

Book review

Serengeti II: dynamics, management, and conservation of an ecosystem.

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Being a Serengeti lover since my early ages, I had great expectations upon this book. Before reading it, I imagined it as a summa of over 30 years of research. Because of this long time span, the visibility of most species, and the high quality of research conducted, Serengeti studies are well placed to help understanding basic ecological processes (e.g. predation, competition) that are still a major challenge for ecologists (MAYR 1996). I was therefore disappointed by the recycling of old data in some of the chapters, by the scarcity of data in others and the consequent low power of many tests.

The 29 chapters are divided in five main sections: after an introduction (two chapters), there is a section on herbivores and their relationship to vegetation (three chapters); eight chapters are devoted to ungulates, and seven to carnivores. The last nine chapters deal with conservation and management.

In the introduction, Sinclair resumes all the basic information (history, climate, geology, flora, fauna, perturbation and dynamics of the system) necessary for a better understanding of later chapters, and suggests priorities for future research. Next, Sinclair and Arcese put the conservation of the Serengeti ecosystem in a broad context, and discuss strategies for conservation and their limitations.

The third chapter by McNaughton and Banyikwa attempts to define plant communities with the use of multivariate techniques (mainly reporting results from earlier studies) and links them with aspects of ecosystem dynamics and animal distribution. The main result is probably the concept of critical habitats for herbivores (particularly the migratory wildebeest). The localisation of such areas, however, is still wanting. Dublin evaluates from a historical perspective the long-term dynamics of tree populations. From these data, the concept of climax in vegetation is seriously threatened: the vegetation shifts from one state to another following destruction of trees by fire and by elephants, without a stable state. Under present conditions, *Acacia* woodlands appear unable to regenerate. Sinclair adds to these conclusions showing that herbivores do not lead to monotonic vegetation changes, but cause "jumps" from a stable state to another.

The distribution and abundance of herbivores in the Serengeti (as detected by flying surveys) are described by Campbell and Borner. Most species had rather stable populations, except rhino, roan antelope and buffalo. The causes of roan antelope decline are unknown. Wildlife declined in areas subjected to poaching, while it increased where patrols were more frequent. Ground surveys were used by Runyoro, Hofer, Chausi and Moehlman for censuses of herbivores in the Ngorongoro crater. Owing to a decrease of wildebeest and an increase of buffalo, the total ungulate biomass has remained stable. The movements of animals in and out of the crater and the effects of the removal of pastoralists from the crater are suggested as the key (but unknown) factors driving the dynamics of the system. Wildlife population

appears fairly stable also in the Masai Mara reserve, whereas in the surrounding farms they are declining (Brotten and Said). Sinclair takes a closer look to the Serengeti and Masai Mara data, supplemented by other information, to test the hypothesis of herbivore population limitation. Several species (topi, impala, Thomson's gazelle and warthog) appear predator-limited, whereas kongoni appears limited by competition with other ungulates. Chapter 10 (Mduma) is devoted to a census of oribi, which is exceptionally abundant in northern Serengeti. Murray describes the nutrient requirements (energy, protein, and minerals) as a determinant of migration for the key Serengeti species, the wildebeest. Fryxell takes a quite different approach, using theoretical models to help understanding the causes of migration and aggregation by ungulates. However, he is unable to draw any firm conclusion because of the lack of data. He states that after over 30 years of research, still no model of demography is available for Serengeti (p. 269). Given the amount of research conducted in the area, the sceptical is left with the question whether such model will ever be available. FitzGibbon and Lazarus concentrate on the ethological side of the predator-prey system, looking at how different antipredator behaviour influences population dynamics through age- and sex-specific mortality of Thomson's gazelles. As in other cases, conclusions remain mainly qualitative, and much further research is needed to quantify them.

Two chapters are dedicated to lions; in the first, Scheel and Packer use long-term data (1966-1991) to show how the availability of migratory prey (particularly wildebeest) influences reproductive rates of lions, that predation patterns are highly variable both spatially and temporally, and that lions rely on buffaloes when and where migratory species are absent. In the second, Hanby, Bygott and Packer describe the ecological and ethological differences between lions living in the Serengeti plains and those living in the Ngorongoro crater. They clearly show how life is much harder in the plains, especially because of fluctuating prey density.

The spotted hyena is the most abundant large carnivore in the Serengeti, and two chapters deal with it. Hofer and East summarise their previous papers on the unusual spatial system of this species, characterized by huge short-term "commuting" trips from a stable territory. They also describe a new census method for hyena and its population dynamics, and suggest that commuting trips, allowing a fuller exploitation of migratory prey, may be the explanation of the ecological success of this species in the Serengeti. Frank, Holekamp and Smale describe the effect of hyena social rank on reproductive success of individual females. Cheetah population dynamic is strongly influenced by predation, especially by lions and hyenas; therefore, Laurenson suggests that more emphasis for the conservation of cheetah should be given to multiple-use areas, where other large carnivores are either absent or live at low densities. The wild dog demographic crash is described by Burrows; the author excludes poaching, genetic bottlenecks and competition as possible causes of extinction, and suggest (as in earlier papers) that handling for research purposes may have reactivated rabies viruses. The rich assemblages of small carnivores would have been completely neglected without the chapter of Waser, Elliott, N. Creel and S. Creel on three species of mongooses. The chapter is focused on the contrasting social structure, population density and dynamics of the three species, and links these aspects to the patterns of food availability and predation risks.

The section on conservation and management attempts to bring together science and politics and, as a result, it is more varied. Chapter 21, by Caro and Durant is a good defence of behavioural and ecological research as a basis for sound conservation, shows convincingly how behaviour patterns and mating systems can influence a species' chances of survival, and calls for more links between behavioural ecology and conservation. [A note: the estimate of *Canis mesomelas* numbers is very crude: it assumes a home range size of 180 ha, with one adult per range (which is not reported for jackals; MOEHLMAN 1989); the author refers to a study conducted on six animals only, followed for very short periods in a different habitat (FULLER et al. 1989); larger studies (e.g. FERGUSON et al. 1983) would lead to very different results]. The powerful genetic methods reveal (chapter 22, by Georgiadis) that the wildebeest population are effectively separated by even thin strips of dense forest, whereas migratory and resident wildebeest are part of the same gene pool.

The ecology and epidemiology of rinderpest virus are described by Dobson with historical data and epidemiological models. Although rinderpest has a major influence in population dynamics and density of wildlife (especially wildebeest and buffalo), the reservoir of the virus is domestic cattle. Continuous vaccination of cattle is therefore suggested as the best way of controlling the disease. Arcese, Hando and Campbell analyse the effectiveness of anti-poaching efforts and the effects of poaching on wildlife. They identify the species most heavily exploited, and suggest ways to improve the effectiveness of anti-poaching patrols. Their suggestion to conduct research to estimate the number of poachers entering the park may be easily criticised by the conservation-enthusiast (and research sceptical): it is surely more effective to deter people from entering (or arresting them if they do) than counting them. These data, among others, are the basis for the next chapter, by Campbell and Hofer, in which an impressive spatial model of man-wildlife conflicts in the park and in the surrounding areas is constructed. The model identifies with unambiguous procedures areas that are subjected to overexploitation, endangered, untouched etc. However the authors admit that some estimates (e.g. offtake of waterbuck by local populations: 94.3% of estimated population size) are "clearly nonsensical". The reader is then left with uncertainty about the reliability of other estimates and therefore of overall conclusions.

Pure management is the focus of next three chapters: the first (Perkin) describes the experience of multiple land use in the Ngorongoro, and suggests ways of planning other areas. As new parks are unlikely to be established, multiple land use may be an interesting conservation option. The second (Northon-Griffiths) shows with a detailed economical analysis of why landowners should (or rather, should not) choose conservation over development. He suggests a very interesting way of solving the problem, in analogy with the "set aside" program of the European Community. The chapter 28 (Mbanjo, Malpas, Maige, Symonds and Thompson) describes from a political point of view the conservation strategy for the area, and is unusual, not citing either a datum or a reference.

The last chapter is the result of a workshop in which most of the authors of other chapters participated. It addresses the crucial issue to which the book is confronted: can science improve management? It is surprising that the whole task of summarising the data of each research group, developing the models, forecasting the scenarios of possible future changes and identifying the directions for future research received so little priority (a four-days meeting). Given these constraints, the scenarios are necessarily "extremely tentative" (p. 631), and the conclusions must be considered "a first look" (p. 636). As explicitly stated, many of the details could have been improved, and many variables should have been included in the model, e.g. cheetahs should decline with the density not only of hyenas (as stated at p. 626), but also of lions (chapter 18).

The lack of summaries for each chapter is very disturbing, as it makes very difficult to recover the necessary information, especially in a book of this size. A number of details are incorrect or inconsistent: the warthog is included among ruminants (p. 7); hyena numbers are estimated at 7,500 (p. 7), 9,000 (p. 19), or 7,200-7,700 (p. 340). I could spot a few misprints (e.g. colinearity instead of collinearity at p. 309; *Circateus* instead of *Circaetus* at p. 442) and many errors in the scientific names in appendix A. In many chapters there is a wealth of citations, also of unpublished reports; however, the same report (BURROWS 1991) is cited in two different ways at pages 417 and 465. The quality and readability of figures may have been improved: the format of figures varies between chapters, and often within a single chapter, and some of them are of poor quality (e.g. p. 77, p. 171); many maps do not bear a scale (e.g. p. 148, p. 171, p. 196, and many others). The log-log plots (e.g. p. 550) give the same information as plots of raw data, which would be much easier to read and interpret.

In conclusion, I believe this book could have been greatly improved by a more thorough editorial work, chapters could be better linked to each other, but most importantly the work outlined in the last chapter would have deserved much more work. On the other hand, the book is an important source of information, and should not be missed by any researcher interested in the ecology and conservation of large African mammals.

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