

MANAGEMENT (FOR BIODIVERSITY) OF FOREST AND OTHER WOODED HABITATS

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Summary

Forest habitats around the world are especially important in terms of both biodiversity richness and complexity of the ecological interactions among the species living inside them. To efficiently manage these crucial habitats, it is necessary to use a multidisciplinary approach in which ecological theory and conservation practice are coupled with silviculture, social politics, and environmental education. In this chapter, after briefly presenting some key concepts of community ecology that lay the groundwork for understanding forest habitat and wildlife management, the problem of forest habitat and biodiversity maintenance is studied. Although an environmentalist would ideally protect *all* the forested areas of the world, it is obviously impossible to protect even a small portion of the earth's forested resource. It is thus necessary to establish protected areas to save the most important portions of the planet's forested regions, and a first important question is therefore how to select appropriate protected areas that match the ideals of current conservation theory. Identification of an ideal system of forest reserves can be done by using species-based approaches or higher classifications approaches (e.g., vegetation communities, land systems, or facets), but a combination of the two is preferred in most cases. But before any management decision, there is an absolute need for detailed knowledge of the ecology of the target forest area.

A case study (rain forests of southeastern Nigeria, West Africa) illustrates how to obtain a good baseline knowledge of a large forest area. When the biodiversity of the study forest is sufficiently well known, it can be reasonably well managed. Sustainable harvesting of forest resources is both biologically feasible and economically viable (with lower operating costs and higher profits than conventional methods). The biological basis for accepting sustainable harvesting is explained. However, the situation is much different between temperate and tropical forests. In fact, tropical forests are fast disappearing, whereas there are wide forested areas in the temperate

regions of northern hemisphere that are growing and that have outpaced forest clearing during the second half of the twentieth century. Forest overgrowth has positive effects on many wildlife species of temperate regions, but some opposite cases are also discussed. Coppicing is the main forest management strategy in wide regions of the "western world." The implications of this sylvicultural practice on wildlife are presented and discussed.

With regard to tropical forests, there are many of them in sub-Saharan Africa, Asia, and South America, where the local human communities are totally dependent on natural resources for their subsistence and where the tropical forests constitute an important gene bank for biodiversity. Local communities must actively participate in the planning and implementation of forestry projects, as their participation may serve to develop a sense of ownership and responsibility through appropriate use and maintenance of the resources. Sustainable development of forest sites should be a multisectoral undertaking, where benefits for the natural environment (via conservation and reforestation) cannot be obtained without *immediate* economic benefits to the people who own a site (via agriculture assistance, environmental education, controlled ecotourism, etc). A concise list of the main points to initiate a well-working sustainable developed management project for tropical forests is presented and discussed. In particular, plantation as a tool to reintegrate biodiversity in very degraded forest areas is discussed, with emphasis on the criteria to be used for a successful biodiversity restoration via plantation. These criteria, although crucial for the implementation of a reliable management policy, are not always applied due to serious economic problems that curtail the efforts of many developing countries that house important tropical forest patches. The future prospects in the field of forest management for biodiversity are also briefly presented and discussed.

1. Before Biodiversity Management: A Short Historical Background

The period 1960–1979 was characterized by an unrivalled attention to the study of the evolution, dynamics, and functional organization (in both space and time) of the *communities* of plants and animals. Indeed, before that age, most ecological investigations were aimed at the production of autoecological research on given single species or qualitative checklists of the species present in given territories.

These two decades were, however, dominated by the views of a group of eminent (mainly American) ecologists that positioned the community at the forefront of attention, and as a consequence, the study of the mechanisms facing coexistence—including inter- and intra-specific competition, resource utilization, and niche partitioning—took center stage of ecological science. Heroes of this revolutionary (but not entirely new, see the pioneering studies of Italian scientist Vito Volterra in the early 1900s) view were, among others, G.E. Hutchinson and R.H. MacArthur.

Hutchinson and MacArthur, as well as their followers, were fully immersed in an age where equilibrium hypotheses were so prevalent that the theoretical developments that characterized this scientific revolution caused a clear underestimation of the role of physical factors and of spatial and temporal variability in the dynamics of natural communities.

Conversely, by the early 1980s, a new impetus arose in community ecology, and the so-called *mechanistic approach* has come to the forefront. This new approach, based on data sets from fields of study as diverse as physiological ecology, behavioral ecology, ecological morphology, etc, has tried to interpret the community patterns as outlets of *individual* patterns, in which any organism is viewed in relation to the constraints that limit its performance. To be short, any organism living in a given environment is subjected to *external constraints* deriving from the environment (e.g., limiting factors, ecological constraints) and *intrinsic constraints* (e.g., physiological, morphological, or phyletic constraints). All of these constraints can be properly understood only after studying a given individual, not only in relation to its interactions with coexisting organisms (prey, predators, potential competitors, etc.), but also in autoecological terms. Thus, the studies of *population ecology* have begun to be the very starting point for the development of an integrated view of community ecology mechanisms, and knowledge of population dynamics has assumed a central position for the entire theory. In practice, what is now becoming clear—after approximately four decades of careful research—is that the ultimate structure, functioning, and complexity of ecological communities can be understood only after careful merging of guild studies with population biology studies. This integrated approach will in fact permit the avoidance of typical errors found in traditional guild studies—the tendency to overlook the roles of (a) physical factors, (b) predators, (c) prey abundance, and (d) other biotic factors—and also the major implicit assumption (that could be indeed false in many cases) of considering a given studied community *in a state of equilibrium* (i.e., quite immutable in space and in time).

This very short (and decidedly incomplete) introductory historical note may appear only slightly related to the topic in question (biodiversity management), but really it is! Indeed, to manage a biodiversity resource of a given place, we *need* to ultimately know that resource, in terms of both complexity and evolutionary dynamics. Therefore, it is necessary to be able to catalog diversity (systematic work), but also to understand the hierarchically related levels of its biological organization (genes, species, and ecosystems), the interactions between organisms, the population dynamics of the various organisms, and the predictable effects that any environmental change may have on the whole diversity. Thus, integrated knowledge of topics as different as community ecology, population ecology, population dispersal, demography, population genetics, gene flow, species turnover, species packing, and minimum viable populations, is an essential tool to understand biological evolution and the maintenance of biodiversity, together of course with more practical knowledge of landscape ecology, habitat disturbance, environmental planning, habitat loss and fragmentation on biodiversity, management of crucial habitat components in the biomass, environmental legislation, etc.

Thus, the study of biodiversity and its conservation is nowadays a complex issue, where descriptive primary research has become as important as predictive research and mathematical modeling, and, as a consequence, the exigence of authoritative international outlets for publication of biodiversity research has strongly emerged. Indeed, the international scientific community has now a very respected vehicle for publication of latest biodiversity research: the monthly journal *Biodiversity and Conservation*.

2. Forest Habitats and Biodiversity

Forests represent crucial components of the terrestrial habitats in every continent, and indeed they house unrivaled biodiversity richness in many cases. For instance, there is a full agreement among scientists that Earth's biologically richest and most endangered terrestrial ecoregions are forested areas (e.g., the rain forests of Venezuela, Ecuador, Brazil, Congo, etc.), and these areas are also crucial hot spots for biodiversity. Thus, it is obvious that careful management of the planet's major forests is a true environmental priority, especially in an actual situation where the progressive destruction of the rain forest causes the extinction of many plant and animal species *before* they are known to science!

Ideally, an environmentalist would protect *all* the forested areas of the world, because many of these areas are important in terms of biological diversity. Nevertheless, in this technologically overdeveloped world it is nearly impossible to protect even a small portion of the planet's forested resource. Thus, the establishment of protected areas to save the most important portions of Earth's forested regions has become an urgent priority for some decades. Indeed, this is still the only way to effectively protect forest biodiversity in the developed western countries as well in the developing countries where industry has grown rapidly.

A first important problem with forest habitat conservation is therefore how to select appropriate protected areas that might match the ideals of current conservation theory. This point is certainly not exclusive of forest habitat management, but is valid for every other type of threatened habitat in the world. Nevertheless, it is obvious that it assumes particular relevance for Earth's wooded habitats that are currently subjected to terrible alteration due to human activity.

Identification of an ideal system of forest reserves is achievable with species-based approaches or higher classifications approaches (i.e., vegetation communities, land systems, or facets). Nevertheless, a combination of the two approaches is preferable in most cases, especially in geographical regions where the basic knowledge of the distribution of the species (mainly vertebrates) is lacking or scarce. This is indeed a common occurrence for vast forested regions in the tropical or equatorial countries, where extraordinary species richness is usually accomplished with inadequate scientific surveys.

Ideally, when one is trying to develop an environmental conservation strategy for a poorly known forested region, it is absolutely necessary to be able (a) to collect as much information as possible on the presence/absence of selected species of conservation priority, (b) to check for congruency among multitaxa hot spots, (c) to evaluate the *potential* distribution of the various species in relation to the main forest habitats, (d) to assess the reasons for eventual decline patterns of the target species, and (e) to establish the crucial territories to be protected. In areas subjected to fast-developing human alteration, urgency in the final decisions can be vital for a well-working strategy for biodiversity conservation. The fact is that case studies are rare, and it is hard to conclude that there is a single "panacea" for the conservation of the threatened wooded zones of the world. Moreover, long-term ecological research in single important forest areas is so

rare that intersite comparisons are often difficult. For instance, Kibale Forest in Uganda has been intensely studied in many respects by many scientists during the last decades (1960 to date, e.g., see many articles by different authors in the *African Journal of Ecology* and in other scientific periodicals), but the results of these long-term research endeavors are often rarely applied to other Afro-tropical forests with different landscape characteristics and human exploitations. Therefore, scientists should be urged to avoid generalizations and should instead develop appropriate strategies that might work well in the single-study cases. In the next section, one such case that may be interesting for several aspects, is presented.

3. The Rain Forests of Southern Nigeria: A Case Study

The rain forest block of southern Nigeria (West Africa), concentrated mainly in the regions of Niger Delta and of Cross River State (near the political border with Cameroon), is an important center of endemism for many faunal and floral groups (Figure 1). Only during the recent years, and just to limit our attention to the order Primates, two endemic monkey taxa (*Cercopithecus sclateri* and *Procolobus badius epieni*) have been discovered, in addition to the other important endemic drill *Mandrillus leucophaeus*, and possibly a new subspecies of gorilla and the chimpanzee.



Figure 1. Map of the Federal Republic of Nigeria, showing the main forested blocks (including both mangrove forests and tropical dry- and swamp-forests)

Note that the total forested territory is situated only in the southern part of the country.

Unfortunately, this important region is currently threatened by the highly developed oil and natural gas industry installations. Indeed, Nigeria is the top-ranked oil and gas producer of sub-Saharan Africa and the sixth of the world, and much of this highly developed industry is concentrated in the extreme south of the country (Figure 2), where there is contextually one of the main rain forest blocks of West Africa, the largest mangrove forest block of the whole continent, and an unique type of coastal forest called "island-barrier forest." Oil-related industry installations are often situated inside rain forest and mangrove patches, and pipes and access roads contribute further to natural habitat destruction. Moreover, there are still strong risks that industrial effluents can contaminate wastewater because of the habit of some people (especially in western Niger Delta) to broach oil transmission pipes and sell oil and fuel on the black market. Indeed, these broaching operations have already caused some dramatic accidents and the death of hundreds people in the years 1998–2000.



Figure 2. Map of the Federal Republic of Nigeria, showing the main industry centers for oil and natural gas production and transmission

Note that these highly developed industries concentrate in the areas of mangroves and tropical forests, which are important biodiversity hot spots.

In addition to industry pressure, there are other factors that have had a devastating effect on forests and wildlife. In fact, Nigeria is the African country with the highest population density (124.5 people/km², 107 129 469 people at 1997 census, and 40% of the people living in urban centers), and human population grows at a ratio of three percent each year, with an average fertility ratio of 6.45 children per mother (second highest in the world, after Somalia).

Indeed, approximately 90% of the Nigerian rain forest has been totally destroyed since

1960. Moreover, the catastrophic effects of industry and human demographic development on the forests have been dramatically enlarged by the political situation that the country has experienced in the 1990s. In fact, the Ogoni people have strongly fought against the military government headed by the late General Sani Abacha. Abacha was accused of "selling" the people's richness—specifically, oil—to the international oil companies, resulting in much pollution and deterioration of living conditions for the local tribes that own sites where oil was extracted. Thus, this internal political instability has caused hard repression of the contestants, and even the killing of many people who have opposed Abacha's power. Among them, prominent people were also persecuted, including awarded poet Ken Saro Wiwa (killed in 1993 at a Port Harcourt prison), and literature Nobel Prize winner Wole Soyinka, who was constrained to escape from Nigeria to avoid a similar fate.

No doubt, the forested areas of Nigeria are a crucial hot spot for conservation, both in biological terms (due to its status of endemism center) and in political terms (as a vital model for bringing industrial development, improving living conditions for the people, and instituting effective conservation planning). Thus, it could serve as a good development model for the environment in the future.

The first major problem in assessing a strategy to preserve and manage the biodiversity in the forested regions of southern Nigeria was that the knowledge of the distribution, ecology, and taxonomy of most animal and plant groups was at an alpha-level until very recent years. Thus, a series of long-term investigations on these topics had built up by the early 1990s, and much progress has been done in many respects. In particular, mammals, reptiles, and birds have been subjected to very detailed studies, and now the available data on the biodiversity richness of that region is incomparably better than before. For instance, three species of terrestrial and freshwater chelonians were known for Niger Delta area until 1992, but since then the number of known taxa has grown to seven. In the same area, 13 species of bats (seven Megachiroptera, six Microchiroptera) are known to be present, but 10 of them (76.9%) were recorded for the first time after 1996! Examples of the novel and much more refined definition of the various species' distribution ranges are presented in Figure 3. It should be noted that the local distribution of the target wildlife species in Figure 3 is presented into a grid of 10×10 km. Grids of this sort are operationally excellent in applied research where it is desirable to integrate forest management, wildlife conservation, and environmental assessment in relation to industry. Moreover, the use of this type of grid permits immediate understanding of the trends of the populations of given wildlife targets when distribution studies are repeated after controlled time (e.g., after 10 years, etc.). It should thus be suggested that any mapping of target species in forest landscapes should be done according to a procedure that is (a) easily understandable by competent authorities, and (b) easily comparable with further studies in the same geographic area.

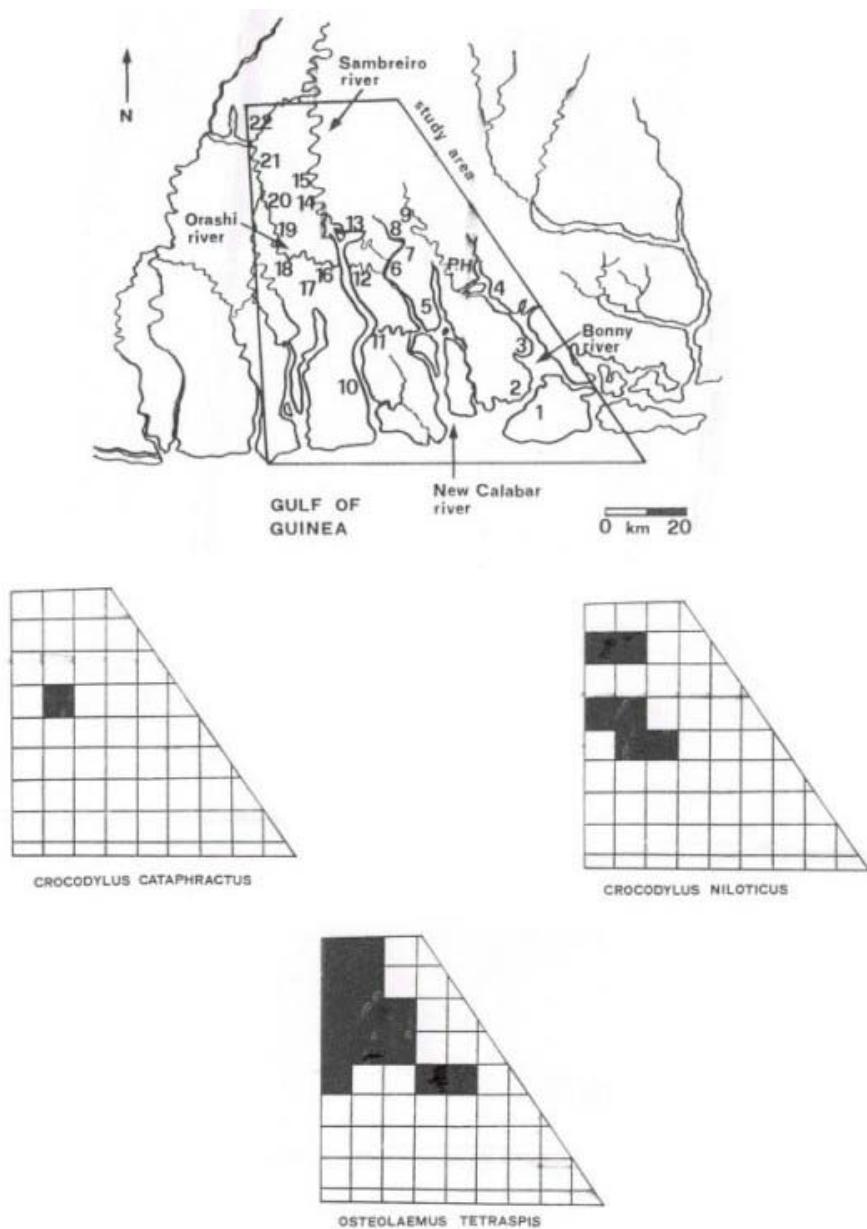


Figure 3. The distribution map (in 10×10 km grids) of three species of crocodiles in the eastern Niger Delta region

Accurate distribution mapping for target species is a priority in any forest management project, especially in regions that are scientifically little known in these respects. It should be noted that, before the beginning of the global conservation program described in the text, nothing was known about the presence/absence or the distribution of these species.

For many vertebrate species, in particular chelonians and snakes, a predictive statistical model to assess the ecological correlates of the single species' distributions has been elaborated, mainly during environmental impact assessment projects conducted by oil companies operating in the region. This model is based on the recording of the environmental and vegetational parameters (e.g., presence/absence and/or relative

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Biographical Sketch

Dr. Luca Luiselli obtained the degree of Doctor in Natural Sciences at the University of Rome "La Sapienza" with a thesis on the comparative eco-ethology of some populations of Italian vipers. Since 1996 he has been a research associate with several industry organizations of the Ente Nazionale Idrocarburi group in Nigeria, as well as with conservation organizations in both Africa and Italy, including several national parks. He has been working for the environmental departments of several oil companies, conservation organizations (e.g., Cercopan), and in cooperation with scientists based at the Rivers State University in Nigeria. He is also a researcher associated with the National Park of Gran Sasso-Laga, the National Park of Majella, the Abruzzi National Park, and the Duchessa Mountains Natural Park. He is chairman for Nigeria of the International Union for Conservation of Nature–Species Survival Commission (IUCN/SSC) for DAPTF, a member of the IUCN/SSC TFTSG, and has won seven international scientific research prizes (four by Chelonian Research Foundation, two by Conservation International and one by IUCN/SSC Declining Amphibian Populations Task Force (DAPTF)). He is also coeditor of *Amphibia-Reptilia*, associate editor of *Endangered Species Research*, and serves on the advisory editorial board of *Herpetozoa*, *African Journal of Herpetology*, *Chelonian Conservation and*

Biology, Applied Herpetology. In the last 15 years, he has published over 150 papers in peer-reviewed journals, including high impact periodicals (e.g., Nature, Oikos, Oecologia, etc). His main research interests are on the ecology of snakes in tropical and temperate regions, and on the modeling of forest reptile communities in areas under strong environmental stress.