strategies. Rather than investing in risky alternative economic ventures such as ecotourism, donors should invest their money in establishing mechanisms, such as trust funds, for a stable and sustainable source of revenue to finance the considerable recurrent costs of the proposed protected area system.

Samenvatting

De Guinean-Congolese Bos Regio is een van de laatst-overgebleven grote wildernisgebieden ter wereld, waar de mega-fauna nog steeds onderhevig is aan natuurlijke fluctuaties in hun dichtheden en nog vrijblijvend kunnen migreren. In het algemeen is het potentieel voor natuurbescherming in deze regio uitzonderlijk goed, alhoewel slechts 6,7 % van het landschap wettelijk beschermd is en een belangrijk aantal van deze beschermde gebieden slechts op papier bestaan. De internationale natuurbeschermings gemeenschap hoopt een effectief beheerd systeem van beschermde gebieden te creeren dat 135.000 km^2 van het Guinean-Congolese Bos zal beschermen, een toename van 76.000 km^2. Gezien het feit dat het huidige systeem van beschermde gebieden al grote geldtekorten heeft, vraagt dit voorgestelde systeem een investering van meer dan 1,3 miljard dollar over de komende tien jaar. Na deze eerste investering is er nog eens $100 milljoen nodig per jaar om de lopende kosten te dekken.

In deze studie onderzochten we de huidige toestand van de beschermde gebieden alsmede van de geclasseerde bossen in de Centraal Afrikaanse Republiek (CAR), een van de landen in deze regio. De CAR heeft 15 beschermde gebieden met een oppervlakte van ongeveer 10,9 % van het totale land met daarnaast nog eens 1,0 % in geclasseerde bossen. De geclasseerde bossen zijn met name bedoeld voor de duurzame productie van hout. Onze analyse van de situatie geeft aan dat slechts 32 % van de beschermde gebieden en slecht 2 van de 47 geclasseerde bossen effectief beheerd worden. Het grootste gevaar voor de natuurbescherming is de stroperij en in geen van de beschermde gebieden was de rechtshandhaving voldoende om de stroperij geheel onder controle te houden.

In het Dzanga-Sangha beschermde complex, een van de relatief goed beheerde natuurgebieden in CAR, onderzochten we hoe menselijke activiteiten invloed hebben op de mega-fauna. Het Dzanga-Sangha beschermde complex bestaat uit twee stukken van het Dzanga-Ndoki Nationale Park en het Dzanga-Sangha Speciale Bos Reservaat, dat een bufferzone vormt voor het nationale park. Onze maandelijkse controle van permanente transecten op sporen van mensen en grote zoogdieren van januari 1997 tot augustus 1999 toonde aan dat stroperij nog steeds een probleem is in dit beschermde gebied. In gebieden regelmatig bezocht door mensen, zoals rondom wegen, waren olifanten en apen significant minder aanwezig. Onze studie vond ook bewijs voor het feit dat stropers gebruik maken van secundaire (bosbouw) wegen om het nationale park binnen te dringen. Onvoldoende financiering op de lange termijn is een van de hoofdredenen dat handhaving en controle onvoldoende waren in dit en andere gebieden in de CAR.

Toerisme, inclusief de optie van het observeren van mensapen, wordt bevorderd als een van de opties om voldoende inkomen te leveren voor het beheer van beschermde natuurgebieden. Om te zien of deze optie realistisch is in deze bosregio onderzochten wij de situatie in Dzanga-Sangha, waar de mogelijkheden voor een dergelijke onderneming tot de beste in de regio behoren. Allereerst maakten we een schatting van de dichtheden van mensapen in de Dzanga-sector van het park. Gebaseerd op de resultaten van onze transecten schatten wij de dichtheid van nest-bouwende gorillas (alle gorillas behalve babies) op 1,6 individuen per km^2. Deze hoge dichtheid bevestigde het belang van Dzanga-Sangha voor de bescherming van de westerlijke laagland gorilla (*Gorilla gorilla*

gorilla) en onderstreepte de mogelijkheden van het ontwikkelen van een toerisme gebaseerd op het observeren van gorillas in het wild.

Het habitueren van gorillas, dat onderdeel uitmaakte van deze studie, werd ondernomen in de Dzanga-sector vanaf augustus 1996 en gaat nog steeds door. Wij presenteren hier de resultaten van het habituatie-process tussen augustus 1996 en december 1999. Vanaf augustus 1998, waren wij in staat om het habituatie-process to concentreren op een specifieke groep, de Munye. Ons doel gedurende dit gedeelte van de studie was om te observeren hoe het habituatie-process het gedrag van de gorillas beinvloedt. Naarmate de habituatie vorderde werd het gemakkelijker om de gorillas te vinden en om bij ze te blijven. De Munye groep negeerde ons meer en meer wanneer we contact maakten en vertoonde minder, zoals in het begin, agressie, angst en schreeuwen. Daarnaast werd de manier waarop het contact eindigde ook geleidelijk kalmer. Habituatie had echter in het begin zeker negatieve effecten op de gorillas: de dagelijkse reisafstand van de Munye groep werd geleidelijk korter, wat aangaf dat de gorillas de bezoekers ontweken in het begin van het habituatie-process. Onze conclusie, gebaseerd op onze resultaten geeft aan dat gorillas negatieve effecten ondervonden als gevolg van het habitueren, maar dat deze effecten in de loop der tijd afnamen. Alhoewel het habitueren mogelijk blijkt te zijn, vraagt het grote investeringen en is niet zonder risico.

Onze ervaringen met de Munye groep leidden tot enige specifieke aanbevelingen voor het habitueren. Regelmatig dagelijks contact met de gorillas is belangrijk voor het habitueren. Contact maken met de gorillas in dichte vegetatie of wanneer ze in een boom zijn lijkt ook positieve resultaten te geven. Daar tegenover staat dat contacten binnen 10 meter en contacten zonder de gorillas van te voren te waarschuwen (in deze studie door te klakken met de tong) moeten worden vermeden.

Onze analyse over de geldstromen in verband met het beheer en de lokale economie in Dzanga-Sangha voor de aanvang van het gorilla-toerism wezen erop dat toerisme niet in staat was zichzelf te financieren. Het is onwaarschijnlijk dat toerisme, met of zonder de optie van gorilla observatie, in staat is om voldoende inkomen te genereren om de kosten van het beheer van het nationale park en het reservaat te financieren. Aan de andere kant is het wel zo dat toerisme belangrijk is voor de lokale economie en heeft bijgedragen tot betere relaties tussen de beheerders van Dzanga-Sangha en de lokale bevolking. Alhoewel toerisme dus belangrijke bijdragen kan leveren tot de lokale economie, in de vorm van inkomen en werk, moeten beheerders deze voordelen afwegen tegen het welzijn van de gorillas en de riskante investeringen in toerisme in centraal Afrika voordat een beslissing over habitueren wordt genomen.

Gezien het feit dat Dzanga-Sangha een van de beste gelegenheden biedt voor het ontwikkelen van een dergelijk type van toerisme in de Guinean-Congolese Bos Regio en dat zelfs hier het economisch succes van een dergelijke onderneming twijfelachtig is, is het onwaarschijnlijk dat ecotoerisme een realistische optie is in deze regio, een aantal uitzonderlijke plaatsen daar gelaten. Deze studie laat duidelijk zien dat ofschoon een aantal gebruikersbijdragen de mogelijkheid bied voor belangrijke inkomsten voor beschermde gebieden in deze regio, deze honoraria bij lange na niet voldoende inkomsten leveren voor het financieren van het beheer van het voorgestelde systeem van natuurbeschermings-gebieden.

Als het dus de international gemeenschap ernst is met de natuurbescherming dan moet de financierings-strategieen worden gewijzigd. In plaats van te investeren in riskante alternatieve economische opties, zoals ecotoerisme, zou het beter zijn om te investeren in financiele constructies, zoals fondsen (trust funds), voor een stabiele en langdurige bron van inkomsten om de aanzienlijke kosten van het beheer van het voorgestelde systeem van natuurbescermings-gebieden te financieren.

Résumé

La Région Forestière Guinneo-Congolaise est une des dernières grandes régions intactes sur la planète, où grands mammifères vivent encore sous un régime naturel de fluctuation et de migration. En général, la potentialité pour la conservation de la biodiversité dans cette région est exceptionnelle, et bien que 6,7% du paysage soient protèges par la loi, beaucoup de ces zones sont uniquement protégées sur papier. La communauté internationale de la conservation envisage la création d'un système de gestion efficace des aires protégées couvrant environ 135.000 km^2 dans le bloc forestier guinneo-congolais, 76.000 km^2 de plus. Étant donné que même les aires protégées existantes manquent de financement, cela requiert un investissement estimé à plus de 1,3 milliards de dollars dans les dix ans à venir, avec une addition de 100 million de dollars nécessaires tous les ans après cela, pour couvrir les dépenses périodiques de fonctionnement.

Dans cette étude, nous avons examiné avec critique le statut des aires protégées et des forêts classées dans un des pays de cette région, la République Centrafricaine (RCA). La RCA abrite 15 aires protégées couvrant environ 10,9% du pays, avec en plus 1,0% établies comme forêts classées. Les forêts classées sont principalement destinées à la production durable des ressources forestiers. Notre analyse montre que seulement 32% des aires protégées et 2 des 47 forêts classées sont gérées convenablement. Le braconnage représente le plus grand danger pour la conservation de la biodiversité, et dans aucune de ces aires protégées il y a un renforcement suffisant des lois pour le contrôle du braconnage.

Nous avons observé et analysé comment les activités humaines affectent les grands mammifères dans une aire protégée relativement bien gérée du RCA, le complexe des aires protégées de Dzanga-Shanga. Le Complexe Dzanga-Shanga consiste en deux secteurs distincts : le Parc National de Dzanga-Ndoki, et la Réserve Spéciale de Forêt Dense de Dzanga-Shanga qui fonctionne comme une zone tampon du Parc National. Le suivi mensuel des grands mammifères et des traces d'activités humaines de Janvier 1997 à Août 1999 confirme que le braconnage reste un problème dans cette aire protégée. Les éléphants et les singes étaient significativement moins communs dans ces régions régulièrement utilisées par les humains, telles que les zones proches des grandes routes. Notre étude montrait également des preuves que les braconniers utilisaient des routes secondaires (exploitation forestière) pour pénétrer dans le Parc National. Le manque de financement durable représente la principale raison de l'insuffisance du renforcement des lois dans ce Parc, et autre part en RCA.

Le tourisme, spécialement les visites des grands singes, a été promu comme une option viable pour générer des revenus conséquents pour les aires protégées. Nous avons testé cette hypothèse à Dzanga-Shanga, une région à une des plus grande potentialité ecotouristique dans la Région Forestière Guinneo-Congolaise. Nous avons mené des études sur les primates diurnes dans le secteur Dzanga du Parc, dans le but d'estimer les densités des gorilles et des chimpanzés. Basée sur la méthode du transect en ligne, nous avons estimé une densité de 1,6 gorilles sevrés/km^2. Cette estimation a confirmé l'importance de la conservation des gorilles de basse plaine (*Gorilla gorilla gorilla*) de la région occidentale, et elle a également souligné la potentialité de développer un tourisme d'aventure et de découverte sur les gorilles.

L'habituation des gorilles, qui était une partie de cette étude, a été initiée dans le secteur Dzanga du Parc National au mois d'Août 1996 et continue encore. Des données sur le processus de l'habituation du mois d'Août 1996 au mois de Décembre 1999 sont présentées ici. A partir du mois d'Août 1998, nous avons pu nous concentrer sur le processus d'habituation d'un groupe spécifique de gorilles, le Munye. Pendant cette partie de étude, notre but a été d'analyser l'impact du processus de l'habituation des gorilles à travers des changements de comportement de ces gorilles. Au cours du processus d'habituation, il était devenu plus facile de localiser les gorilles et de rester avec eux. Habitués aux contacts, les gorilles du groupe Munye ignoraient de plus en plus les observateurs, alors qu'ils montraient des réactions d'agressivité, de peur; et de vocalisation, qui étaient plus communes au début du processus d'habituation. La façon dont les contacts avec le groupe Munye ont pris fin, devenait également plus atténuée avec le temps. Néanmoins, l'habituation a dû avoir initialement des impacts négatifs sur les gorilles. Des données sur leurs déplacements indiquent que la moyenne de chemin parcouru quotidiennement diminuait avec le temps, indiquant que le groupe se déplaçait (évitant les observateurs) plus loin avant le début des études. Avec nos résultats, nous avons conclu que les gorilles enduraient des impacts négatifs pendant le processus d'habituation, mais ces impacts négatifs diminuaient avec le temps. Bien que l'habituation des gorilles ait rendu possible aux touristes de les voir, cela a requis un investissement substantiel en temps et financièrement, et cela n'a pas été sans risque.

Notre expérience avec le groupe Munye nous a également donné de nombreuses recommandations pour le processus d'habituation. Des contacts journaliers et réguliers semblent être un important facteur pour promouvoir l'habituation. De même, contactant les gorilles quand ils sont dans les arbres ou dans les forêts denses semble fournir de bons résultats. D'un autre côté, des contacts de moins de 10 mètres et des contacts sans prévenir les gorilles (effectués dans notre étude en claquant la langue) doivent être évités.

Nos analyses sur l'impact financier du tourisme à Dzanga-Shanga sur la gestion de l'Aire Protégée et sur l'économie locale démontrent qu'avant l'option "visite des gorilles", le tourisme n'a pas pu devenir financièrement autonome. Le tourisme, avec ou sans visites des gorilles, a peu de chance de fournir des revenus suffisants pour couvrir les coûts de fonctionnement du Parc et de la Réserve. Par contre, l'impact du tourisme sur l'économie locale est substantiel et facilite les relations entre le projet de conservation et les communautés locales. Même si ce genre de tourisme peut apporter des gains importants à la région, comme les revenus financiers et emplois, les gestionnaires doivent peser avec précaution les avantages entre le bien-être des gorilles et les risques économiques du tourisme en Afrique Centrale avant de décider d'habituer ces singes.

Étant donné que Dzanga-Shanga fournit une des grandes opportunités pour ce genre de tourisme dans la région forestière de Guinneo-Congolaise, et que même le succès économique est hautement discutable, c'est peu probable que l'écotourisme ne sera une option réaliste que dans un nombre restreint de sites exceptionnelles dans cette partie du monde. Le cas étudié montre clairement malgré une grande potentialité de générer des revenues substantielles pour les aires protégées dans la région forestière de Guinée Congolaise, que ces frais seront loin d'être suffisants pour gérer le système d'aire protégée proposé.

Alors, si la communauté internationale de bailleurs de fonds est soucieux avec la conservation de la biodiversité, ils ont besoin de changer leur stratégie de financement.

Plutôt que d'investir dans des alternatives économiques aventureuses et à risques tels que l'écotourisme, les bailleurs de fonds doivent investir dans l'établissement du mécanisme, tels que les fonds fudiciaires, pour une source stable et durable de financement des coûts de fonctionnement du système d'aire protégée proposé.

Curriculum vitae

Allard Blom was born on May 8, 1962 in Breda, The Netherlands. He holds a B.Sc. ("Kandidaats Diploma") in Biology of Wageningen University, and a M.Sc. ("Ingenieurs Diploma") in Biology from the same University, with ecology and wildlife management as main subjects. His first experience in Africa was in Gabon, during his MSc. While in Gabon he obtained his first job in 1987 carrying out a nation-wide survey of elephants for Wildlife Conservation International. This program was extended with the help of several donors and permitted him to continue in Equatorial Guinea and Zaire, with a brief period at Cambridge in England to analyze the data. This was followed by a period of work as a consultant in Ivory Coast and Kenya, before taking the job as World Wildlife Fund (WWF) project director in the Ituri forest in Zaire. There he helped establish the Okapi Wildlife Reserve in 1992. After the establishment of the reserve, the project was discontinued and he moved to the Central African Republic in January of 1993 to take over as principal technical advisor of the Dzanga-Sangha project. Between 1995 and 1998 he combined this job with the job of national coordinator (country representative) of WWF in the Central African Republic. During this period he obtained authorization and funding to set up the gorilla habituation program. When this program became fully operational he left his job to concentrate on his Ph.D. research. He left the Central African Republic at the end of 1999 to settle on Long Island close to the State University of New York at Stony Brook, where he is an adjunct professor, while writing up his thesis. He is planning to return to central Africa in the near future.

Printed by: Ponsen & Looijen, Wageningen, The Netherlands
Cover design: Willemien Schouten
Cover photos: Allard Blom
Gorillas, members of the Munye group in tree

This study was financially supported by the World Wildlife Fund, Inc. – USA and the World Wide Fund for Nature – Germany.