CHAPTER 3

Biodiversity in Central African forests: an overview of knowledge, main challenges and conservation measures

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Introduction

As in previous State of the Forest (SOF) reports, the term biodiversity is defined here as "the variability among living organisms in the terrestrial and aquatic ecosystems of the Central African forests". This definition includes diversity within species, between species and of ecosystems (according to Hooper *et al.*, 2005).

Such a broad definition of biodiversity necessitates great modesty on the part of anyone interested in acquiring knowledge of biodiversity and its sustainable management, including planners and researchers. Actually, there continues to be a significant shortage of scientific data on species and highly complex ecological systems.

This chapter is divided into two parts:

- The first part summarizes what is known about the main groups and families of fauna. It supplements information contained in previous State of the Forest reports (SOF 2006 and 2008). These reports placed particular emphasis on improving expertise in monitoring emblematic biodiversity as well as its conservation: this concerns a small number of animal species, mainly large mammals. Conservation leaders focus on these emblematic species as they are particularly vulnerable. They are in effect the only species to be systematically hunted to the point that they are threatened by extinction. We will refer to previous editions of the report to familiarize ourselves with the situation of elephants, primates and small monkeys, as well as large antelopes and duikers, especially those in the protected areas (PAs) and forest concessions. Here, they will only be addressed in terms of general numeric data.
- Work on biodiversity conservation in Central Africa has focused on PAs and, more recently, forest concessions and community forests. Together these represent about 40 % of the forested area in the Congo Basin. There are no specific biodiversity conservation measures, apart from "ordinary" law, for other areas that have no particular status, calling attention to the remaining 60 % of land where biodiversity is under the greatest threat:
  - These are the areas that are the least documented;
  - These areas are at the highest risk for deforestation;
  - These areas may have high economic potential for agricultural expansion or increasing urban sprawl, which may bring important social changes (e.g., urbanization);
  - These areas lack adapted planning tools.

Protected areas are the principal land use units dedicated to biodiversity conservation in the Congo Basin. This chapter does not present a complete overview of PAs in Central Africa, but it does provide recent information on their development, in particular as regards to transboundary protection. In addition, this chapter reviews the main principles associated with biodiversity conservation in forest concessions.

Photo 3.1: Area of swamp in Gabon

Understanding biodiversity in order to improve management

A partial assessment of biodiversity in Central Africa

Scientists are a long way from finalizing an exhaustive list of the species present in Central Africa's forest ecosystems. Additions are constantly being made to lists of species, genera and families. The OFAC website works to assemble the most up-to-date knowledge on species, which even at its best only addresses one of three components of biodiversity (diversity between species).

Quite a lot is known about large and medium-sized mammal species, even if the sun-tailed monkey (*Cercopithecus solatus)* was only described in 1984 and the false potto (*Pseudopotto martini),* which has been identified from a skeleton and skull found in Cameroon, still needs to be officially confirmed. For a long time the Salongo monkey (*Cercopithecus dryas)* was known through two samples; however, a recent study (Lokasola, 2008) of four groups of 15-31 individuals has provided more information on their diets and social and territorial behaviors. For small species, especially small rodents, shrews and bats, the state of knowledge is very different:

- Several species are only known from a single sample or a few samples collected in the same location;
- The aspects that differentiate some species are still badly defined and it is difficult to decide whether some forms should be considered as separate species or as sub-species;
- The specific affiliation of some populations is still a problem;
- The environment and behavior of these species are largely unknown.

Given this state of understanding, it remains very likely that additional species remain to be discovered. Furthermore, apart from a few dozen species, which have been widely studied and are generally very symbolic, the geographic distribution of the species described is still largely unknown.

Another important characteristic of biodiversity knowledge in Central Africa is that existing data depends to a large extent on the effort that has been spent on data collection. This means that the best known collection of bats (*Soricidae* and *Chiroptera*) is in Gabon as opposed to the Republic of Congo. This is likely due to the fact that more in-depth data collection has been carried out in Gabon.

It should also be highlighted that scientific understanding rarely captures the knowledge of local populations. A species that is labeled "new to science" can very well be known, named and even collected for different purposes, by local populations living in the forest. A complete inventory of local knowledge does not exist.

In order to try and assure accuracy by linking information presented with reliable sources of data, it was proposed that the State of the Forest reports should record and report on specific sites where faunal inventories have been implemented in the main areas of the sub-region. This approach permits an overview of areas where properly measured data exists, including the date and methodology implemented, as opposed to areas where data modeling has been employed using variable mathematical methods.

The African Mammals Databank (L. Boitani Institute of Applied Ecology, University of Rome, Italy, IUCN) gives an example of modeling which provides possible species distribution areas using recognized census points. Based on what is known about the biological needs (habitats) of the animals, this is extrapolated for the entire region, using a probabilistic model (http://www.gisbau.uniroma1.it/amd/). An example of the red river hog (*Potamochoerus porcus*) distribution area is presented at figure 3.1. It should be noted that this method has a certain number of limitations which are currently being addressed. In addition, IUCN intends to make another database available, this time at a global scale; however, this has yet to happen.

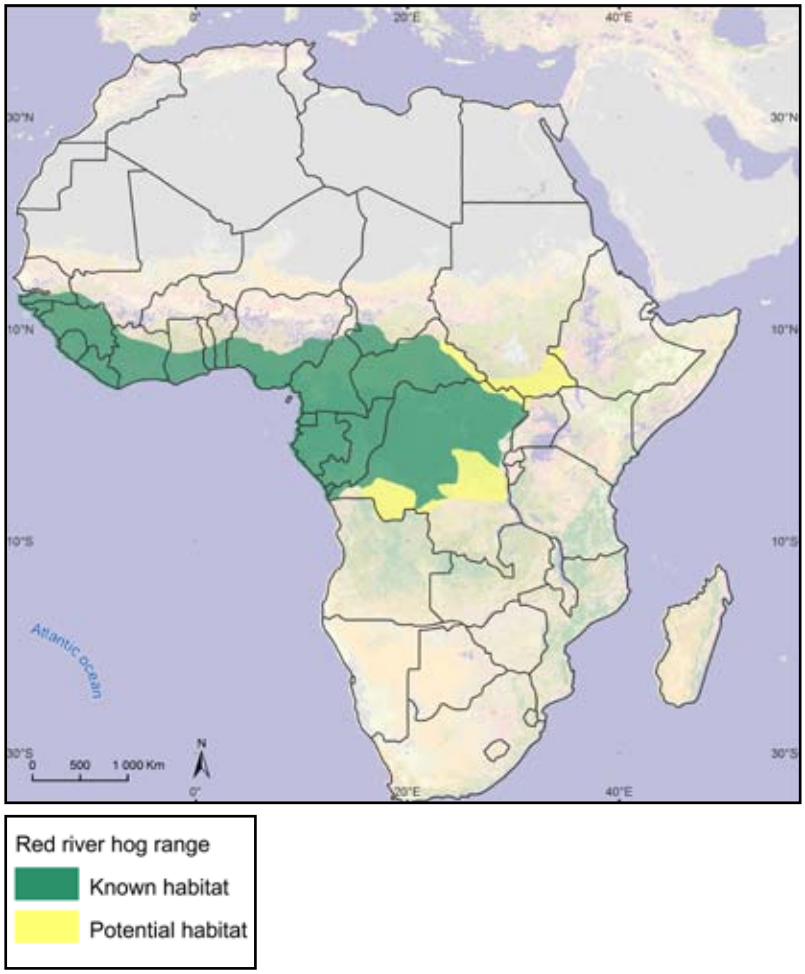

Figure 3.1: Example of cartographic modeling of recorded red river hog distribution and area of potential habitat
Source : African Mammals Databank

Current state of knowledge: from species lists to geographic distribution maps

A basic definition of biodiversity focuses on establishing lists of species, which simply identify the presence or absence of a species, normally from a national perspective. Obtaining information on a scale that is more precise than the national one requires lengthy research into site surveys and spatial extrapolation for areas where there are no inventories. In some cases, being listed is the result of a single sighting or specimen. Lists do not therefore necessarily provide an indication of species rarity.

Based on these lists, numbers of species and genera can be calculated and classified by country, giving an indication of the country's wealth in biodiversity. Numbers and geographical distribution of some of the largest animal species are presented below. Vande weghe prepared most of the data compilations on biodiversity. These are available on-line on the OFAC/COMIFAC website with a series of tables and distribution maps (http://observatoire-comifac.net/, under the heading "Biodiversity").

Photo 3.2: An orange-headed lizard of the genus Agama, very common in urban areas of Central Africa

Photo 3.3: Nile monitor (Varanus niloticus)

Reptiles

Approximately 460 reptile species have been recorded in the region. These are divided into three orders (chelonians, crocodilians and squamates). Chelonians (turtles) belong to 5 families, none of which are unique to Africa. The three types of crocodilians in the region all belong to the *Crocodylidae* family, which is also widespread outside Africa. The region's squamates belong to 17 families, of which only one - the *Cordylidae* - is unique to Africa.

The largest number of species in Central Africa has been recorded in the Democratic Republic of Congo (DRC). Of the 302 species that have been confirmed in DRC, 27 are endemic. This abundance is explained by the very large size of the country and the variety of its habitats. Proportionately, Cameroon, which is five times smaller than DRC, has the highest abundance and specific endemics, with 249 confirmed species, no less than 22 of which are endemic. This abundance can be explained by the wide variety of habitats, ranging from high mountain ranges (over 3,000 meters in altitude) to the sea and from the Sahel desert to dense moist forests.

Birds

For many bird families, DRC has the largest number of species. This is due to the size of the country and the fact that it extends across the Zambezi zone and the Sudanese savanna area (table 3.1). For some families, other countries, such as Chad, Cameroon or the CAR, with areas ranging from dense forests to arid or semi-arid habitats, are more diversified.

A study of species distribution per country, excluding occasional species, shows that numbers are practically proportional to the logarithm of the area (figure 3.2).

Mammals

There are 552 species of mammals in the 10 Central African countries. In descending order, the six biggest orders by number of species are:

- ***Rodentia*** (rodents)
- ***Chiroptera*** (bats)
- ***Soricomorpha*** (shrews)
- **Primates** (monkeys, galagos, pottos), consisting of 56 diurnal and nocturnal species:
  - 3 *Lorisidae*
  - 12 *Galagidae*
  - 37 *Cercopithecidae*
  - 4 non human *Hominidae*
- ***Cetartiodactyla*** (hippopotamuses, whales, dolphins, *suidae*, giraffes, *bovidae*). There are 48 known species in the 10 Central African countries:
  - 2 *Giraffidae*
  - 1 *Hippopotamidae*
  - 1 *Tragulidae*
  - 4 *Suidae*
  - 40 *Bovidae*
- ***Carnivora*** (cats, panthers, mongooses, jackals…). There are 41 known species of terrestrial carnivores in Central Africa:
  - 7 *Felidae*
  - 10 *Viverridae*
  - 1 *Nandiniidae*
  - 12 *Herpestidae*
  - 1 *Hyaenidae*
  - 4 *Canidae*
  - 6 *Mustelidae*

Table 3.1: Number of bird species in relation to the size of the country

Country	Size (x 1,000 km²)	Number of species (excluding occasional or unconfirmed species)
São Tomé and Príncipe (STP)	0.9	80
Chad	1,284	409
Cameroon (Cam)	475	725
CAR	623	690
Equatorial Guinea (Eq-G)	28	535
Gabon (Gab)	268	600
Congo	342	586
DRC	2,345	1,017
Rwanda (Rw)	26	614
Burundi (Bu)	28	606

Source: OFAC/COMIFAC

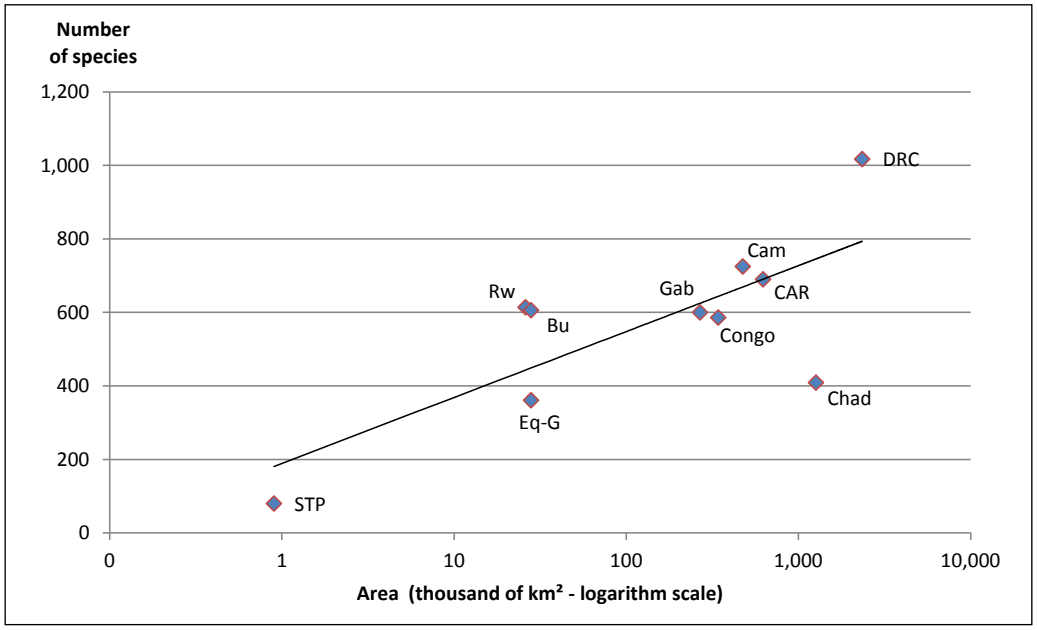

Figure 3.2: Relationship between the number of bird species and the logarithm of the size of the country.
Source: OFAC/COMIFAC

The great apes are the objects of special attention as they are extremely vulnerable and emblematic. As a result, the APES program (see box 3.1) and the Great Apes Survival Partnership (GRASP) (http://www.unep.org/grasp/index.asp), under the auspices of UNEP and UNESCO, research groups, NGOs and government authorities, were established to monitor and protect the great apes in their natural habitat. Apart from the orangutan and some sub-species of chimpanzees, the vast majority of great apes live in Central Africa.

Photo3.4: Blue-breasted bee-eater (Merops variegatus) watching for prey

Photo 3.5: African Jacana (Actophilornis africana) in flight

Photo 3.6: Male sitatunga (Tragelaphus spekei)

Detailed information on gorillas and chimpanzees is provided below.

Kingdom: *Animalia*
- **Phylum:** *Chordata*
  - **Class:** *Mammalia*
    - **Order:** Primates
      - **Family:** *Hominidae* (great apes and humans)
        - **Genus:** *Gorilla*
          - **Species:** *Gorilla beringei* (eastern gorilla)
            - **Sub-species:** *G. beringei graueri* (eastern lawland gorilla)
            - **Sub-species:** *G. beringei beringei* (mountain gorilla)
            - **Sub-species:** *G. beringei* spp. (Bwindi gorilla)
          - **Species:** *Gorilla gorilla* (western gorilla)
            - **Sub-species:** *G. gorilla gorilla* (western lowland gorilla)
            - **Sub-species:** *G. gorilla diehli* (Cross River gorilla)
        - **Genus:** *Homo* (Humans)
          - **Species:** *Homo sapiens*
        - **Genus:** *Pan*
          - **Species:** *Pan paniscus* (bonobo)
          - **Species:** *Pan troglodytes* (chimpanzee)
            - **Sub-species:** *P.t. verus* (western chimpanzee)
            - **Sub-species:** *P.t. velerosus* (Nigerian chimpanzee)
            - **Sub-species:** *P.t. troglodytes* (central chimpanzee)
            - **Sub-species:** *P.t. schweinfurthii* (eastern chimpanzee)
        - **Genus:** *Pongo*
          - **Species:** *Pongo pygmaeus* (Bornean Orangutan)
          - **Species:** *Pongo abelii* (Sumatran orangutan)

Figure 3.3: The classification of great apes

Source: GRASP, according to the University of Michigan, Museum of Zoology.

Gorillas

The eastern gorilla (*Gorilla beringei)* is composed of two sub-species:

a) The eastern lowland gorilla (*G. beringei graueri*) is only found in eastern DRC between the Lualaba River and the Burundi-Rwanda-Uganda border. Its distribution covers an area of about 90,000 km², within which the gorillas occupy an estimated total area of 15,000 km² covering four main areas: (i) Kahuzi-Biega National Park and the neighboring Kasese region; (ii) Maïko National Park and the adjacent forest; (iii) Itombwe Forest; and (iv) North Kivu. It is estimated that their population size amounts to between 3,000 and 5,000 individuals.

b) Mountain gorillas (*G. beringei beringei)* are only known to exist in two populations covering three countries: DRC, Rwanda and Uganda. One population which is estimated at about 380 individuals lives in the Virunga massif. The other population, estimated at 320 individuals, is to be found mainly in Bwindi National Park in the south-west of Uganda on the border with DRC. The mountain gorilla occupies about 375 km² in the Virunga massif and 215 km² in Bwindi National Park. These two areas are separated by a 25 km agricultural zone.

The western gorilla (*Gorilla gorilla*) is also composed of two sub-species:

a) The western lowland gorilla (*G. gorilla gorilla)* is the largest gorilla population with an estimated total of 94,000 individuals. From north to south, this sub-species can be found in the south and south-east of Cameroon, in the extreme south of the CAR, in continental Equatorial Guinea, in western Congo and in the landlocked area of Cabinda in Angola.

b) The Cross River gorilla *(G. gorilla diehli)*, in Nigeria and Cameroon, constitutes the most northern and western gorilla populations. Their total population is estimated at 200-250 individuals. In Nigeria, they can be found in the Mbe Mountains, in the sanctuary for the fauna of Afi Mountain, in the Okwangwo section of Cross River National Park and in the neighboring Takamanda Forest Reserve, as well as in the Mone Forest Reserve. In Cameroon, they live in the south-western Mbulu forest.

Chimpanzees

Chimpanzees consist of two main species, the bonobo and the chimpanzee, which itself consists of four sub-species.

The bonobo *(Pan paniscus)*

The bonobo only lives in the DRC. Most publications refer to a population of about 15,000 individuals. In 2001, Butynski increased this figure to 30,000 - 50,000 individuals but recent analytical inventories consider this estimation to be too high (Grossmann *et al.*, 2008).

The chimpanzee *(Pan troglodytes)*

The chimpanzee has a very wide-ranging but discontinuous distribution in Equatorial Africa, in 21 countries from Senegal to Tanzania. Estimations of total populations range from 172,000 to 301,000 individuals.

a) The eastern chimpanzee *(P.t. schweinfurthii)*

is found in a region that extends from eastern CAR, and the south-west of Sudan, to the Nyungwe and Gishwati forests in Rwanda and the extreme west of Tanzania. The estimated population is between 76,000 and 120,000 individuals.

b) The chimpanzee *(P.t troglodytes)*

The distribution area for this sub-species covers about 695,000 km^2. They can mostly be found in southern Cameroon to the west of the Sanaga River, in western CAR and in Equatorial Guinea. They are spread throughout Gabon and in northern Congo. Their most southern location is in the land-locked area of Cabinda and in the extreme west of the DRC. Population figures are estimated to be between 70,000 and 117,000 individuals.

c) The Nigerian chimpanzee *(P.t. velerosus)* This chimpanzee can only be found in southern Nigeria and along the border with Cameroon. Populations are fragmented and estimated to amount to between 5,000 and 8,000 individuals.

d) The western chimpanzee *(P.t. verus)* is found from the south-east of Senegal to the south-west of Mali to Guinea, Sierra Leone, Liberia, most of Côte d'Ivoire to western Ghana. Much uncertainty exists about the number of individuals, which is thought to be between 21,000 and 56,000.

Photo 3.7: Western lowland gorilla (Gorilla gorilla)

Box 3.1: Africa-wide great ape population surveillance

Hjalmar Kühl, Jessica Junker, Yasmin Möbius, Christophe Boesch

Max Planck Institute for Evolutionary Anthropology

African great ape populations are declining throughout their range due to poaching, disease and habitat loss. Well substantiated information on their status, threats to their survival, and conservation opportunities is scarce but urgently needed in order to develop sound conservation strategies. Only recently have attempts been made to collect data over entire landscapes (http://carpe.umd.edu/) or to synthesize and analyze existing site-level data to provide a more coherent picture across the geographic range of the different ape species. However, the latter approach is hampered by a lack of standardization in the data collection methodology and sampling intensity which leads to varying data quality.

The Department of Primatology at the Max Planck Institute for Evolutionary Anthropology (www.eva.mpg.de/primat/) and the Wild Chimpanzee Foundation (www.wildchimps.org) have therefore initiated a program which aims to provide standardized high quality data for evidence-based conservation of great ape populations. The information gained will allow identifying high priority populations, quantifying rates of population decline as well as global and site specific threats and opportunities, and evaluating the impact of extractive techniques on great ape populations.

Within five years, this program plans to obtain range-wide estimates of abundance and distribution of great ape populations and associated threats in order to assess their status and trends. Data are collected across the entire geographic range of African great apes, focusing on areas for which no recent and quantitative information is available: both within and outside of protected areas (figure 3.4). This initiative is implemented in collaboration with national wildlife authorities, as well as conservation and research projects in the respective countries.

Data are collected using a combination of classic and innovative monitoring methods to increase sensitivity in the information gained. Sampling effort per area is guided by prior estimation of great ape occurrence probability in the respective area to increase efficiency in data collection and accuracy in the abundance estimates. More effort is expended in areas where great apes are likely to occur at higher densities.

In small countries the program uses a fine grained systematic survey design and conduct interviews with the local human population to classify the immediate neighborhood into areas of high or low ape density. Results from a chimpanzee survey conducted by the Tacugama sanctuary in Sierra Leone in 2009 showed that the information gained from interviews with villagers almost perfectly predicts the probability of finding chimpanzee nests along line transects (http://www.tacugama.com/census.html).

In larger countries or countries with large and continuous forest cover, data collection is directed by the output of a habitat suitability model which predicts the probability of apes occurring based on available ape survey data.

Currently country-wide surveys are taking place in Liberia, Guinea and Côte d'Ivoire. By 2012, we would have a complete picture of chimpanzee abundance and distribution in West Africa and the associated threats, which will greatly facilitate priority setting for regional conservation strategies in terms of location and actions.

Data collection will start in Central Africa in 2011 with a national survey in Equatorial Guinea, in collaboration with Conservation International. The combined experience and results from West Africa and Equatorial Guinea will serve to evaluate and further develop the occurrence probability model and determine the data collection protocol for the other Central African countries. It will likely be a pre-stratification of the area according to the great ape occurrence probability model and gaps in survey data availability. A representative sample of data will then be collected in areas of high-, medium- and low-probability of great ape occurrence.

All data collected will be archived in the APES Database (http://apes.eva.mpg.de). The results and conservation opportunities will be provided via the different sources of the APES Database project and the interactive web-based interface which is currently being developed to inform conservation management.

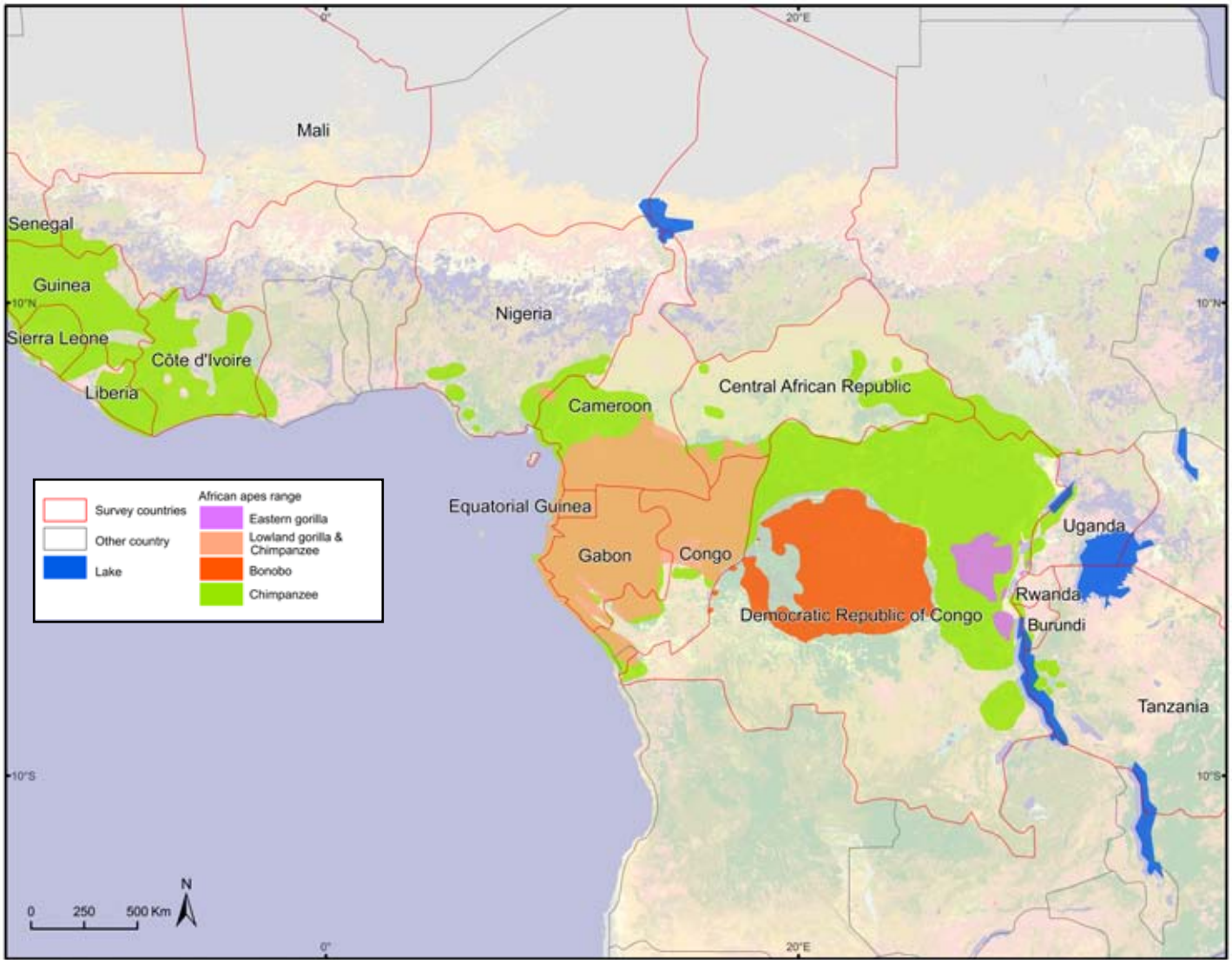

Figure 3.4: African ape range countries that will be surveyed within the following five years (red country borders) and geographical ranges (provided by the IUCN) of the different great ape species indicated in different colors.

Source: Max Planck Institute (MPI)

These six orders of mammal alone account for 525 species, or 95 % of the total number of species. The three countries that, relatively speaking, have the most fauna are Rwanda, Cameroon and the DRC. Yet again, this is due to the wide diversity of habitat and the presence of forested and non-forested land.

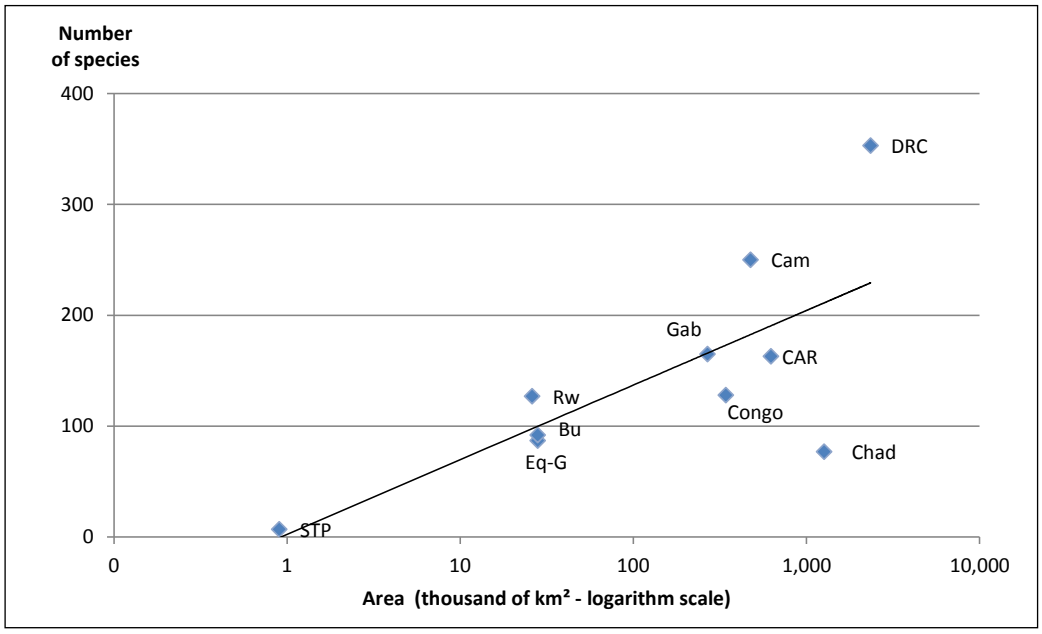

Figure 3.5: Relationship between the number of mammal species and the logarithm of the size of the country. Source: OFAC/COMIFAC

Looking at the ensemble of mammal species, it is possible to distinguish three "bio-geographical regions" within the forested regions in Central Africa, which can be further subdivided into "faunal regions" (Colyn *et al.*, 1987; Colyn & Deleporte, 2002; Grubb, 2001).

The bio-geographical region on the Atlantic coast:

- Faunal region of western Cameroon covers the Sanaga-Cross interfluves (1a);
- Faunal region of Rio Muni (1b) (Grubb, 2001);
- Faunal region of southern Ogooué (1c).

The Congolese bio-geographical region:

- The western Congolese region corresponds to the Sangha-Oubangui interfluves (2a);
- The eastern Congolese region extends to the east and the north-east of the Congo River (2b);
- The southern Congolese region extends to the south of the Congo River (2c).

The mountainous region:

- The Albertine Rift region (3a);
- The western Cameroon region (3b) which comprises two areas (western Cameroon and Mount Cameroon/Bioko).

The forests located between the various faunal regions are hybrid zones which do not have any endemic species.

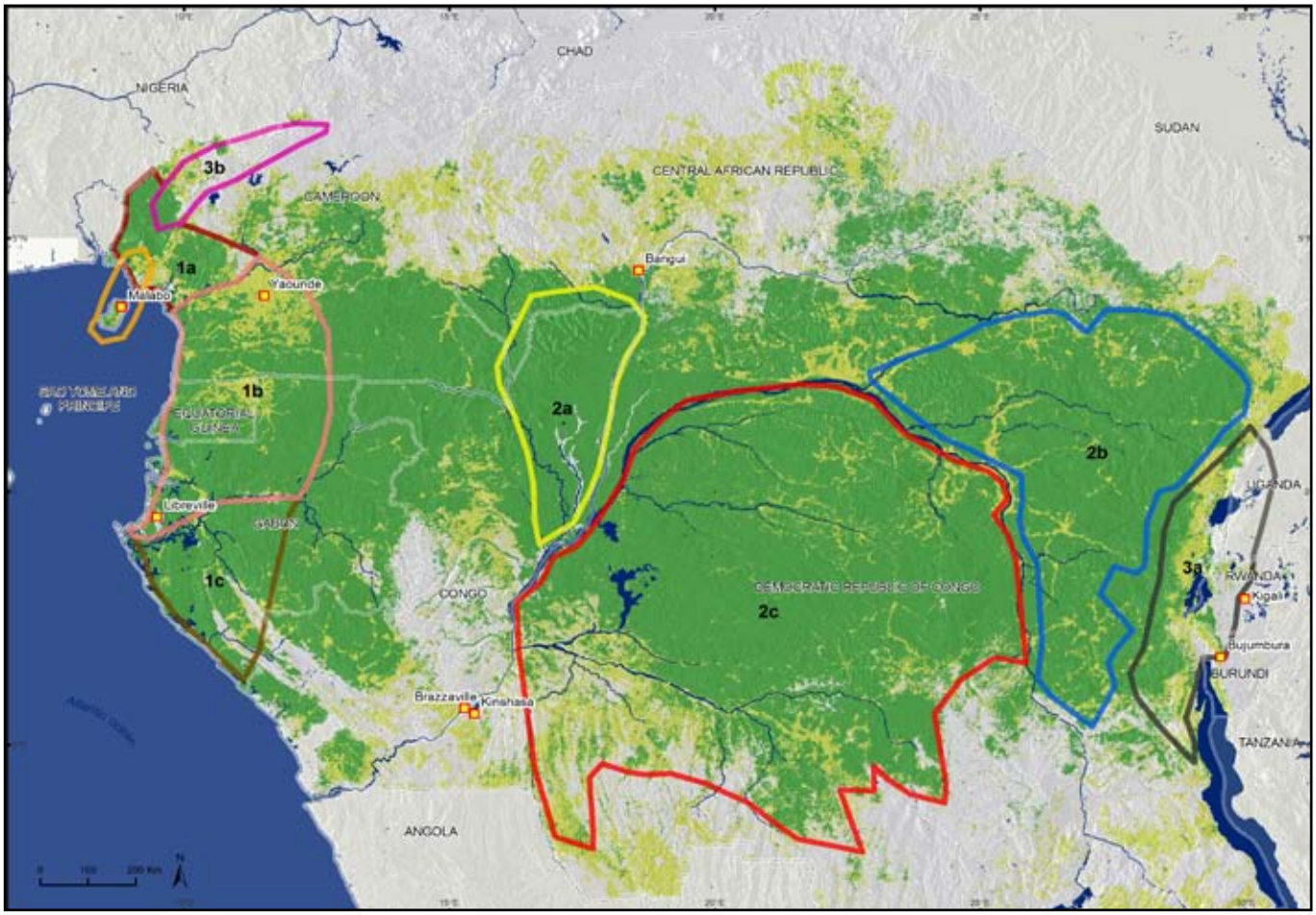

Figure 3.6: Bio-geographical and faunal distribution zones for Central African mammals

Photo 3.8: Aerial view of a blind to view wildlife in Dzanga Bai, CAR

Another emblematic species is the forest elephant *(Loxodonta africana cyclotis)*

IUCN's African Elephant Specialist Group (AfESG) has prepared a summary of the situation of elephants in Central Africa dating from 2007. More precise maps exist for the various areas as well as for some protected areas in the Congo Basin. It is worth noting that the IUCN map shows the presence of elephants in very extensive areas in Central Africa to be "questionable" (figure 3.7). Comparison with survey areas (inputs zones) shows that no information on elephants exists for a large part of the sub-region. This is particularly the case for the DRC where this species seems to be confined to protected areas where its presence has effectively been documented. It would be interesting to consolidate the most recent data, in particular data from the inventories of forest logging concessions under management, which record in an extensive fashion the presence of all visible fauna, including elephants.

The 2008 State of the Forest report summarizes the situation of large mammals (great apes and elephants) in the context of protected areas and forest concessions.

Photo 3.9: Forest elephant (Loxodonta cyclotis)

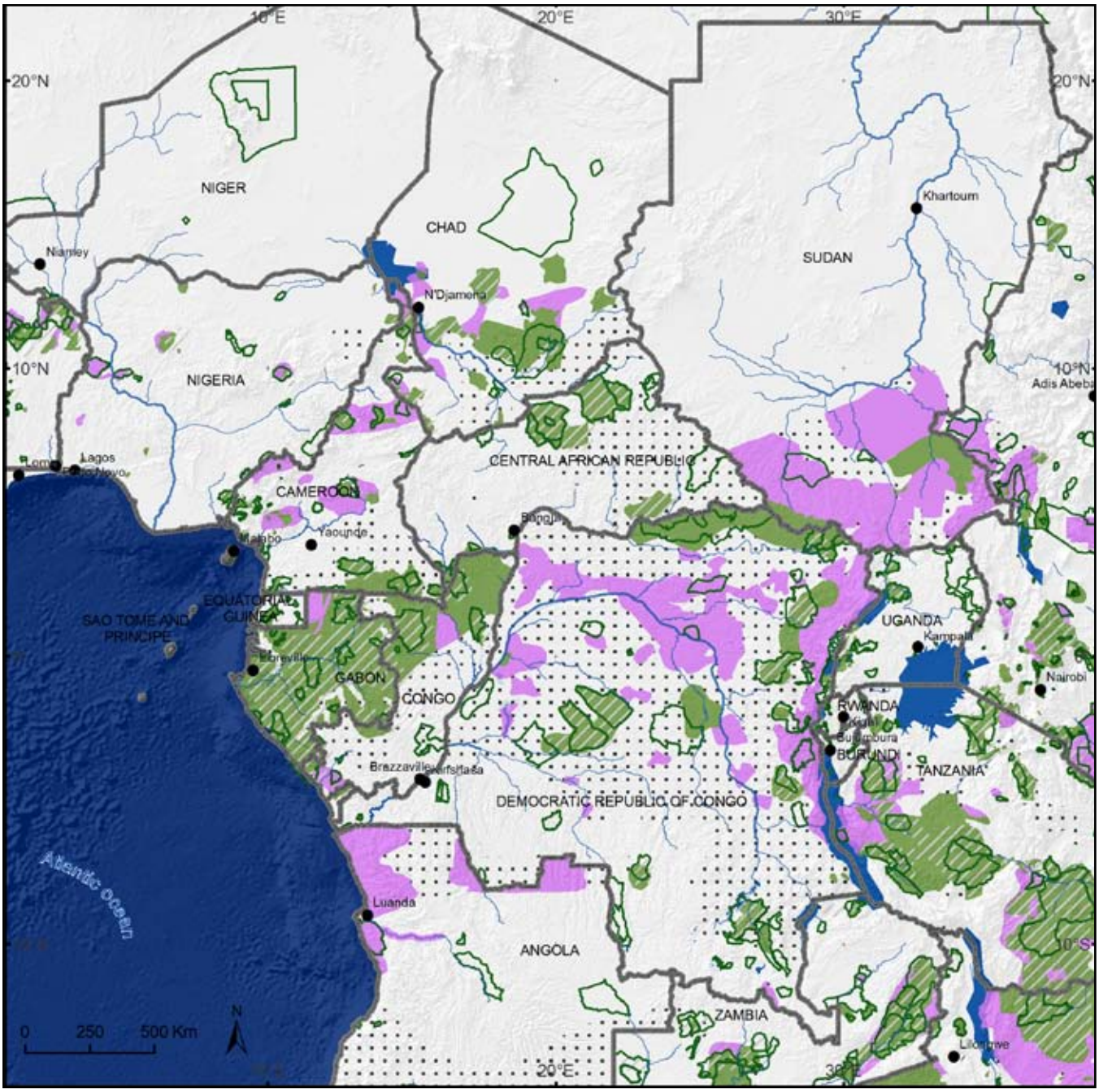

Figure 3.7: Map showing the presence of elephants in Central Africa

Source: AfESG database, IUCN, 2007

Fish

Only very sketchy information on fish is available for Central Africa. There has been quite a lot of research on the situation in Cameroon, Chad, Rwanda and Burundi but little if anything is known about vast areas in Gabon (particularly the Nyanga Basin) and the DRC. Much taxonomy (classification) work also remains to be done; information on fauna in DRC, for example, has not been revised for a long time (Teugels & Thieme, 2005). Several species still need to be described and even discovered. Information is still fragmented on species biology and the workings of aquatic ecosystems. This is a problem with regard to the design and implementation of sustainable exploitation.

The Congo Basin constitutes the richest aquatic ecosystem in Africa and, after the Amazon Basin, is the second richest in the world (Teugels & Thieme, 2005). The richest regions in Central Africa are Lower Guinea, the Malebo Pool and the central Congo Basin, Lake Tanganyika, Lake Edward, which forms part of the eco-region of Lake Victoria and Lake Albert, which is part of the eco-region of the Upper Nile. In contrast, the oceanic islands of the Gulf of Guinea are extremely poor. The richest areas for endemic species are Lake Tanganyika and the eco-region of Lake Victoria. The vast majority of endemic species belong to the *Cichlidae* family. Lower Guinea and the Kasai eco-region are also very rich.

Central Africa is made up of four ichthyological provinces (Stiassny *et al.*, 2007) which are sub-divided into aquatic eco-regions (Thieme *et al.*, 2005):

The Nilo-Sudan province consists of three distinct eco-regions: the Chad, Niger-Bénoué and Nile basins, which are represented by the Lake Albert aquatic eco-region (table 3.2).

Photo 3.10: Mangrove in Gabon

Table 3.2: Number of fish species per basin in the Nilo-Sudan province

Basin	Number of species	Number of endemic species	Endemic species (%)
Chad	140	4	3
Lower Niger-Bénoué	202	17	8
Upper Nile	115	16	14

Source: Thieme et al., 2005

The East Coast province comprises the aquatic eco-region of Lake Victoria and Lake Edward and the Akagera Basin in Rwanda and Burundi. It has 80 species of *Cichlidae,* of which about 60 are endemic. Lake Kivu, whose waters flow into Lake Tanganyika and then to the Congo Basin, is also part of this aquatic eco-region. Its fauna includes 28 species.

The hydrological basin of the Congo is divided into 17 aquatic eco-regions (table 3.3).

Table 3.3: Number of fish species and endemism level in the aquatic eco-regions of the Congo basin ichthyological province

Aquatic eco-region	Number of species	Number of endemic species	Endemic species (%)
Lower Congo	200	11	6
Lower Congo Rapids	162	26	16
Malebo Pool	231	14	6
Sangha	170	8	5
Congo-Oubangui	164	13	8
Kasai	224	49	22
Tumba	48	2	4
Mai Ndombe	30	3	10
Cuvette Centrale	238	14	6
Uele	149	9	6
Upper Congo Rapids	170	3	2
Upper Congo	182	10	5
Albertine Highlands	16	0	0
Upper Lualaba	101	11	11
Lake Tanganyika	288	231	80
Malagarazi-Moyowosi	88	15	17
Bangweulu-Mweru	111	31	28

Source: Thieme et al., 2005

Photo 3.11: River running through a forested area: a common sight in the Congo Basin

Lower Guinea includes the coastal river basins stretching from eastern Nigeria to Mayombe in DRC. The largest basins are Ogooué in Gabon and Sanaga in Cameroon. This area is sub-divided into four eco-regions: northern Lower Guinea, central Lower Guinea, the endorheic lakes of western Cameroon, and southern Lower Guinea (table 3.4).

The Oceanic Islands in the Gulf of Guinea: Annabón, São Tomé and Príncipe also constitute a distinct eco-region where there is a severe shortage of freshwater ichthyofauna.

Table 3.4: Number of fish species and endemism level in the aquatic eco-regions of the Lower Guinea

Aquatic eco-region	Number of species	Number of endemic species	Endemic species (%)
Northern coastal (Cross)	187	30	16
Cameroon lakes	38	27	71
Central coastal (Cam, Eq-G)	279	57	20
Southern coastal (Ogooué-Niari)	236	28	12

Source: Thieme et al., 2005

Insects

There is no overall summary of insects in Central Africa. Existing calculations vary considerably. Globally approximately 900,000 species have been described out of estimates ranging from 2 to 30 million, depending on the authors. Sub-Saharan Africa accounts for about 100,000 of the described insect species and likely a high number of the to-be discovered species. Insects represent an animal taxon that, on the whole, is under little threat with only 3,269 insect species on the IUCN Red List.

Ants

Inventories exist for some specific families. "The Ants of (sub-Saharan) Africa" database (http://antbase.org/ants/africa/) lists 1,968 ant species, including 158 in Cameroon, 21 in CAR, 50 in Congo, 51 in Gabon and 225 in DRC.

Butterflies

OFAC has prepared an overview of butterflies that lists 2,391 Rhopaloceres species (or day butterflies as opposed to Heteroceres or night butterflies), which is divided into 6 families across the 10 countries that are members of COMIFAC's Observatory. The figures presented are a good illustration of the challenges associated with developing comprehensive species lists when the information available is directly associated with the difficulty of collecting the data on the ground. As regards individual countries[11]:

- DRC, with 1,785 species, is the richest country in Central Africa and even in the whole of Africa;
- Chad has the least number of species (33), which is explained by the absence of a forest ecosystem, but also and above all, the lack of available data;

[11]No data identified for the Republic of Congo

Photo 3.12: River rich in sediments in the heart of the forest in Cameroon

- São Tomé and Príncipe has a small number of known species (47);
- Rwanda, with 327 species, and Burundi, with 300 species, are not as rich as other countries on the continent;
- Equatorial Guinea's continental component lists only 119 species, despite being the same size as Rwanda and Burundi. This is due mostly to the paucity of published data and also to the fact that much data lacks detail;
- Cameroon, with 1,557 species, is in second position behind the DRC;
- CAR, with 697 species, clearly lacks sufficient information;
- Gabon, with 935 known species, had little research in the past, but new data will significantly increase the number of known species in the country.

The website of the "*Association des Lépidoptéristes de France"* presents a page with links dedicated to the tropical African region (http://www.lepido-france.fr/liens/categorie/region-afrotropicale/).

Photo 3.13: The flora of Central Africa displays a wide variety of forms and colors

□ *Vegetation*

Lists and species inventories

Depending on the sources, estimates for vascular plant species in Central Africa vary considerably. OFAC could provide support and assistance to regional organizations and specialized networks, including REBAC (Central African Botanists Network), to enable them to establish a set of bibliographical references that could serve as an authoritative source for the region. In addition, available data varies greatly from one country to another. In 1998, a review of the situation was carried out by Lemmens and Sosef.

It is thought that Central Africa has the highest number of plant species per unit area of any region in the world. Reitsma (1988) found over 200 different plant species on a 0.02 ha plot in Gabon and, similarly, Letouzey (1985 and 1986) found 227 species on a 0.01 ha plot in Cameroon. A study carried out by Wilks (1990) in Gabon has shown that these forests are richer in plant species than those in West Africa.

Cameroon

According to Stuart *et al.* (1990), and World Conservation Monitoring Centre (WCMC, 1992), Cameroon has about 8,260 plant species. More recently, this estimate was lowered to 7,850 plant species, 815 of these are threatened with extinction (Onana & Cheek, 2011). The National Herbarium of Cameroon has produced 37 publications on flora in Cameroon. The first 20 issues were edited by the *Muséum national d'Histoire naturelle* (MNHN) in Paris.

Republic of Congo

An estimated 6,000 vascular plant species (Hecketsweiler, 1990) was recently revised to about 4,538 species, of which 15 are endemic (Sonke *et al.*, 2010).

Gabon

According to a check-list of vascular plants in Gabon (Sosef *et al.*, 2006), the most recent estimate is for 4,710 species, 508 of which are thought to be endemic (*Projet Sud Expert Plantes*, 2010). This figure is lower than previous estimates of 6,000 to 8,000 plants (Breteler, 1988; Lebrun, 1976) or 7,151 vascular plants (Stuart *et al.*, 1990; WCMC, 1992).

The Gabonese Flora series deals with about a third of these species. Founded in 1961, Gabonese Flora is published sporadically. Through 2002, 35 issues had been published before a relaunch resulted in the publication of volume No. 41 in 2010.

Central African Republic

Sources of a very general nature estimate that there are 3,600 known plant species (Stuart *et al.*, 1990; WCMC, 1992), of which 100 are endemic and two species are threatened with extinction.

Democratic Republic of Congo

A list of biodiversity references in DRC is available on the website of the DRC *Centre d'Echange d'Informations* (CEI) (http://www.biodiv.be/cooperation/). A database of the flora of Central Africa is maintained by the Belgian National Botanic Garden and covers DRC, Rwanda and Burundi (http://www.br.fgov.be/RESEARCH/DATABASES/FOCA/index.php?la=en).

Table 3.5: Inventory of plant species in the DRC

	Family	Genus	Species
Algae	30	71	249
Mushrooms (*Basidiomycota*)	41	174	655
Lichens	3	4	21
Bryophytes	48	87	154
Pteridophytes	39	89	378
Spermatophytes	216	1,731	8,867

Source: CEI-DRC

The "*Cuvette centrale*" is the main endemic region in the DRC. It has 952 endemic Spermatophyte species, which is 10.7 % of all the known species in this group (table 3.5). Two other endemic areas have been identified. One is in the mountainous region in the east (where the microthermal orophile species, that include the *Lobelia*, *Philippia* and *Senecio* genera, can be found) and the other is in the region of the Katanga high plains in the south-east of the country.

São Tomé and Príncipe

Global estimates indicate that there are 700 plant species, including about one hundred orchids. São Tomé has a level of endemism of 15.4 % and Príncipe 9.9 %, which contrasts with the islands of Bioko and Annabón in Equatorial Guinea that have endemism levels of 3.6 % and 7.7 % respectively. There are a total of 37 endemic plant species in Príncipe, 95 in São Tomé (with one endemic genus), and 20 endemic species in Annabón (Figueiredo, 1994b; Figueiredo *et al.*, 2011). Of the endemic species in the region, only 16 can be found on more than one island. This shows how remote this kind of vegetation is and suggests that the continent has influenced each island differently. The *Rubiaceae, Orchidaceae* and the *Euphorbiaceae* are characteristic of the islands' flora, and have a high level of generic diversity and endemism (Figueiredo, 1994b). There are also thought to be many Pteridophytes (ferns) (Figueiredo, 1998). These islands are known as "Centers of Plant Diversity".

Data collection and updating for biodiversity in Central Africa: examples of large scale mechanisms and processes

Via national herbaria, mechanisms have been established to identify the plant species in some countries. For example, the herbaria in Libreville, Wageningen, Missouri, Paris and Brussels are collaborating to collect specimens of all plants in Gabon. This initiative, called "**Plants of Gabon**", has already collected over 65,000 specimens (http://dps.plants.ox.ac.uk/bol/Gabon/Home/Index).

In a more targeted way, the online database "***Orchidacea d'Afrique Centrale***" (Central African Orchids) has listed 622 taxa, with 200 photos, and supports the maintenance of a network of shade structures for collection and reproduction in Gabon, Cameroon, Equatorial Guinea and São Tomé.

The **PROTA Foundation** summarizes information from a variety of sources on about 7,000 useful plants in tropical Africa and provides access to this information through databases on the web, books, and CD-Roms (http://www.prota.co.ke/en/home). Detailed data records for 1,070 plant species are available on the on-line data base http://www.prota4u.org/searchresults.asp.

In Central Africa, trees constitute the main plant species to have been documented on a large scale. The first forest inventories in the 1960s focused on about several dozen species of commercial value. Since 2000, a growing number of management inventories have included the total number of tree species contained in the concessions, which in certain areas means over 200 species are recorded. Nevertheless, particular care is required when using these inventories for scientific purposes (Réjou *et al.*, 2010). For plants in general, trees are relatively easy markers in terms of identifying ecosystems. Using reliable global and regional references, such as the plant map of Africa at 1/5,000,000 (White, 1983) or the Letouzey maps, 1978-9, which are still relevant, several recent initiatives have tried to summarize available information on a regional scale. A very broad estimate for the total number of tree species in Central Africa is between 700 (Vivien & Faure, 1995) and 1,000 (Vande weghe, 2004).

A cartographic atlas of commercial species from tropical humid Africa, **PhytoAfri**, has been jointly established by IRD (*Institut de Recherche pour le Développement)* and CIRAD (*Centre de Coopération internationale en Recherche agronomique pour le Développement*) (Chevillotte *et al.*, 2010). The data used is from the FAO historical series, including regular inventories of the Congo Basin carried out from1970-1980, and available botanical identification cards for all target species.

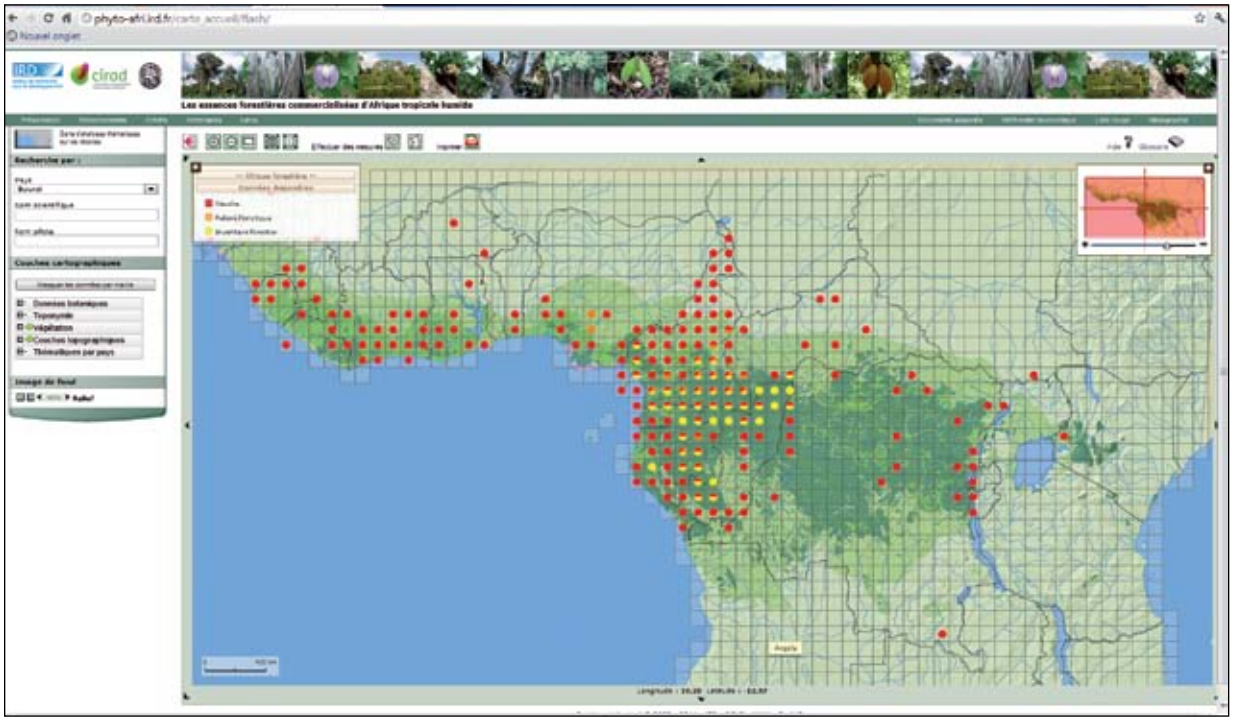

Figure 3.8: Example of a Phyto-Afri map for sapelli
Source: http://phyto-afri.ird.fr/carte_accueil/flash/

The **Coforchange Project** uses recent data gathered via management inventories for industrial forest concessions in Cameroon, Congo and in CAR. These inventories are based on systematic sampling, with a sampling rate of about 1 %. Inventories detailing over 5 million ha have been collected and standardized for scientific purposes. Field measurements are then combined with an analysis of a wide range of satellite imagery. This process results in a new means of mapping land cover, with plant classes defined using multiple criteria, such as trees, soil characteristics, climate and hydrology. This new representation of forest vegetation aims to provide natural resource managers with more precise information at a site specific scale (for example, a forest concession or a protected area). Coupled with historical climate information from the past 4,000 years, this representation provides a better means of understanding the crucial factors determining the current composition of flora in Central African forests and provides a basis for predicting what might happen in the case of future human pressure and climate change.

The **Association for the Taxonomic Study of the Flora of Tropical Africa (AETFAT)** has as its objectives to coordinate studies on African flora, harmonize methods and share results. AETFAT was established in 1950 by researchers from institutions working in Africa. The key members and founding organizations are the Royal Botanic Garden at Kew (UK), National Botanic Garden in Meise (Belgium), *Muséum national d'Histoire naturelle* in Paris (France), and the CTFT in Nogent-sur-Marne/CIRAD-Montpellier (France), Portugal and Spain.

The **Central African Botanists Network (REBAC)** (http://www.rebac-botanists.com) is a scientific group that was established in September 2000 following the AETFAT Congress in Meise, Brussels (Belgium). It acts as a coordinator for the network of Central African herbaria which are geographically distributed as follows:

- Burundi: Bujumbura
- Cameroon: Yaoundé, Garoua and Limbe
- Congo: Brazzaville (IEC) and Brazzaville (IRSC)
- Gabon: Libreville
- Equatorial Guinea: Bata
- CAR: Bangui and Boukoko
- DRC: Kinshasa, Yangambi, Lubumbashi (EBV), Lubumbashi (LSHI) and Kisangani
- Rwanda: National Herbarium of Rwanda
- São Tomé and Príncipe: *Herbário Nacional of São Tomé e Príncipe*
- Chad: N'Djamena

Networks and tools of a more general nature, that are not specific to Central Africa, are also available, such as:

The **Tela-botanica portal** (http://www.tela-botanica.org) disseminates information in French on botany world-wide.

Also of note is the **"BRAHMS" tool** which is a computerized database management system for herbaria and botanical researchers (http://dps.plants.ox.ac.uk/bol/).

With an even wider focus, the **Global Biodiversity Information Facility (GBIF)** (http://www.gbif.org/) is a meta-database of available datasets on biodiversity in most museums, herbaria, and other collections in the world.

The brand new biodiversity center of Kisangani in DRC is also to be mentioned (http://www.congobiodiv.org/en).

Status: threat or protection

Lists and numbers provide introductory information for natural resource managers. However, management measures must take account of (i) species status in relation to the threat of extinction (very real for some emblematic species such as the rhinoceros) and/or (ii) the level of protection offered to them by international conventions or the country's legal provisions.

□ *IUCN's Red List: threat level*

The IUCN is the world's reference organization for maintaining up-to-date lists per country of animal and plant species. The "Red List" (http://www.iucnredlist.org/), based on the recommendations of a panel of experts, provides an evaluation of the degree of threat for each species relative to seven standardized levels (box 3.2).

□ *CITES Lists (Appendix I, II and III) on trade limitations for wild species*

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) maintains a list of species whose trade must be controlled or limited with the aim of preventing their local or global extinction. Species are classified from Appendix I, which lists the species that are the most threatened and whose trade is very strictly regulated and must prove that its trade does not put the species in danger of extinction, to Appendix III, which simply requires verification that laws and conditions for adequate transportation are being followed. CITES lists, which are regularly up-dated, are available at http://www.cites.org/eng/app/appendices.php. Unfortunately, the appendices are not listed per country.

Box 3.2: IUCN Red List for threatened species: global figures (April 2010)

Total number of species evaluated: 55,926

Number of species according to the 7 degrees of threat:

- Extinct: 791
- Extinct in the wild: 63
- Critically endangered: 3,565
- Endangered: 5,256
- Vulnerable: 9,530
- Near threatened: 4,014
- Least concern: 24,080

– Total number for Low risk/depending on conservation measures: 269 (this is an old category that has gradually been eliminated from the Red List)

– Data insufficient: 8,358

In 2009, a "Red List" workshop on Central African plants was organized to update the level of threat status for plants in the sub-region. REBAC proposed that the following taxa and target groups be evaluated on a priority basis over the next three years:

- Endemic plants of São Tomé and Príncipe;
- Endemic plants of the Katanga copper outcrops;
- Endemic plants of Cameroon;
- Species of timber and non-timber forest products used in the sub-region of Central Africa;
- Some taxa of *Orchidaceae*;
- Some taxa of *Rubiaceae*;
- The *Begoniaceae*;
- Saprophytes plants;
- The *Podostemaceae*.

Box 3.3: Botanic gardens in Central Africa: roles and prospects

Francesca Lanata

National Botanic Garden of Belgium

According to the Botanic Gardens Conservation International (BGCI), "a botanic garden is an institution holding documented collections of living plants for the purposes of scientific research, conservation, display and education".

Botanic gardens are of primary importance in Central Africa which is home to about 14,000 listed plant species, many of which are threatened with extinction (including in parks and reserves).

Botanic gardens do not only serve to house collections of plant species. They are also (i) key awareness-raising instruments for matters related to environmental conservation; (ii) ideal settings for environmental education and tourism; (iii) centers for promoting activities related to biodiversity conservation in parks and reserves; (iv) centers for technical and scientific knowledge on flora usage and sustainable management.

Botanic gardens and arboretums therefore have a key role to play in:

- Educating the urban population whose first steps in learning about nature are no longer acquired by living in the forest as once was the case;
- Conserving species and providing for their reintroduction into their natural habitat;
- Restoring degraded habitats;
- Monitoring species migration and their vulnerability to climate change.

A growing number of people are realising that botanic gardens and arboretums play a vital role in Central Africa and that improving their management in what is the world's second largest tropical forested area is essential.

For all these reasons, botanic gardens (*ex-situ* conservation) should be thought of as privileged partners for governments and organizations responsible for *in-situ* conservation.

Today botanic gardens in Central Africa are symbols of both hope and resilience. For the past thirty years, botanists and technicians have worked in botanic gardens that lacked the necessary financial resources and had dilapidated collections and infrastructures. It is thanks to these devoted people that there has been limited loss of local knowledge on flora in the Congo Basin and the heritage of these institutions has been kept alive. Unfortunately, these gardens have worked in isolation, cut off from other conservation actors.

In 2003, representatives of botanic gardens, herbaria, arboretums and urban parks in Cameroon, Congo, CAR, DRC, Gabon and São Tomé and Príncipe established the "Central African Botanic Gardens Network" (CABGAN) in order to break this isolation and sensitize decision-makers on the importance of these gardens. This network aims to promote cooperation between members for biodiversity conservation and cultural heritage in the Congo Basin. In the network's official documents, CABGAN representatives made a point of emphasizing the fact that the majority of botanic gardens are protected areas and must therefore be prohibited from carrying out any activity that is not in line with this status. All the network's activities are focused on carrying out the Global Strategy for Plant Conservation adopted by the Convention on Biological Diversity (CBD). Since 2008, the Kisantu Botanic Garden[12], an *ex-situ* example and conservation model, and a showcase for conservation in the national parks, has, with the assistance of the National Botanic Garden of Belgium[13], provided secretariat services for CABGAN.

[12]The rehabilitation of the Kisantu Botanic Garden (http://www.kisantu.net) began in 2004. Following its success, the DRC Government helped to restore the Eala (Mbandaka) and Kinshasa botanic gardens which re-opened in June 2010.

[13]http://www.jardinbotanique.be

Biodiversity conservation: the formal process

Protected areas

Not enough effort is being spent on management planning for the protected areas (PAs) in Central Africa[14]. Having an approved management plan for a PA does not of course guarantee that all on-site problems will be resolved. However, the process has the advantage of: (i) specifying partnerships between the management team and all local actors; (ii) identifying an overall strategy and specific objectives for the short, medium, and long term; (iii) organizing all available resources (human, technical, financial) over an operational period of four to five years. Even without sufficient funding or staff, the management plan can optimize available and likely resources.

Also characteristic of PAs, and recurrent since their establishment, is the serious lack of resources at their disposal. Supervisory authorities allocate very limited annual amounts in terms of staff and funding. The international funding they receive is usually earmarked for a small number of PAs that are regarded as global public goods. Some sites that were already symbolic or have become symbolic, receive subsidies, and in some cases, continue to receive them for over twenty years. The sustainability of some approaches, or the tendency to replace the national administrations, can be questioned. However, it nevertheless remains true that, without this more or less regular funding, the global situation with regard to biodiversity would undoubtedly have deteriorated more than it has done.

A recent partial inventory of the Dja Faunal Reserve (Cameroon) shows that, despite the extreme pressure it is facing with regard to hunting, it still has significant populations of large mammals. This is among the rare but compelling examples that illustrate that it is possible to conduct (successful) biodiversity protection policies, notably by establishing an efficient system to counter poaching[15].

[14]Statistics on PAs in Central Africa can be found on OFAC's website under the heading "Biodiversity/ Protected Areas" – http:// observatoire-comifac.net/pa.php and per country under the heading "Maps and National Indicator" – http://observatoire-comifac.net/ indicators.php?lvl=cntr).

[15]A policy made possible by mobilizing the international community (notably through the EU/ECOFAC program) and the public authorities in Cameroon.

Box 3.4: Central Africa World Heritage Forest Initiative (CAWHFI[16])

Thomas Fondjo

CAWHFI / UNESCO

Africa is under-represented on the UNESCO World Heritage List, encompassing just 9 % of the listed sites. The CAWHFI program (see box 16.1 of the 2008 State of the Forest report) has as one of its objectives to promote protected areas by including them in the World Heritage List. In order to do this, it encourages State parties to promote their transboundary ecological sites. This objective is perfectly assimilated with the aspirations of the COMIFAC Convergence Plan.

Aware of the absolute need to involve administrations, communities, forest operators and NGOs to ensure that protected areas are properly managed, the CAWHFI program has established a "Consultation Framework" for conservation and world heritage site partners. Through activities to promote information and experience exchanges and facilitate communication between partners, CAWHFI seeks to improve:

- Effectiveness of support of partners in the field of conservation;
- Finding sustainable funding for activities;
- Strengthening the private sector and decentralized governmental services dealing with nature conservation in collaboration with partners in the field;
- The negotiation process between countries, which requires long-term strategy and vision.

According to a mid-term review (EU Evaluation ROM928770), the "Consultation Framework" provides an appropriate response to guarantee both the efficiency and effectiveness of the project.

In light of this, CAWHFI will pursue its goals to achieve improved management and conservation for ecological landscapes so that they are recognized as having outstanding universal value. It intends to implement new activities related to climate change concerns (i.e., adaptation, mitigation, carbon markets), or to other topics where ecological sites identified by CAWHFI, could serve as pilot areas (for instance in the implementation of REDD+ in the Congo Basin).

[16]The CAWHFI program is available on website http://whc.unesco.org/en/cawhfi/

Photo 3.14: Lopola village in northern Republic of Congo

□ *The threats*

Biodiversity in Central African forests is facing a number of threats of varying levels of severity.

Some threats are particularly prevalent and are the subject of more wide-spread studies.

Hunting

Hunting has the potential to be damaging for biodiversity. Three types of very different forms of hunting can be found in the sub-region: (i) hunting for food, which can be subsistence level or commercial, (ii) hunting for products that are unrelated to food (e.g. ivory, pelts) and (iii) hunting tourism.

Hunting tourism is a special case. This form of hunting only affects a very small number of animals that are killed each year. Sport hunting, whether managed by private enterprises or communities, is very seldom the subject of structured management plans. All in all, it has some direct impact on biodiversity (particularly if quotas for young or female animals are not properly respected) but it is of marginal importance on a global scale. Hunting tourism can, indirectly, have a positive effect on neighboring PAs because it can act as a buffer zone where illegal hunting is properly monitored. Community sites that are open to hunting tourism (e.g., COVAREF[17] in Cameroon) provide revenue for local populations from hunting taxes paid by tourists (in addition to revenue from entry fees/accommodation).

In nearly all countries, hunting for food, be it subsistence or commercial, is part of the informal economy. Countries do not account properly for this economic sector which mobilizes the equivalent of an annual turnover of CFA 2,000 billion or € 3 billion in Central Africa[18].

The laws in most countries in Central Africa authorize hunting for food under very precise conditions that govern (i) the type of weapon that can be carried; (ii) the hunting season; (iii) the number, sex and size of what can be hunted. These conditions are rarely respected and hunting can therefore be qualified in most cases as illegal.

Despite numerous reforms, these laws are still hardly applied as they are ill-adapted to the real practicalities of hunting. Neither are they used very much for purposes of monitoring and repression as administrations lack human, financial and material resources.

A number of projects have taken up the question of regulating hunting practices in commonplace sectors such as community zones, regulated spaces such as forest concessions or PAs and their peripheral zones. Some projects have shown interesting results which could reduce the impact of hunting on wildlife. However, no overall solution currently exists. Often, results are dependent upon budgetary concerns and the need for international expertise.

An approach that is frequently put forward consists of looking for ways to substitute bushmeat with other sources of protein. Breeding wild animals, game ranching, and in many cases breeding common domestic animals (e.g., chickens, fish, rabbits, goats) has been carried out in several areas without really spreading to forest areas. Bushmeat continues to be consumed as its acquisition (buying, hunting) requires less effort than the effort required to substitute it. This is noticeable where urbanization has changed the diets of populations that have moved away from the forest. However, eating bushmeat is also a traditional preference and some populations are therefore willing to make an extra effort (pay more, take risks to hunt illegally) in order to obtain it (see chapter 6).

Generating alternative revenues has been the subject of research through projects on ecotourism, but has not produced significant results with regard to bushmeat. It can be noted however that, despite about twenty years of attempts at ecotourism, revenues in Central Africa are still marginal. Potentially interesting products exist but problems in implementing them (e.g., transport, accommodation, security, visas, expense, availability of qualified staff) hamper the further development of this industry. While hunting tourism in the forest (see above) remains a niche activity, it is one of the activities that best manages to find a balance between economic development needs and biodiversity conservation objectives.

Approaches for organizing and formalizing hunting are also being implemented. The *Projet de Gestion des Écosystèmes dans la Périphérie du Parc national de Nouabalé-Ndoki* (PROGEPP) in northern Congo seeks to have the rights of hunting communities formally recognized in forest concessions. In addition to a zoning plan for the CIB concession (*Congolaise industrielle des Bois*), the project helped to organize community hunting in collectively designated village zones.

[17]COVAREF : *Comité de Valorisation des Ressources fauniques*.

[18]This figure is estimated on the basis of an annual consumption of 1 million tons and on the assumption that the price per kilo is CFA 2,000 (Bushmeat Crisis Task Force. Online at http://www.bushmeat.org/sites/default/files/FSeconomics.pdf).

Other threats seem to be much more difficult to tackle:

War or rebellion

In dealing with the threats faced by PAs, one of the main constraints is not being able to undertake any kind of land initiatives in zones where there is war or rebellion. National parks in northern CAR, as well as Garamba and Virunga national parks in DRC, are constantly in mourning following the violent deaths of staff who were carrying out their duties. In addition to human challenges of this kind, the consequences for biodiversity are also significant. Chad and CAR are the victims of unprecedented elephant massacres on territories that are impossible to control (Poilecot, 2010).

On the other hand, as far as health is concerned, be it human or animal, the region has not suffered any major new epidemic, such as the Ebola disease, for the past two years.

Mining, petroleum or agro-industrial exploitation

A disturbing trend that has been challenging the conservation world for some time now, and which is likely to grow, is the emergence of mining, petroleum or agro-industrial exploitation projects.

The economic development prospects and employment brought about by the exploitation of these natural resources are extremely important for the countries concerned. Such is the case, for example, of the vast iron ore deposits in Gabon (Belinga Mountains), in Cameroon and Congo, or the discovery of petrol in Virunga National Park in DRC. Protected areas should expect to undergo a significant increase in direct or indirect pressure. An influx of salaried workers, opening up channels of communication, deforestation, and hunting, all represent threats to the ecological integrity of PAs.

States sometimes employ legal instruments and procedures such as environmental impact assessments in order to reduce the negative ecological consequences. Nevertheless, the law that governs Gabonese national parks is one of the only laws that provide for compensation in cases of loss of land by the mining industry or others. A dialogue between supervisory administrations is absolutely necessary.

□ *Funding and management opportunities*

Economic Community of Central African States (ECCAS) has become increasingly important as the institution responsible for implementing regional policy on the environment and management of natural resources in Central Africa, as adopted by Heads of State in 2007. Consequently ECCAS was given the responsibility for two major regional programs dealing with natural resource management and support for PAs: (i) The Congo Basin Ecosystems Conservation Programme (PACEBCo), with financing of CFA 28.53 billion from the African Development Bank (AfDB) and ECCAS, and (ii) the ECOFAC Regional Indicative Programme (RIP) from 2011 to the end of 2014 with financing of € 30 million from the European Union. At the same time, the Central Africa Protected Areas Network (RAPAC) has confirmed its authority in the region by being given the role of coordinating PACEBCo and RIP/10th EDF programs, as well as the Project to Support Biodiversity Management in Salonga National Park in the DRC.

RAPAC has furthermore provided support and facilitated initiatives for Transboundary Protected Areas (TBPA), including participating in steering committees. Eight countries participated in the process of establishing TBPA, representing 19 protected areas and 7 cross-border complexes (table 3.6).

The most recent transboundary cooperation agreements relate to the establishment of the BSB Yamoussa TBPA and the Mayumba-Conkouati Transfrontier Park (PTMC). They were validated by the COMIFAC ministerial meeting which was held in Kinshasa from 8 to 11 November 2010.

TBPAs help to strengthen cross-border cooperation and security. They can act as incentives for the establishment of new PAs. One of the newest national parks in Africa is Sena Oura National Park in Chad which was legally established on 31 May 2010.

Table 3.6: Transboundary Protected Areas in Central Africa

Protected areas	Year of creation	IUCN category	Area (ha)	Country
PTMC				
Mayumba	2002	II	80,000	Gabon
Conkouati-Douli	1980/1999	II	505,000	Congo
TNS				
Nouabalé-Ndoki	1993	II	419,000	Congo
Lobéké	2001	II	43,000	Cameroon
Dzangha-Ndoki	1990	II	125,100	CAR
Special Reserve of Dzangha – Sangha	1990	IV	310,000	CAR
TRIDOM				
Odzala-Koukoua	1935/1999	II	1,350,000	Congo
Dja Faunal Reserve	1950	UTO cat.1(*)	526,000	Cameroon
Minkébé	1997/2000/2002/	II	756,700	Gabon
MA-MC				
Monte-Alen	1997	II	200,000	Equatorial Guinea
Monts de Cristal	2002	II	120,000	Gabon
Campo-Ma'an Rio-Campo				
Campo Ma'an	2000	I	771,000	Cameroon
Natural Reserve of Rio Campo		IV	33,000	Equatorial Guinea
BSBY				
Bouba Ndjidda	1968	II	220,000	Cameroon
Sena Oura	2010	II	73,890	Chad
TBPA project in the Mayombe Forest				
Biosphere Reserve of Dimonika				Congo
Biosphere Reserve of Luki				DRC
Natural Ecosystem of Cacongo				Province of Cabinda in Angola

(*) UTO: Technical Operational Unit

Source: RAPAC

Another key factor is the increase in the number of foundations involved in the funding and management of PAs in the region:

- The trust fund to support the establishment and management of the Sangha Tri-National (TNS – see box 10.3) completed the funding process for the first two financial contributions provided through German (KfW) and French (AFD) cooperation.
- Management of the national parks of Garamba in DRC and Odzala-Kokoua (OKNP) in Congo has been assigned to the African Parks Foundation. In DRC, management has been transferred by the ICCN national regulatory authority.

One more important point is the announcement made by the DRC in Bonn in 2008 to create 13 to 15 million hectares of supplementary PAs in order to have a protected area network that represents 17 % of its territory, which would bring it into line with its international commitments. The inclusion of local communities in this process is a crucial factor. This decision also means that difficult economic arbitration is required in protected areas with rich mineral or petroleum resources that the country would need to refrain from exploiting.

□ *Legal provisions*

The legal provisions that take biodiversity in Central African concessions into account are very heterogeneous. Some common components of these stand out:

- Although all countries have regulatory texts that govern forest management (law, forest codes), these texts are nearly always different from the texts that govern the management and conservation of fauna. These two types of text are very different; in general the texts on fauna appear to be older;
- National texts on the conservation of fauna, (in particular lists of protected species) can in every case be applied to logging areas, but they were not written with this in mind. They do not contain, or hardly contain, specific reference to concessions. Apart from standard measures applicable across national territories, texts on fauna most commonly refer to dedicated areas such as hunting areas or protected areas;
- Regulatory texts on forests are supplemented by national standards and terms and conditions that indicate the measures that need to be followed to protect biodiversity in concessions. These contractual documents become binding between the State and companies once they are signed. However, implementation and on-site monitoring are problematic and limited;
- National measures to safeguard biodiversity in concessions are still generally limited to some animal species or symbolic plants. Most national standards require companies to monitor hunting and the transportation of game in their concessions;
- In most countries, regulatory instruments (including the texts as well as the administrative services responsible for implementing them), are largely divided between administrations responsible for fauna and those responsible for forest production.

Specific safeguards exist for some species of interest for industrial logging, but that the State, CITES or IUCN recognize as being threatened (table 3.7). The main producing countries have drawn up lists that apply across their overall territory or to specific concessions on a case-by-case basis based on the findings of management inventories. Restrictions on the exploitation of these species depend on the overall richness of the areas to be exploited as well as the abundance of the specific species in classes of different diameter ranges.

In most countries, the zoning plans for concessions include special environmental protection measures under specific "management series". The two main categories of series include either a ban that only affects forest logging, but authorizes populations to carry out all forms of harvesting that is not damaging, or a total ban on all human activity. Supplementary measures relate to the protection of river banks and slopes that are prone to erosion.

Table 3.7: Commercial species with specific protection regulations in forest concessions in Central Africa

Species	Country	Status	Geographical zone
Afo	Gabon	Logging ban	In all CFAD[19]
Afrormosia (Assamela)	Cameroon	Appendix II CITES	The whole country
	Congo (*)	Threatened (IUCN)	FMU(**): Tala Tala, Bétou
Andock	Gabon	Logging ban	In all CFAD
	Equatorial Guinea	Under authorization	The whole country
Anigré	CAR	Partially protected	All concessions
Ayous	CAR	Partially protected	All concessions
Bubinga (Kevazingo)	Equatorial Guinea	Under authorization	The whole country
Douka	Gabon	Logging ban	In all CFAD
Ebony	Cameroon	"Special product"	The whole country
	Congo (*)	Threatened (IUCN)	FMU(**): Ngombé, Pokola
	CAR	Partially protected	All concessions
Kapok - Fuma - Fromager	Equatorial Guinea	Under authorization	The whole country
Iroko	CAR	Partially protected	All concessions
Kosipo	CAR	Partially protected	All concessions
Moabi	Gabon	Logging ban	In all CFAD
	Equatorial Guinea	Under authorization	The whole country
Ozigo	Gabon	Logging ban	In all CFAD
Padouk	CAR	Partially protected	All concessions
Prunus	Equatorial Guinea	Under authorization	The whole country
Sapelli	CAR	Partially protected	All concessions
Sipo	CAR	Partially protected	All concessions

(*) IUCN data for the Republic of Congo cannot be confirmed without a more detailed study.
(**) FMU: Forest Management Unit
N.B.: Currently, none species is under protection status in DRC.

Source: OFAC

□ *Voluntary measures*

In addition to legal obligations, companies are encouraged to include voluntary measures that take biodiversity into consideration in their industrial practices. Public and international recognition of such efforts is sought through voluntary eco-certification. Several certification mechanisms co-exist in Central Africa:

- Certificates of "legality" are based on criteria established by audit companies (see chapter 2). Despite this term, these certificates go beyond a legal designation, by further integrating criteria of good practices into social and environmental sectors. These certificates incorporate, for example, TLTV by SGS and VLO by Smartwood or OLB by Eurocertifor/BVQI;
- The "Controlled Wood" label aims to guarantee that timber with an FSC label are well and truly from a verified and approved FSC source, or that they contain FSC monitored material mixed with non-certified timber;
- Sustainable management certificates are established based on criteria and indicators that are issued by independent audit bodies, such as PAFC (Pan African Forest Certification) and FSC. In less than five years, there has been a rapid increase in the areas certified under the FSC label in Central Africa. The FSC encourages companies to designate areas of high conservation value in their concessions, in principle according to a national framework, where there is a total or partial ban on logging, and/or specific protection measures (box 3.5);
- The TFT (The Forest Trust) label plays an intermediary role by providing labels for progress achieved: it applies to a product whose timber has been taken from a forest "exploited in collaboration with the TFT, using a closely monitored forest management program that will steer it towards independent certification", primarily FSC certification.

[19] CFAD: Forest Concession under Sustainable Management.

Box 3.5: Main FSC Principles and Criteria having a direct or indirect link with biodiversity considerations

Principle 1- Compliance with laws and FSC Principles

Forest management shall respect all applicable laws of the country in which they occur, and international treaties and agreements to which the country is a signatory, and comply with all FSC Principles and Criteria.

Criteria 1.1 - Forest management shall respect all national and local laws and administrative requirements.

Criteria1.3 - In signatory countries, the provisions of all binding international agreements such as CITES, ILO Conventions, ITTA, and the Convention on Biological Diversity, shall be respected.

Principle 2 - Tenure and use rights and responsibilities

Long-term tenure and use rights to the land and forest resources shall be clearly defined, documented and legally established.

Criteria 2.1 - Clear evidence of long-term forest use rights to the land (e.g. land title, customary rights or lease agreements) shall be demonstrated.

Principle 3 - Indigenous peoples' rights

The legal and customary rights of indigenous peoples to own, use and manage their lands, territories, and resources shall be recognized and respected.

Criteria 3.2 - Forest management shall not threaten or diminish, either directly or indirectly, the resource or tenure rights of indigenous peoples.

Principle 6 - Environmental impact

Forest management shall conserve biological diversity and its associated values, water resources, soils, and unique and fragile ecosystems and landscapes, and, by so doing, maintain the ecological functions and the integrity of the forest.

Criteria 6.1 - Assessment of environmental impacts shall be completed - appropriate to the scale and intensity of forest management and the uniqueness of the affected resources - and adequately integrated into management systems. Assessments shall include landscape level considerations as well as the impacts of on-site processing facilities. Environmental impacts shall be assessed prior to commencement of site-disturbing operations.

Criteria 6.2 - Safeguards shall exist which protect rare, threatened and endangered species and their habitats (e.g. nesting and feeding areas). Conservation zones and protection areas shall be established appropriate to the scale and intensity of forest management and the uniqueness of the affected resources. Inappropriate hunting, fishing, trapping and collecting shall be controlled.

Principle 8 - Monitoring and assessment

Monitoring shall be conducted - appropriate to the scale and intensity of forest management - to assess the condition of the forest, yields of forest products, chain of custody, management activities and their social and environmental impacts.

Criteria 8.2 - Forest management should include the research and data collection needed to monitor, at a minimum, the following indicators:

… c) Composition and observed changes in the flora and fauna…

Principle 9 - Maintenance of High Conservation Value Forests

Management activities in High Conservation Value Forests shall maintain or enhance the attributes which define such forests. Decisions regarding High Conservation Value Forests shall always be considered in the context of a precautionary approach.

Criteria 9.1 - Assessment to determine the presence of the attributes consistent with High Conservation Value Forests will be completed appropriate to scale and intensity of forest management.

Criteria 9.2 - The consultative portion of the certification process must place emphasis on the identified conservation attributes, and options for the maintenance thereof.

Since 2009, the ATIBT (*Association technique internationale des Bois tropicaux*) has supported a regional initiative to refine the more generic FSC principles and criteria to suit the specific conditions of the industrial forest logging in Central Africa.

What contribution can concessions make towards biodiversity protection in Central Africa?

Several regulatory guidelines, as well as practical manuals and training materials, are available to assist companies to implement good practices. Parts of the "ATO-ITTO[20] Principles, Criteria and Indicators for the Sustainable Management of African Natural Tropical Forests" (2003) provided inspiration for certifiers. In 2006, the IUCN and the ITTO also produced "Guidelines for the Conservation and Sustainable Use of Biodiversity in Tropical Timber Production Forests".

The ATIBT (*Association technique internationale des Bois tropicaux*) has produced three practical manuals for timber companies in Central Africa, including one volume which is devoted to fauna (Billand, 2005). A vocational training guide has also been prepared and widely disseminated in the region.

How committed are companies? A regional survey carried out by the FAO and CIRAD in 2008 and 2009 among 26 companies (some of which have several concessions in one country, or concessions in several countries), showed that the degree companies are integrating biodiversity concerns into management of concessions is directly related to the awareness levels of entrepreneurs (figure 3.9). In a panel of four types of company ((i) with no management plan; (ii) with a draft management plan; (iii) with a management plan that is being implemented; (iv) with FSC certification), the survey showed that monitored and audited measures in favor of biodiversity were only being undertaken in certified concessions. In general, it therefore appears that simply adopting a management plan does not constitute a sufficient incentive to encourage companies to advance from purely stating intentions to actually undertaking regular and effective operational action in the field.

This observation shows that awareness-raising efforts remain essential. It also shows that, with the current set of regulations and their level of application, promoting legal monitoring mechanisms will not be sufficient to guarantee the implementation of good practices in favor of biodiversity. As eco-certification is by definition a voluntary approach, new regulatory measures will need to be developed to provide for auditing and the sanctioning of offenders.

Photo 3.15: The canopy structures combined with local topography create a varied landscape pattern

[20] ATO-ITTO: African Timber Organization - International Tropical Timber Organization.

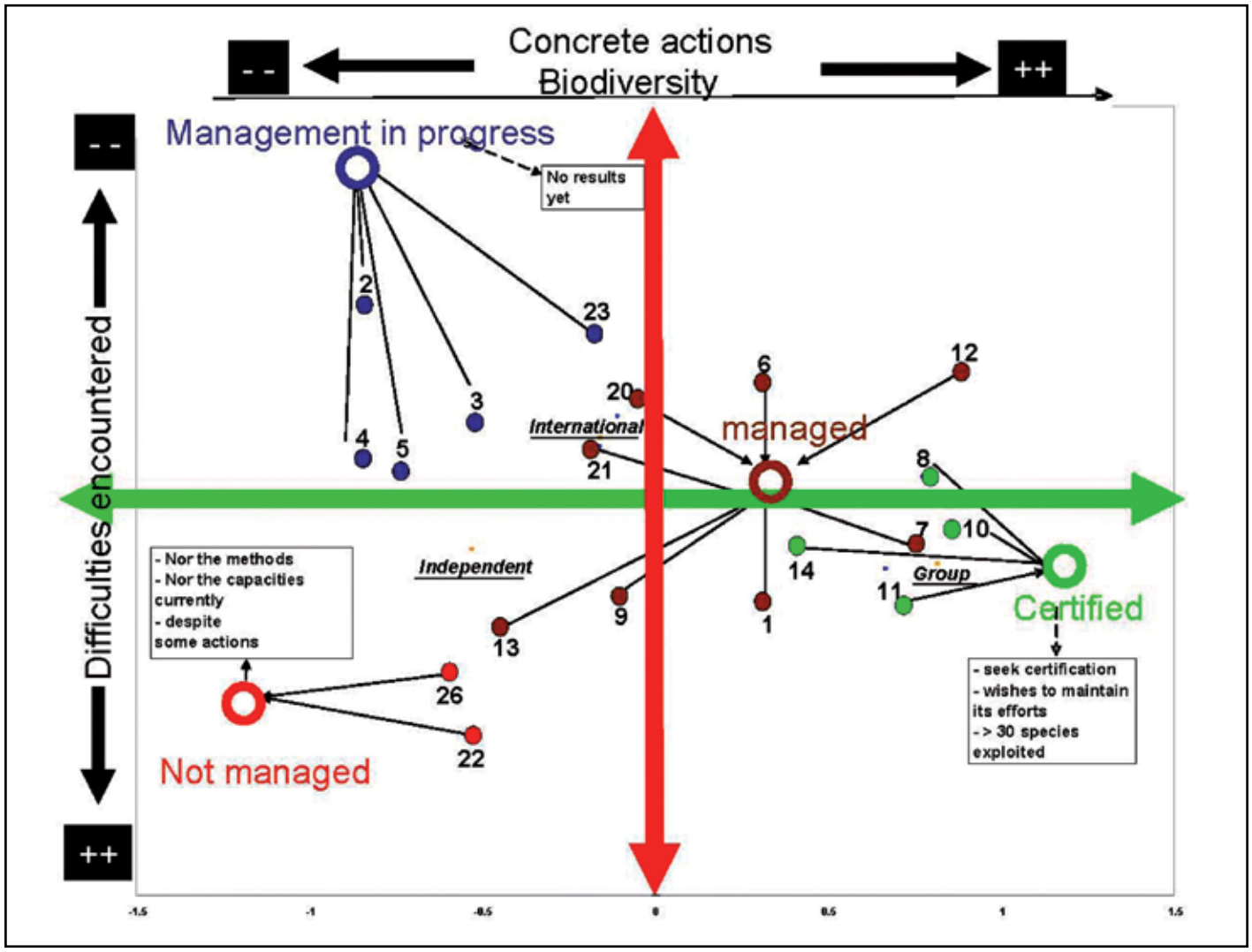

Figure 3.9: Distribution of four types of forest exploitation in accordance with action taken in favor of biodiversity and difficulties encountered
Source: Billand et al., 2010

The graphical representation of the 26 concessions studied (figure 3.9) shows a clear gradient of measures in favor of biodiversity. In addition, the certified concessions and the non-managed concessions expressed the greatest difficulty in integrating biodiversity concerns, but for different reasons: these were either due to highly demanding certification criteria or because they did not know how to obtain certification.

What are the measured impacts of the timber industry on biodiversity?

The direct and indirect impacts of forest logging on biodiversity have been widely written about (table 3.8). It is generally considered that selective logging[21] has a limited direct impact on ecosystems. The main impact that was noted was an indirect one and related to increased hunting by company personnel or non-native hunters, made possible by increased forest accessibility through the opening up of roads.

Table 3.8: Direct and indirect impacts of forest logging

Impacts	Direct	Indirect
Unavoidable	• Decreased biomass • Fragmented habitats • Loss of forest surface area; permanent (about 10 to 15 %) and temporary (about 20 %) • Noise, various disturbances • Change in the floral composition (trees and vegetation) • Local faunal disturbances • Increased heterogeneity	• Increase in human populations in the forest • Nutrient removal • Change in animal composition (e.g., in favor of herbivores) • To a certain extent, biodiversity diversification (mixed ecosystems)
Avoidable	• Damaged settlements • Soil erosion and pollution • Reduction in the number of seeds • Possible genetic erosion (has yet to be demonstrated)	• Increased access to isolated forests and means of transport • Increasing deforestation for agriculture • Increased hunting • Proliferation of exotic species • Increasing sanitary risks

Source: Billand et al., 2010

In recent years biologists have launched extensive regional surveys, based on harmonized protocols, on the status of some species of emblematic fauna (see de Wasseige *et al.*, 2009). These surveys have helped to measure the full-scale impact of logging. For example, a recent scientific publication by Clark *et al.* (2009) focused on studying four large mammals (elephants, gorillas, chimpanzees and bongos) across 3,450 km of transects in 1.2 million ha of logging concessions in northern Congo. The study showed that species abundance was often linked to how far removed they were from unexploited sectors and also that average abundance changed on the plots during the post-logging thirty-year regeneration period. Other determinant factors were the distance from roads and from natural forest clearings and villages. Finally, authors suggested that conservation policies could successfully work on concessions provided that hunting was monitored. On concessions that were sufficiently large, it would need to be organized so as to allow areas of forest to be left intact and plots to have periods of sufficiently diversified exploitation over time.

[21] A maximum disturbance of 20 % of the logged area and a rotation allowing forests to rest for 25 to 30 years.