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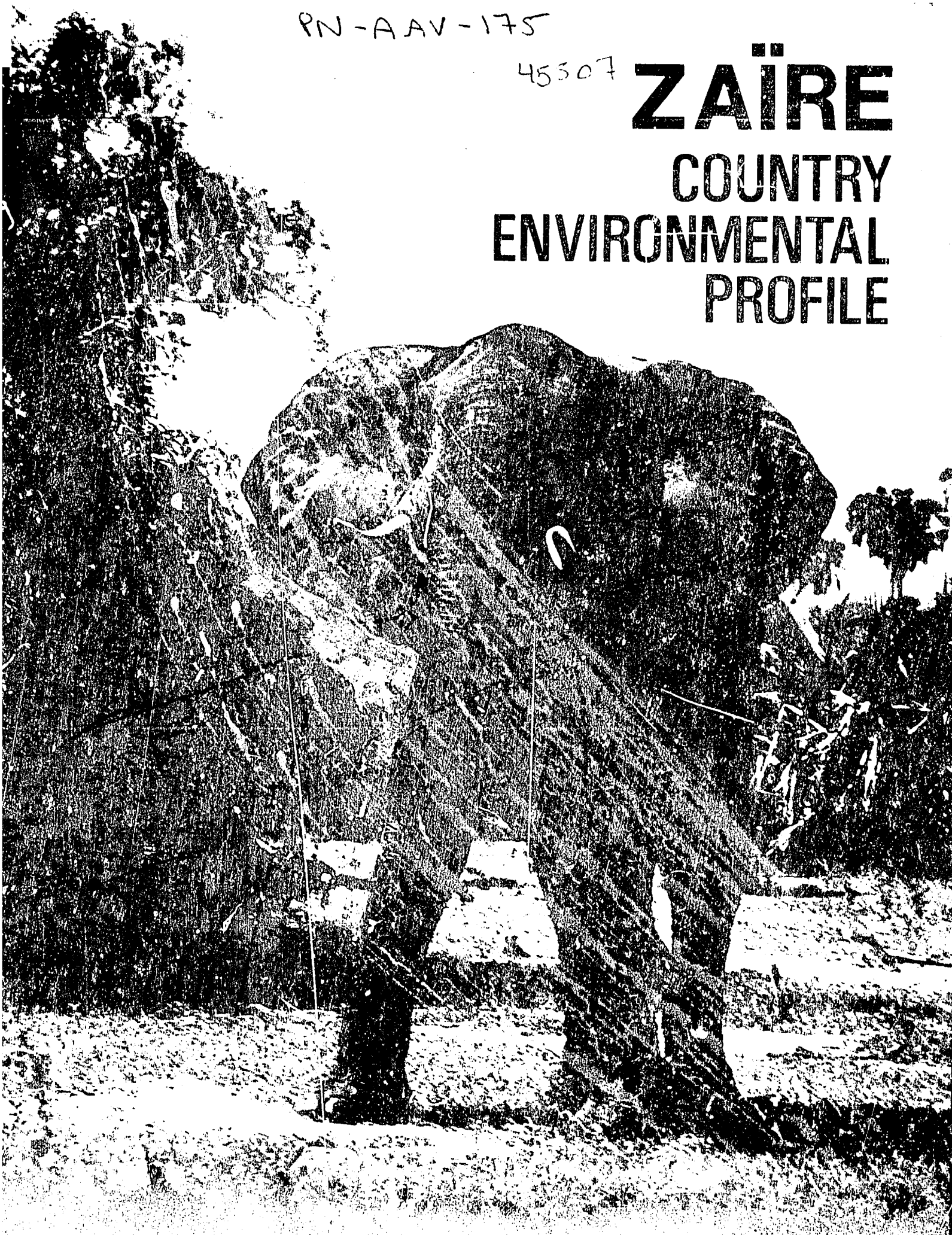
ZAÏRE

COUNTRY ENVIRONMENTAL PROFILE



UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

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Abstract

This environmental profile was developed to assist the Government of Zaîre and the developing agencies assisting the government in identifying environmental problems and possible solutions. Major environmental problems are described for the existing land, water and human resources of the country. Recommendations are presented to begin corrective measures that will improve the outlook for the protection and management of Zaîre's environmental resources. Emphasis is placed on two catagories of environmental problems: those that affect present day human life and resources and those that will exert an adverse effect on future resource use if corrective measures are not taken soon. Both environmental problems and recommendations are presented in the context of Zaîre's national objectives.

By

HARZA ENGINEERING COMPANY

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I. INTRODUCTION

Report Objectives

The development and management of natural resources in a large country entail risks of adversely affecting the future use of the same or other resources through failure to understand fully the complex interactions of human and natural systems. These interactions, often termed "environmental impacts," may be predicted on the basis of the general world experience with similar systems and may be controlled through effective planning.

This study was undertaken with the aim of assisting the Government of Zaîre and the development agencies assisting it in identifying environmental problems and possible solutions. If this report can enable planners to more effectively utilize natural resources and avoid adverse side effects of development, we will consider it a success.

Scope and Limits

For the purposes of this report, we define as "environmental" all aspects of the intricate relationship between man and nature. In order to understand the problems arising from this relationship, we will begin by surveying the natural resources of Zaîre and the demands that human society places upon them. We will examine the social, legislative, administrative, educational and economic factors affecting resource conservation and management. And we will explore the ways in which resources are under- or overexploited and the causes of resource management problems, for the optimal long-term utilization of a resource requires a comprehensive management approach. Lastly, we will suggest some approaches to the management of Zaîre's resources that would provide some measure of environmental protection.

The term "environment," taken in its broadest sense would lead to this report touching upon every aspect of Zaîrian society, since the whole society rests on a resource base, but such a scope would hopelessly enlarge the study. We have tried to restrict our consideration to those aspects of human activity that directly or indirectly affect the resource base in ways that are amenable to improvement.

Participants

This report is the result of a visit to Zaîre by a team of five specialists from Harza Engineering Company over a six-week period during July and August, 1981. The composition of the team was as follows:

Dr. Peter L. Ames	Team Leader/Technical Editor, Senior Ecologist, Harza
Mr. John P. Chitty	Forester/Soil Scientist, Watershed Management Planner, Harza
Prof. Paul Jonas	Resource Economist, Dept. of Economics, University of New Mexico
Prof. Brooke G. Schoepf	Social Anthropologist, Tuskegee Institute for Human Development, Tuskegee Institute, Alabama,
Dr. James H. Thrall	Aquatic Biologist, Senior Ecologist, and Head Environmental Sciences Section, Harza
Mr. John E. Priest	Project Manager (Chicago), Senior Associate, Harza
Mrs. Sharon Dohy	Translator (Chicago), Harza
Mr. Bob Reiden-Bach	Computer-Photocomposer / Typesetter (Chicago), Harza

The staff of USAID/Kinshasa provided Harza's team with wide-ranging support, without which this report could not have been prepared. This support extended beyond contributing information and report

review to include arranging for housing, transportation, in-country travel and meetings with Zaîrian officials. The following deserve special thanks.

Mr. Norman Sweet	Mission Director
Mr. Richard J. Peters	Project Coordinator
Mr. Willson G. Lane	
Mr. Robert Navin	

Mr. James S. Hester, Africa Bureau USAID/Wash served as Backstop Officer for this study.

Harza's study team worked closely with Zaîre's Department of Environment, Nature Conservation and Tourism, numerous members of which generously provided documents, raw data, and personal knowledge of environmental conditions in the country. Several accompanied team members on extended visits to areas of importance to the study. The following deserve collective and individual thanks:

Cit. Djogo Basome	Secrétaire d'Etat, pour l'Environnement, Conservation de la Nature, et Tourisme.
Cit. Masankene Dumbul	Directeur, Direction de Tourisme et Hotellerie, DECNT
Cit. Kasela bin Kembolo	Ex-Délégué Général à l'Office National de Pêche
Dr. P. Hennequin	Ingénieur des Eaux et des Forêts, Conseilleur à la Direction Gestion Ressources
Cit. Luketa Shimbi	Directeur des Services Généraux
Cit. Mady Arule	Chimiste, Chef de Division de la Surveillance Continue de l'Environnement et Salubrité
Cit. Mbusu	Directeur de Planification et Programmes DECNT
Cit. Nlendi	Directeur de la Gestion des Ressources Naturelles Renouvelables
Cit. Kanu Mbizi	Directeur du Service Permanent d'Inventaire et d'Aménagement Forestier (SPIHF)
Cit. Gombo Eunda Mat	Chef de Division, Service National de Reboisement
Cit. Mbo Kendi Afiza	Directeur du Contrôle et de l'Inspection, DECNT
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Dr. Y. Duvivier	Délégué Général, Office National du Tourisme
Cit. Mayemba	Chef de Division, Tourisme et Hotellerie
Cit. Zola Kuandi	Chef de Bureau, Tourisme et Hotellerie
Prof. Jean-Pierre LaPerches	Faculté des Sciences UNAZA
Dr. Boduga Etikatika	Directeur, Jardin Zoologique et Botanique de Kinshasa
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Cit. Ngoma Tsasa	Ingénieur Forestier, Service National de Reboisement, DECNT
Cit. Bieseka Monkanza	Ingénieur Technicien, Service National de Reboisement, DECNT

II. NATURAL RESOURCE BASE

Physical Resources

Geography 1/

The Republic of Zaîre is a largely landlocked country centrally located in equatorial Africa. With a 40–km (25–mi) coastline on the Atlantic Ocean, it is bordered by the Cabinda enclave of Angola and the People's Republic of the Congo on the west, the Central African Republic and the Sudan on the north, Uganda, Rwanda, Burundi, and Tanzania on the east, Zambia on the southeast, and Angola on the south. Zaîre's area is 2,344,885 sq km (905,365 sq mi), making it the third largest country in Africa, roughly equal in size to the United States east of the Mississippi.

Zaîre can be divided into three major geographic regions, on the basis of terrain and vegetational distribution: the Cuvette Centrale (central basin), the northern and southern uplands, and the eastern highlands and Rift valley (see Map 1).

The Cuvette Centrale. The Zaîre (or Congo) River system and its basin constitute the dominant physical feature of Zaîre that gives the country a certain geographic unity. The basin, known as the "Cuvette Centrale," covers an area of about 800,000 sq km or about a third of Zaîre. The Cuvette Centrale is a broad flat basin that constitutes a slight depression of the African continental platform. It is the most clearly distinguished of the various geographic depressions situated between the Sahara to the north, the Atlantic Ocean to the south and west, and the Eastern Highlands, and may once have been an inland sea whose vestiges are the lakes of Tumba and Mai-Ndombe. Both relief and geologic formation are basin shaped, demonstrating a persistent tendency to subsidence in this part of the continent that is compensated for by a corresponding uplifting at the rim of the basin, especially in the east and southeast (hence the name "cuvette" or saucer). The rims of the Cuvette have an elevation of 1500 m on the south, 1000 m on the north and west, and nearly 3000 m on the east. The floor of the Cuvette has an average altitude of 400 m; Lake Mai-Ndombe marks the lowest point at 338 m. The monotonous basin plains and terraced plateaux have some elevations, such as the hill country around Zongo and Mobayi-Mbongo in the north which reach elevations of 700 m. The Cuvette is filled with alluvial deposits from a number of large tributaries of the Zaîre River, such as the Ubangi, Lualaba, and Kasai Rivers.

Extensive depressions occur along some portions of the Zaîre River, giving rise to swampy areas. Some of these depressions may be considered ancient lakes that have evolved from the endorheic into the exorheic type, later becoming swamps after changes in the climate from dry to wet and the acquisition of an outlet to the Cuvette Centrale. A prominent example is the Kamoiondo depression in northern Shaba, a swampy area of about 10,000 sq km inundated during the rainy season by the overflow of various affluents. Another significant depression of this type is the Bangweulu Lake area in northern Zambia, which drains into the Lualaba-Zaîre system through the Luapula River, Lake Moero, and the Luvua. The Bangweulu depression lies at an elevation of 1,148 m and is 4,150 sq km in area. The Bangweulu-Luvua watershed has an area of over 218,000 sq km.

The Northern and Southern Uplands. These regions are parts of a ring of mostly dissected high plateaux and some minor mountainous areas which completely surround the Cuvette Centrale, to which almost the entire ring drains. To the south is the Southern Uplands region, which covers about a third of the country. The northern part of this region slopes from south to north, starting at about 1,000 m and descending to about 500 m as it approaches the basin. In the southeast the peaks of the Shaba plateaux, somewhat higher plateaux and low mountains, tower over the entire area and extend as far north as the Lukaga River. A small part of southeasternmost Zaîre lies in the Zambezi River Basin, which drains into the Indian Ocean. The northern escarpment of Angolan plateau rises in the southwest. In the westernmost section of Zaîre is the coastal region, an extension of the southern uplands that drops sharply to a very narrow shore. The coastal region consists of a fairly low plain that runs inland from the

1/ This section has been extracted, essentially verbatim, from the Phase I Report (LC, 1979).

GEOGRAPHIC REGIONS

MAP 1

Atlantic Ocean to the Bangou-Mokaba highlands, which are deeply dissected by the Zaîre River and its tributaries as it cuts its way from the Cuvette Centrale to the Atlantic Ocean.

The Northern Uplands are composed of the undulating Ubange-Uele plateaux, rising as high as 900 m where they meet the northwestern edge of the eastern highlands. Together with the Bongo Mountains in the Central African Republic, this region forms a watershed between the drainage basins of the Nile, Zaîre and Lake Chad systems.

The Eastern Highlands and Rift Valley. The western Rift Valley and highlands terminate the western arm of the east African plateau system (part of the Great Rift Valley), a depression extending discontinuously from the Zambezi Valley in central Mozambique northward to the Red Sea. Along its Zaîre section, the depression contains Lakes Moero, Tanganyika, Kivu, Amin, and Mobutu, which are separated from each other by plains situated between high mountain ranges. The trough-like depression of Lake Tanganyika attains a depth of more than 1,400 m and is the world's second deepest lake. Its surface, at 779 m altitude, lies more than 150 m below the surrounding country, which is deeply incised by the streams flowing to the lake.

The eastern highlands of Zaîre, dominated by the Mitumba Mountains, run parallel to the rift system and extend over 1,500 km from the southern tip of Shaba, south of Lubumbashi, to above Lake Mobutu. This is the highest region of the country, ranging in altitude from about 1,000 m to over 5,000 m. The eastern plateau also forms part of this area.

The snow-covered peaks of the Ruwenzori Range form the highest point of the region. The range runs parallel to the rift system, to which it drops steeply. The descent to the uplands of western Uganda is more gradual. At its base the range is 120 km long. The summit zone contains six distinct mountain massifs, which are separated by well-defined passes and deep river valleys.

The Virunga (or Nufumbiro) Mountains are a string of volcanoes which, together with their associated lava fields, extend from west to east for nearly 80 km across the Rift from Zaîre to Rwanda and Burundi. Lying between Lake Kivu to the south and Lake Amin to the north, they divide the drainage basin of the Nile River from that of the Zaîre River. Lakes Kivu and Tanganyika thus drain via tributaries of the Zaîre to the Atlantic Ocean, and Lakes Amin and Mobutu drain via the Nile into the Mediterranean. Of the eight principal volcanoes, Nyamulagira, Nyiragongo, and Mikeno lie within Zaîre. Karasimbi, at 4507 m the highest of the peaks, is on the Zaîre-Rwanda frontier, and Sabinio is at the juncture of the boundaries of Zaîre, Rwanda, and Uganda. The crater of Mikeno has disappeared and erosion has imposed a jagged relief. However, the lava fields of Nyamulagira and Nyiragongo have remained active, and successive lava flows have reached as far as Lake Kivu. Significant eruptions have occurred in 1912, 1938, and 1948.

Rainfall. Zaîre is a country with an abundance of water, when considered in comparison with Africa as a whole. Virtually every part of the country receives at least 100 millimeters of rain per year, with amounts in excess of 2,200 mm occurring in the central part of the Cuvette and in Kivu (see Map 2). Most parts of the country experience short to medium dry seasons (periods with less than 50 mm per month), the longest being about seven months in the southern tip of Shaba (Kabala, 1976). In general, the dry season shortens as one approaches the equator.

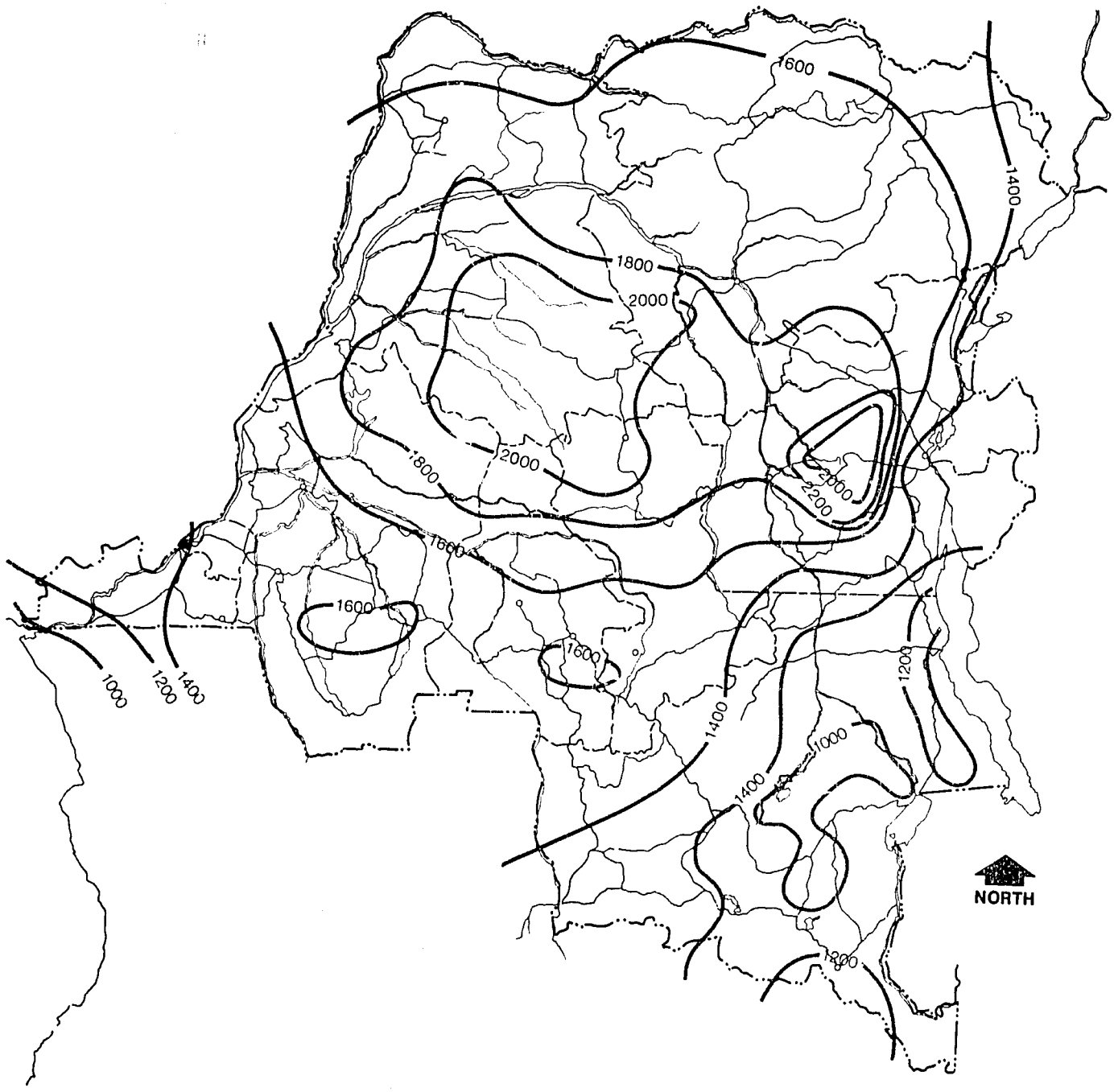
Surface Waters. Consistent with its high rainfall, the country is rich in surface water resources, having within its boundaries the major part of one of the great river systems of the world, the Zaîre River. About 62 percent of the 3,222,000 km^2 of the Zaîre Basin lies within the country.

Originating in the highlands of Zambia, to the south of Zaîre's Shaba Region, the River Zaîre flows in a large counterclockwise arc, north through Shaba and Kivu to Kisangani, in Haut-Zaîre, then west past Lisala, in Equateur, then gradually to the southeast into the Atlantic Ocean at Banana, in Bas-Zaîre.

By convention, the upper mainstem river, above Kisangani, is known as the Lualaba-Zaîre; it is treated by Marlier (1973) as the major tributary of the Zaîre River proper. Within the country, this upper drainage includes the swamps of the Kamolondo Depression, which contains several areas of shallow but open water considered lakes. Of these, Lake Upemba has a surface area of some 500 km^2 and an average depth of about 5 m (Aubray, 1976). Other "lakes" of the Kamolondo Depression are Kabwe, Kabale and Kisale, as well as numerous smaller areas of open water. Aubray reported these to have an aggregate area of about 1,200 km^2 and mean depths of less than one meter. These water bodies are said by Marlier (1973) to be heavily

RAINFALL

MAP 2



overgrown with aquatic plants and to intergrade into the seasonally flooded swampy areas of the Kamolondo Depression. With the permanent bodies of water, the depression covers some 10,000 km^2.

The water quality of the Kamolondo Depression lakes was studied by Bard (1973), who provided the data in Table II–1.

Table II–1

WATER QUALITY OF THE KAMOLONDO DEPRESSION LAKES	
Conductivity	255 μmhos
Surface Temperature	23.5 - 33.0°C
pH	6.4 - 8.0
Calcium	20.6 - 42.3 mg/l
Magnesium	2.9 - 17.3 mg/l
HCO_3 & CO_3	1.80 - 3.33 meq/l
SiO_2	68 - 144 mg/l
PO_4P	41 - 65 μgm/l

Two rather large manmade lakes are located in the upper Lualaba-Zaîre drainage: Lake Mwadingusha, also called Lake Tchangalele, with a surface area of 390 km^2 and a mean depth of 2.6 m, and Lake Nzilo, with a surface area of 280 km^2 and a mean depth of 5 m. Bard gives the conductivity of both lakes as 400 μmhos and the pH of Lake Mwadingusha as 8.0.

In eastern Shaba, to the east of the Kamolondo Depression, lies Lake Moero, a large lake on the border with Zambia. About 40 percent of its 4,720–km^2 surface lies in Zaîre. It has a surface elevation of 930 m and a mean depth of 8 m (Aubray, 1976). Bard gives the water quality data in Table II–2 for Lake Moero.

Lake Moero has an annual average surface temperature of 25°C with a range of 22.5 to 27.5°C (Aubray, 1976). Unlike the deeper Rift Valley Lakes (Tanganyika and Kivu), this shallow lake does not stratify.1/ At its shallower southern end it is covered with papyrus. The lake is reported by Aubray to support a high biomass of phytoplankton.

Lake Moero is fed at its southern end by the Luapula River, which drains a large swamp around Lake Bangweulu, in Zambia, and the

1/ A stratified lake is one with well defined water layers which never completely circulate or mix.

Table II–2

WATER QUALITY OF LAKE MOERO	
pH	6.4 - 9.3
Dissolved Solids	76 mg/l
Sodium	4.6 mg/l
Potassium	1.25 mg/l
Calcium	7.5 mg/l
Magnesium	5.1 mg/l
HCO_3 + CO_3	0.8 meq/l
Chlorine	5.0 mg/l
Sulfate	3.7 mg/l

southeastern arm of Shaba Region. Lake Moero drains into the Lualaba-Zaîre system via the Luvua River.

Two of the lakes, Kivu and Tanganyika, in the Great Rift Valley also contribute to Lualaba-Zaîre system. Both lie partly within Zaîre. Lake Kivu drains south via the Ruzizi River into Lake Tanganyika, which in turn drains into the River Lukuga at the city of Kalemie. The Lukuga joins the Lualaba just below Kabalo.

Lake Kivu has a total surface area of 2,700 km^2, of which 1,700 km^2, 63 percent, lies in Zaîre. It is a deep stratified highly mineralized lake with a maximum depth of 490 m and a mean depth of 240 m (Aubray, 1976). The upper, oxygenated layer, or epilimnion, extends to a depth of 50–60 m, below which is an oxygen-poor, highly mineralized lower layer, or hypolimnion. The latter contains up to 1,430 parts per million dissolved minerals and substantial amounts of methane, which is being commercially recovered (Marlier, 1973). Aubray estimates the amount of recoverable methane at 5,500 million cubic meters. Water quality data for Lake Kivu (Table II–3) are provided by Bard (1973).

Table II–3

WATER QUALITY OF LAKE KIVU	
Conductivity	1,240 - 2,000 μmhos
pH	9.1 - 9.5
Dissolved Solids	975 - 1,020 mg/l
Sodium	129 mg/l
Potassium	85 mg/l
Calcium	21.2 mg/l
Magnesium	84. mg/l
HCO_3 & CO_3	16.4 meq/l
Chlorine	31 mg/l
Sulfate	15 mg/l
Silicate	9 mg/l
Nitrate Nitrogen	41 μg/l
Phosphate Phosphorus	39 μg/l

Although diluted to a salinity of 600 ppm by small tributaries, the Ruzizi River remains the major source of minerals for Lake Tanganyika.

With a total surface area of 34,000 km^2 and a mean depth of 572 m, Lake Tanganyika is the second largest of the African Great Lakes (after the much shallower Lake Victoria) and the third largest mass of inland water in the world (after the Caspian Sea and Lake Baikal). The deepest point in Lake Tanganyika, 1,470 m below its surface, is nearly 700 m below sea level. The lake is completely lacking in oxygen below the 100–200 m depth, depending on the season. It is generally thought there is only a very slow rate of exchange between the upper and lower water masses, but Hecky (1981) points out that upwelling does occur in the southern basin and there is a brief seasonal destratification, allowing some mixing of the nutrient-rich lower waters with the surface waters.

The apparent stability of stratification, lack of nutrients in the surface layers, clarity of water and lack of plankton led early workers to classify Lake Tanganyika as poorly nourished (oligotrophic). The high fish productivity, however, along with the lack of pronounced water quality differences between surface and deeper waters (other than dissolved gases) and increasing evidence of heterotrophic (bacterial) productivity utilizing nutrients stored in the deeper water (Hecky 1981) suggest a complex, as yet poorly understood, limnological and biological regimen. Bard (1973) provides a summary of water quality for Lake Tanganyika (Table II–4).

Table II–4

WATER QUALITY OF LAKE TANGANYIKA

Conductivity	520 - 610 μmhos
pH	7.3 - 7.8
Sodium	57 mg/l
Potassium	37 mg/l
Calcium	9.8 mg/l
Magnesium	43.3 mg/l
$HCO_3 + CO_3$	6.71 meq/l
Chlorine	26.5 mg/l
Sulfate	5 mg/l
Silicate	0.38 mg/l

1/ The reach of the river below the confluence of the Kasai and the Lukemie is traditionally called the Kwa. The 1980 map of the Institut Geographique du Zaîre does not mention this name.

The total flow of the Lualaba-Zaîre system can be determined from the limited hydrologic data available in terms of the source components discussed above, summarized in Table II–5.

Table II–5

AVERAGE FLOWS OF LUALABA-ZAIRE RIVER SYSTEM

Station	Representing Flows From	Mean Annual Flow m^3sec
Mulongo	Kamolondo Depression and Upstream Lakes	569
Kiambi	Lake Moero and the Bangweulu Depression	669
Kalemi	Lakes Kivu and Tanganyika	ca. 100
	TOTAL	ca. 1,440

Between the confluence of the Lukuga and the Lualaba-Zaîre, near Kabalo, and Kindu, about 500 km downstream, the annual average flow increases to 2,213 m^3/sec. At Ubundu, another 400 km downstream, the flow has increased to 6,282 m^3/sec, due largely to three large righ bank tributaries, the Lowa, Ulindi and Elila Rivers, all relatively short rivers draining an area of high rainfall. At Kinsangani, considered the lower limit of the Lualaba-Zaîre and the beginning of the Zaîre proper, the annual mean flow is about 6,380 m^3/sec and the river is 630 m wide.

Stanley Falls, below Kinsangani, comprises seven cataracts and marks the upstream limit of the navigable Zaîre River. This middle course of the river flows west-southwest for some 1,600 km to a point just above Kinshasa. This part of the river flows through the more level central part of the Cuvette. A bit below Stanley Falls the river forms a number of channels, separated by islands. Major left-bank tributaries in this reach are the Lomami, Lulonga, Ruki and Kwa (Kasai)1/ all of whose basins, except for part of the upper Kwa-Kasai, lie in Zaîre. From the right (north) come the Shanga and Ubangi. The latter, with a drainage basin of 777,000 km^2, is considered by Marlier (1973) to be the largest tributary to the Zaîre after the Lualaba-Zaîre. At Bangui, 500 km above its confluence with the Zaîre, the Ubangi has an an-

nual mean flow of about 4,000 m^3/sec. Together with the Shanga, which contributes something over 1,800 m^3/sec, the Ubangi provides about 14 percent of the total flow of the Zaîre River.

Near the confluence of the Ubangi and the Zaîre is an area of low-lying swamp forest, covering some 45,000 km^2. Two floodplain lakes are found in this area, Lake Tumba, just east of the junction of the rivers, and Lake Mai-Ndombe, about 100 km further south.

Lake Tumba has a surface area of about 700 km^2 and a mean depth of only about 3.5 m. Lake Mai-Ndombe has an area of 2,300 km^2 and a mean depth of 5 m (Aubray, 1976). Both lakes reportedly receive runoff from "blackwater" swamp forest. Other tropical blackwater systems are characterized by acid water conditions (low pH), low nutrient levels, and high concentrations of tannins and humic acids. Lakes Tumba and Mai-Ndombe undergo annual fluctuations of about 3 m and have surface water temperatures of 27–32°C (Marlier, 1973; Aubray, 1976).

The Kwa-Kasai drains a watershed of some 900,000 km^2 and discharges an average of 1,200 m^3/sec (Marlier, 1973). Near its junction with the Kwa-Kasai, the Zaîre narrows to a width of 800–1000 m. This "chenal" region is considered the lower limit of the Middle Zaîre and at Kinshasa the Lower Zaîre begins. Just above Kinshasa and Brazzaville, the river divides into two broad branches, flowing around Ile Mbamou, which lies in the territory of the People's Republic of the Congo. The opposite banks of this broad area, called the Mlebo Pool, are 23 km apart and the wider left branch is 10 km wide. At Kinshasa, the river is 1.7 km wide and at Matadi, about 400 km downstream, only 450 m. In this narrow section below Stanley Pool rapids and cataracts prevent navigation. Below Matadi river again widens before reaching the Atlantic Ocean. Unlike many other major rivers, the Zaîre has a relatively small delta. The mean annual discharge at the mouth (Banana) is reported as 40,604 m^3/sec.

In addition to the Zaîre River system, the country has parts of two important lakes, shared with Uganda: Lake Idi Amin (formerly Lake Edward) and Lake Mobutu Sese Seko (formerly Lake Albert). The former has a surface area of 2,240 km^2, 72 percent of which lies in Zaîre, and a mean depth of 30 m. Aubray (1976) notes that it is highly mineralized and Bard (1973) provides the water quality data in Table II–6.

Lake Mobutu receives much of its water

Table II–6

WATER QUALITY OF LAKE AMIN	
Conductivity	900 - 925 μmhos
Surface Temperature	26°C
Dissolved Solids	521 mg/l
pH	8.5 - 9.3
Sodium	110 mg/l
Potassium	9.0 mg/l
Calcium	12.4 mg/l
$HCO_3 + CO_3$	9.85 meq/l
Chlorine	36 mg/l
Sulfate	31 mg/l
Silicate	31 mg/l
Nitrate Nigrogen	24 μmg/l
Phosphate Phosphorus	18 μmg/l
Total Phosphorus	127 μmg/l

from Lake Amin via the Semliki River. The lake has a surface area of 5,270 km^2, 40 percent of it in Zaîre, and a mean depth of 25 m (Aubray, 1976). Its surface temperature of 27°C is similar to that of Lake Amin and it too is highly mineralized. At the southern end, where the Semliki River has deposited sediments, there is a papyrus swamp. Lake Mobutu is drained by the Albert Nile.

Land Use and Vegetation

Land use and vegetation will be considered jointly because human activities influence and are influenced by the natural vegetative cover in a continuous interaction. After the initial alteration of the natural plant community, human use of the land is the basic determinant of the plant cover, even when the human population is not actually occupying the land for agriculture, living space or other activities. The length of time that a piece of tropical land requires for natural restoration of the forest community is unknown — no area on earth has been studied long enough — but Richards (1952) estimates that it may take several centuries.

Natural Plant Formations

Zaîre lies in two basic floristic regions: the Guineo-Congolian Region, a wet forest formation, and the Sudano-Zambezian Region, a dry forest "miombo" and savanna zone. The former region covers 40 to 50 percent of the country. Parts of the lowland moist forest can be characterized as evergreen rain forest. Tropical rain forests are generally mixed forests, where individuals of a given species are widely scattered. Estimates as to the extent of Zaîre's tropical rain forest reserves range from a low of 750,000 km^2 (75 million ha) to as high as 1,100,000 km^2

(110 million ha), to which can be added the approximately 200,000 km^2 (20 million ha) of miombo forest for an estimated total area of between 950,000 and 1,300,000 km^2. Based on what seems to be the most widely used figure of 1 million sq km of tropical rain forest, Zaîre possesses over half of the remaining rain forest area in tropical Africa, and probably around one-tenth of the entire tropical rain forest biome. No data are available to even make an estimate of the extent of primary forest in Zaîre, though the center and the humid zones of the massif have been little affected by man and large areas are still virgin.

Wet Forest. The Guineo-Congolian Forest is a "wet forest" formation, as defined by Richards (1952), since in most parts of the Cuvette Centrale there is a dry season of five months with less than 100 mm of rain per month. Evergreen lowland rain forest occurs in scattered islands, principally where the annual rainfall exceeds 2,000 mm.

The Guineo-Congolian moist forest (called Sudano-Guinean by Aubreville, 1950) has been studied intensively in the Shasha Reserve, Nigeria. It is a rich formation containing thousands of plant species. The forest comprises three canopy layers of trees, a shrub layer and a low layer of herbaceous plants and tree seedlings. The uppermost, or "A", layer presents a discontinuous canopy formed by giant trees, 35–45 m high, of the genera *Chlorophora*, *Diospyros*, *Entandrophragma*, *Guarea*, and others. The middle, or B, stratum consists of trees 20–25 m high, whose canopies may touch or be separated. The C stratum is about 10 m high.

The lower strata of this complex forest are composed of young individuals of the large A-level species and mature individuals of species adapted for shade conditions. The "shrub" layer in Richards' study area consisted of more young trees than shrubs and, as in most equatorial rain forest was quite open, allowing easy walking.

Montane Forest. At higher elevations, 1,000 to 2,500 m or more, a slightly different rain forest formation occurs, in response to higher and more evenly distributed rainfall. Most of the lowland tree genera are represented by montane species. Tree ferns (*Cyathea*) and tropical conifers (*Podocarpus*) occur in this formation. At about 2,500 to 4,000 m in the Ruwenzori and Virunga Mountains one encounters a *Hagenia* forest.

Swamp Forest. A large area of western Equateur and northern Bandundu, as well as the adjacent Likuala region of the northeastern People's Republic of the Congo, is a sparsely populated swamp forest composed of flood-tolerant rain forest species. In structure, it is like the Guineo-Congolian wet forest, but the canopy is more open at all levels (LC, 1979).

Alpine Vegetation. In the Ruwenzori Mountains, the Virunga Volcanoes, and similar areas of Kenya and Tanzania there are bands of specialized plant formations that depend on special features of temperature, rainfall, and soils. Above the level of *Hagenia* woodland is a band of dense bamboo thickets (2,500–2,900 m) and above that (2,700–4,000 m) a band of ericaceous (heath) woodland. The characteristic vegetation of 4,000–5,000 m is a *Dendrosenicio* or *Senicio* woodland. These plants, and the herbaceous species accompanying them are adapted to the cold, wet conditions of the high altitudes. Curiously, many are giant members of families such as Ericaceae and Compositae that have few tree-sized members elsewhere.

Secondary Grassland. Large areas of the southern part of Zaîre are vegetated in a savanna formation that is widely believed to represent a fire-climax. The original forest was cleared long ago and the repeated burning has prevented the succession of these areas into forest formations (Richards, 1952; LC, 1979). The dominant grasses are *Panicum maximum*, *Pennisetum purpureum and Imperata cylindrica*.

Miombo Woodland. A characteristic open woodland covers much of Kenya, Tanzania, Zambia and southern Zaîre. Malaisse (1978) reports that miombo woodland covers 11 percent of Zaîre. It is found in areas where the rainfall is 750 to 1200 mm and the dry season lasts five or six months. Miombo sometimes is referred to as "*Brachystegia-Julbernardia-Isoberlinia* woodland," after the dominant genera. The actual term "miombo" is derived from the Kinyamwezi name for *Brachystegia boehmi*, a common species in this type of woodland (Lind and Morrison, 1974).

Miombo woodland is a two-layered forest, in which the crowns of the dominant trees are 14–18 meters above ground and those of the second layer are 8–12 m high. The crowns of the upper layer may be in contact or somewhat separated.

Although miombo often is referred to as a "fire climax", the dominant trees are not exceptionally fire resistant and annual burning tends to convert it into savanna. An actual dry forest climax, called "muchulu", occurs in areas that escape burning for many decades.

Forest Resources

Although well known botanically, the forests of Zaîre are poorly known in terms of species distribution, standing crop and potential yield. The available quantitative information consists largely of general estimates, based on figures derived from past forest exploitation. A broad review of forestry in Zaîre was performed in 1978 by the World Bank and FAO. Scattered information also is available in old publications of the Institut National d'Etude et Recherches Agronomiques (INERA) and the former Institut National d'Etude Agronomique au Congo (INEAC).

A forest inventory and management program currently (1981) being conducted by the Canadian International Development Agency (CIDA) and the Service Permanent d'Inventaire et d'Amenagement Forestier (SPIAF) has provided field data on the Mayumbe Forest (Bas-Zaîre) and some 50,000 km^2 in the Cuvette Centrale. The Phase I of the study (1976 through 1981) has been directed at the forest inventory, improving the organization of SPIAF, and (with a local forest products company, FORESCOM) developing economic and physical guidelines for development of the tropical forest. A second five-year program (Phase II) will extend the inventory to an additional 120,000 square kilometers and continue the forest utilization studies. The locations of the forest inventory parcels are presented on Map 3.

Size of the resource. Despite the lack of data on the exploitable timber resource, Zaîre obviously contains enormous areas of forests. The Cuvette alone is estimated to contain about 100 million hectares of forest (Kaplan, 1978; LC, 1979), of which about 60 million are considered economically exploitable. With the known resources of the rest of the country, the forest area may be summarized as shown in Table II–7.

Estimates of usable timber volume vary, depending on what species and size ranges are considered usable. SPIAF has identified more than 100 tree species from Zaîre that have timber value and has divided them into four classes (see Appendix A) on the basis of physical properties, availability and known commercial uses. Initial results of the CIDA inventory in Equateur Region (5,300,000 ha) indicate that the 60 million ha in the Cuvette contains a potential annual yield of 9–10 million cubic meters, based on a rotation period of 70–80 years (LC, 1979). In the absence of active reforestation programs, and with the ecologically destructive methods prevalent in modern tropical forest exploitation, it is doubtful that significant regeneration could be expected in so short a time.

Table II–7

AREAS OF PRIMARY FOREST IN ZAIRE	
Cuvette Centrale, dense wet forest	101,000,000 ha
Bas-Zaîre (Mayumbe Forest, 1969)	240,000 ha
Scattered gallery forest, mostly along rivers	760,000 ha
Dense montane forest	300,000 ha
Miombo woodland (Shaba)	20,000,000 ha
TOTAL	122,300,000 ha

The quarter million hectares of the Mayumbe Forest were heavily exploited during the 1960's, so that production of timber has been restricted since 1969. Agricultural clearing has combined with timber extraction to substantially deplete that resource. As cutting continues far in excess of any natural regeneration, the Mayumbe area will soon cease to constitute a significant resource. Second growth forest of *Terminalia*, *Xylopia* and *Gossweilerodendron* will provide a lower level yield.

The dense montane forests of the Kivu and Ituri represent an unexploitable resource, due to the difficulties of topography, elevation (2000–2400 m) and distance to markets. These forests have great value in preventing soil erosion by slowing the runoff from heavy rains.

Miombo woodland contains a high percentage of trees of low timber value, due to their relatively short stature and branching growth form. Miombo in Shaba consists of species of *Brachystegia*, *Julbernardia* and *Isoberlinia* that have high charcoal value. It also contains numerous edible shrubs and herbaceous plants. Other members of this formation provide medicinal compounds and fish poisons.

Timber Production. Despite the vast forest resource that it possesses, Zaîre has been unable to effectively exploit its forests. During the 1970's production by the forest industry rarely exceeded 500,000 cubic meters of "roundwood" per year, of which only about one quarter was exported. The 1977 export of 126,700 m^3 represents less than four per cent of total agricultural exports (LC, 1979) and contributed only about 0.3 per cent of the Gross Domestic Product (GDP).

The Office National de Bois (ONB) collected data on commercial timber production until 1977, when an administrative reorganization placed that responsibility with the DECNT. The ONB data (Tables II–8 and II–9 represent only the part of timber production controlled by cutting permits, registered sales and export permits. The changing political climate and relaxation of

Table II–8

INDUSTRIAL ROUNDWOOD PRODUCTION
(1975–1977) (cubic meters) 1/

Product	1975	1976	1977
Sawnwood			
Local	98,000	63,900	64,400
Export	16,300	14,200	25,900
Total sawnwood	114,300	78,100	90,300
Veneers			
Local	14,400	7,800	6,100
Export	3,700	---	2,400
Total Veneers	18,100	7,800	8,500
Other			
Local	6,900	6,810	9,900
Export	2,100	2,500	---
Total	9,000	9,310	9,900
Total, Local and Export	141,700	95,200	108,700
Roundwood equivalent	332,000	215,000	247,000
Roundwood, exports	2,000	57,000	56,000
Total Roundwood Production	334,000	272,000	303,000

1/ Reports of the Office National des Bois.

Table II–9

DOMESTIC CONSUMPTION OF WOOD AND WOOD PRODUCTS,
1975–77 (cubic m) 1/

	1975	1976	1977
Total local production (roundwood)	282,000	179,000	176,000
Imports *(tons)*			
Sawnwood	60	1,740	80
Veneers	500	870	180
Other	1,850	700	700
Subtotal	2,410	3,310	960
Total imports (as roundwood)	8,600	11,800	3,400
Total Consumption (roundwood)	290,600	190,800	179,400

1/ Source: Reports of the Office National des Bois.

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enforcement may have altered the proportion of total production included in the permit system, so the data should be considered only as general estimates. The figures do not include forest exploitation occurring outside the permit system, which is believed to constitute a significant fraction of the total commercial production. The Division de la Gestion de Ressources Naturelles Renouvables has neither sufficient field staff nor adequate transport to control or even monitor forest exploitation.

Even allowing for discrepancies in the available forest production data, clearly the country's wood resource is underutilized. The reasons for the current low production level lie in the location of the resource and the high cost of transportation. By 1980, such easily accessible areas as the Mayumbe Forest had been largely cut over, leaving only the difficult and costly areas in the Cuvette. Gaining access to the latter areas will require major investments in road development, heavy equipment and vehicles. Sharp increases in fuel costs have made the transportation of heavy logs extremely costly and even with the general rise in international timber values, Zaîre may not be able to compete in the international market as long as other countries such as Indonesia and Brazil have readily available timber resources. Foreign investment in the timber industry in Zaîre has been slow in coming.

The development of all-weather roads in the Cuvette will be costly, due to high rainfall, large areas of wet terrain, and large rivers. High initial capital investments in roads and high maintenance costs would mean that logging operations would require several years to become established and would not show profits for several years thereafter. The use of logging trucks on the existing road system will introduce a hidden cost in road deterioration or a real cost in additional maintenance.

Fuelwood Production. Firewood and charcoal (referred to collectively as fuelwood) provide the sole source of heat energy for virtually all rural Zaîrian families and about 70 percent of urban households (Boute and de Saint-Moulin, 1980). Because of its bulk and weight (relative to the available energy), firewood usually is cut close to the site of consumption. As available resources near the major urban markets are consumed, commercial fuelwood suppliers turn to charcoal, which offers higher energy yield per unit of weight and thus becomes cost competitive as transport distances increase. Cutting for fuelwood, as well as clearing for other reasons, had, by 1980, removed virtually the entire forest resource within 60 to 100 km of Kinshasa and within comparable distances of the other cities. With the increasing distance of transport and rising vehicle fuel costs the urban family must spend an ever larger percentage of its income on cooking fuel. Personnel of the Service National de Reboisement informed us in 1981 that a 20–kg sack of charcoal cost 35 zaîres in Kinshasa. Annual per capita consumption of charcoal has been estimated at 74 kg in 1980, with no change expected through 1985. The SNR estimated a national charcoal demand of 415,600 metric tons (MT) in 1980 and 498,900 in 1985. These figures are consistent with those of the Commissariat au Plan (Boute and de Saint-Moulin, 1980) who provided the estimates in Table II–10), based on anticipated urban growth.

The estimates in Table 10 represent only minimum figures, based on only 14 large cities. The World Bank (1980) and the Bureau du President (1974) estimated that 40 percent of the population of Zaîre is urban — and this percentage is increasing — so the total urban figures for 1980 and 1985 may be twice those given above. In that case, the total urban charcoal demand would be closer to 900,000 MT in 1985.

All charcoal for domestic use is produced in earth pit kilns, the traditional but rather inefficient method found throughout Africa, Asia and Latin America. The earth kiln operates at 25–30 percent production, depending on the skill of the operator, yielding about 1 metric ton of charcoal for each ton of wood cooked. Generally the wood burned for heat consists of branches too small to charcoal. Vangu-Lutete (1979) estimates that Brazilian earth kilns require 0.35 m^3 of wood to produce 35 kg of charcoal. On this basis, the urban charcoal demand estimates of 500–900,000 MT for 1985 would require about 4.5 to 8 million cubic meters of wood. Much of this will continue to come from second growth stand and fallowed fields, but the combined pressures of fuelwood and charcoal inevitably will contribute to the loss of forests.

Agriculture

Agriculture in Zaîre consists of two distinct systems: subsistence cropping and commercial production. About 70 percent of the rural population, on 3 million small farming units in 1978, engaged in traditional subsistence agriculture. In the poorly nourished forest soils of the Cuvette subsistence farmers must practice shifting cultivation, but in the more fertile soils of the savanna and the volcanic soils of the Eastern

Table II-10

ESTIMATED CHARCOAL CONSUMPTION IN MAJOR ZAIRE CITIES, 1980 and 1985

City	1980 Population	Charcoal	1985 Population	Charcoal
Kinshasa	2,410.6	178.0	3,302.7	243.0
Bandundu	78.5	5.8	84.0	6.2
Boma	127.7	9.5	137.0	11.0
Bukavu	209.9	15.0	225.0	17.0
Kananga	434.0	32.0	463.0	34.0
Kikwit	179.0	13.0	191.0	14.0
Kisangani	325.0	24.0	344.0	26.0
Kolwezi	191.8	14.0	203.0	15.0
Likasi	245.3	18.0	259.0	19.0
Lubumbashi	643.5	47.0	679.0	50.0
Matadi	190.6	14.0	202.0	15.0
Mbandaka	200.6	14.8	215.0	16.0
Mbuji-Mayi	388.0	29.8	414.0	31.0
Zongo	20.0	1.5	22.0	1.7
Totals	5,435.0	416.4	6,740.7	498.4

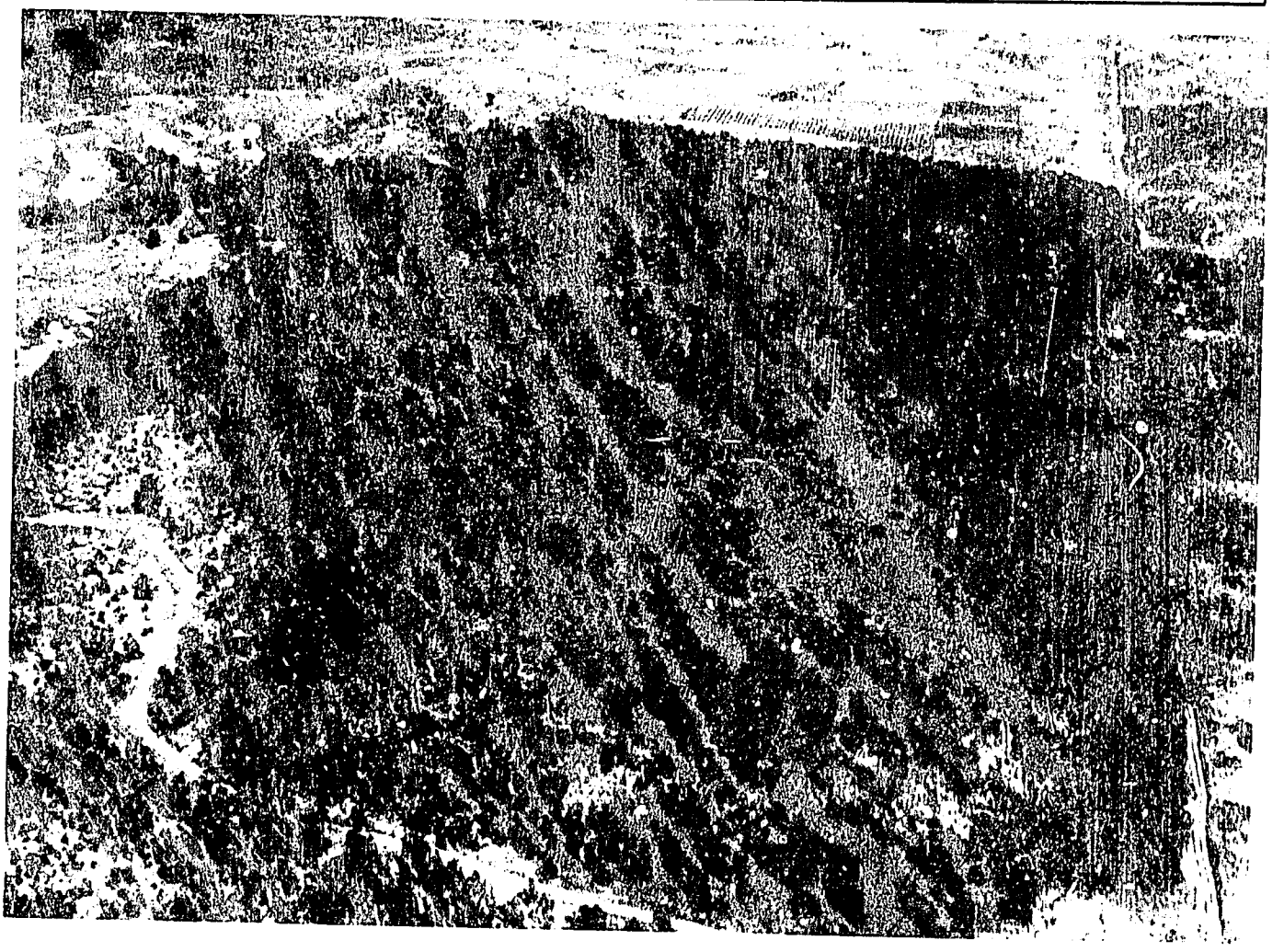

Figure 1. Eucalyptus plantation near Goma. Despite the acute need for fuelwood, these trees are being grown for timber.

Highlands the same fields may be used for many years.

Commercial agriculture employs about 30 percent of the total wage labor force, about 350,000 full- and part-time agricultural workers in 1970. Commercial production is severely hampered by the fact that the best soils are located in the eastern part of the country, at great distances from the major internal markets and export sites. Government pricing policies, increasing taxes, difficulties with the transportation network, and shortages of almost all the materials for large-scale commercial production (fertilizers, pesticides, vehicles and spare parts, harvesting and packaging equipment, etc.) have combined to prevent desired increases in production and have severely reduced production of some important export crops (Departement de l'Agriculture et du Developpement Rural, 1980).

Traditional Agriculture

The shifting agriculturist farms four to six plots of about 0.5 ha each, rotating them through phases of clearing, burning, cultivation and fallow. In forest areas of the Cuvette a plot will be planted in field crops for two to four years, by the end of which time declining production, due to soil nutrient exhaustion and increasing problems with insects (principally ants), indicates the need to fallow the plot. The vegetative regrowth is a dense brush of colonizing species which gradually tie up nutrients and enrich the soil.

The dominant subsistence crop varies somewhat from region to region, but cassava certainly is the most widespread staple, averaging around 10 million metric tons per year (Kaplan, 1979). In Shaba and parts of Kivu maize is preferred over cassava. Rice is grown by small farmers in western Equateur and along the Lualaba-Zaîre in the Maniema Subregion of Kivu. In savanna areas, where the growing season is shorter, millet and sorghum are important staples. In some forest areas potatoes and yams are preferred. Plantains and bananas are grown throughout Zaîre, especially in Kivu.

Commercial Agriculture

The major crops grown for the internal and export markets are rubber, cocoa, tea, coffee, sugar and oil palm. Most are produced on plantations of a few hundred to a few tens of thousands of hectares, but cotton, tobacco and, increasingly, coffee are grown by smallholders.

Oil palm products, principally palm oil and kernel oil, were a mainstay of the nation's exports until the 1970's. Production averaged more than 200,000 MT/yr during the 1950s and 1960s, but dropped to 136,000 MT by 1976 (Kaplan, 1979). The decrease is blamed on failure to replace overaged trees, shortage of investment credit, labor shortages, lack of equipment, lack of experienced managers at smaller refineries, artificially low prices (set by the government), lack of transport, and delays in decision making in the Department of National Economics. Thus, the exporters tend to export illicitly to obtain a better price and these exports go unreported.

Parallel declines, for similar reasons, are reported for rubber (1959–1979 decline of exports from 40,000 to 6,900 MT), cacao (1971 high of 6,000 MT down in 1979 to 3,500 MT), and tea (1970 and 1971 levels of 6,900 MT down to 2,710 MT in 1979). A few products, notably quinine and cotton, attained high export levels during the mid–1970's but fell drastically by the end of the decade. Cottonseed production is reported at 68,282 MT in 1973 but only 18,252 in 1979. Among the reasons given are price difference in comparison with food crops, dishonesty of government buyers, failure or lateness in provision of seed, poor condition of processing plants, and degradation of the transport system.

The World Bank (1975) provided estimates of 1980 and 1990 production levels of major crops, based on trends of the early 1970's. These indicated substantial increases in most crops during the 1980's, in some cases doubling or tripling output. The Departement de l'Agriculture et du Developpement Rural estimates that most of the major agricultural products will remain at low levels or rise only slightly unless special programs are implemented.

Agricultural Extension

Programs to assist and educate farmers are centered in Kinshasa and the regional capitals. They are short of technical staff, equipment, reference material, transport and expendables.

Ecological Resources

Wildlife

The native fauna of Zaîre is widely considered to be one of the country's richest natural resources. The large grazing and browsing mammals, carnivores such as lions and leopards, and primates such as the Mountain Gorilla

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are a major tourist attraction which, with the appropriate infrastructure and logistic support, could provide much-needed foreign exchange (Kabala, 1976). With proper management, wildlife can provide a sustained source of protein in a country where animal protein is in short supply. Recognition of these facts led to the issuance of hunting regulations during the colonial era that have been renewed and extended by the Government of Zaîre. In addition, from 1925 to 1970 seven national parks were created, ranging in size from 600 to 36,000 km^2. A government department, the Institut National pour la Conservation de la Nature (INCN) was created to manage the parks and regulate hunting in game areas. The agency subsequently was placed in the DECNT and its acronym changed to IZCN (through substitution of "Zaîrois" for "National").

Characteristics of the Faunal Resource

Like the vegetation of the country, the wildlife is well-known taxonomically, although a number of controversies remain for further study. A number of studies in the past two decades have been directed at specific problems, such as the ecology of the Mountain Gorilla, but overall knowledge of wildlife populations remains spotty.

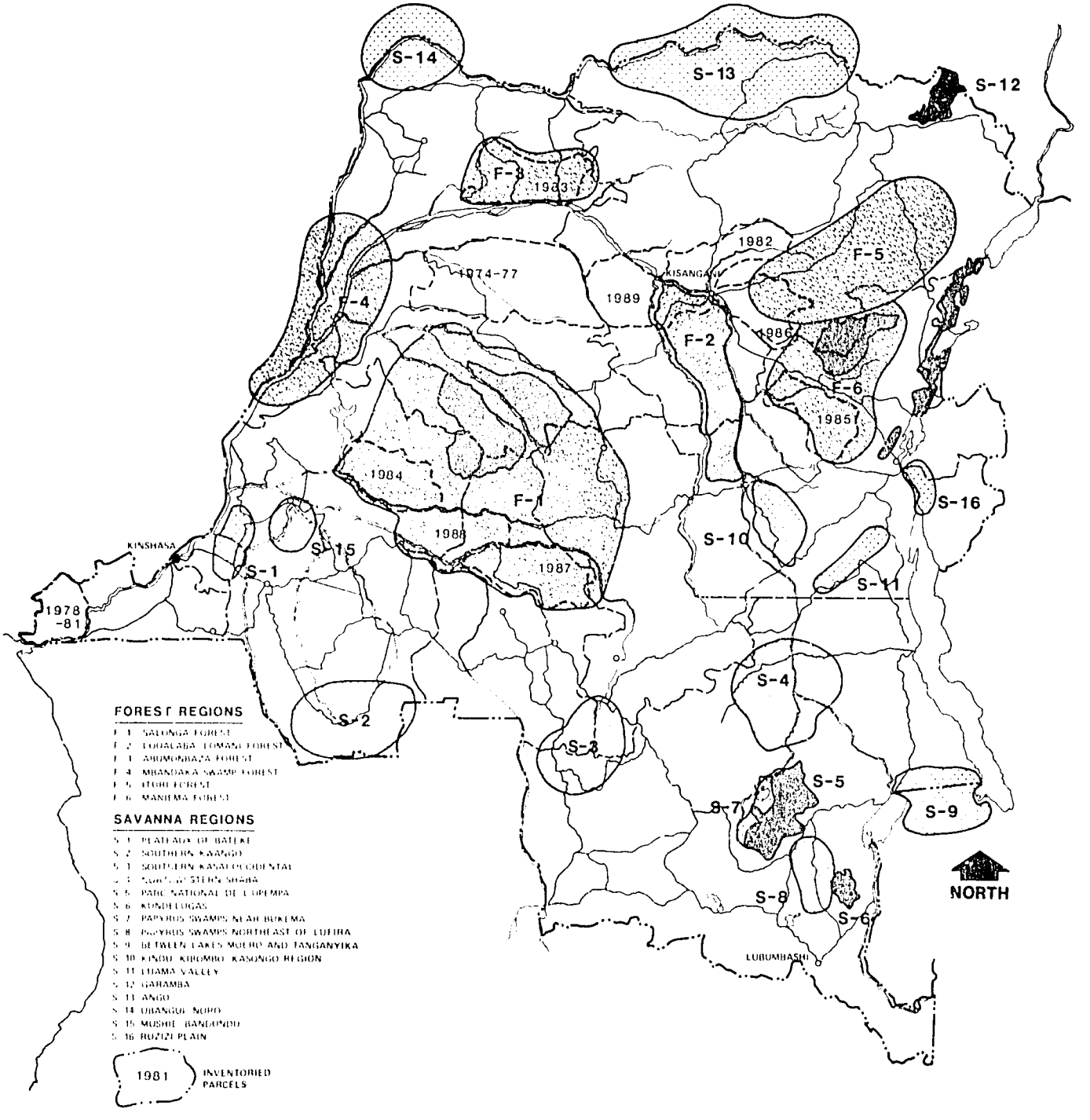
A broad faunistic division can be made between the forest and savanna ecosystems, although there are intermediate ecosystems and many specialized habitats. The majority of the animals of particular scientific or conservation interest are specialized for high forest or savanna.

The major forest areas containing significant wildlife resources were identified by Verschuren (1975) as follows (see Map 3):

1. **Salonga Forest.** This is a large block of equatorial rain forest covering some 80,000 km^2 in southern Equateur Region, northeastern Bandundu and northern Kasai Occidental. It contains the 36,000 km^2 Parc National de la Salonga. Most of the forest is relatively unspoiled but several blocks to the south of the national park are scheduled for the CIDA/SPIAF forest inventory in 1984, 1987 and 1988, and this may lead to logging. According to Kabala (1976) the forest contains a rich and unstudied fauna, including:
   - Forest antelope such as Bongo (*Boocercus euryceros*) and Sitatunga (*Tragelaphus spekei*).
   - Duikers of the genera *Sylvicapra* and *Cephalophus*
   - Monkeys, a particularly rich part of the fauna
   - Pygmy Chimpanzee (*Pan paniscus*), a rare small chimpanzee treated as a full species by many authorities and as a subspecies of *P. troglodytes* by others. It is considered endangered by the IUCN (1976)
   - Elephant, the specific status of which is uncertain. Kabala reports that the Pygmy Elephant, sometimes considered a separate species (*Loxodonta* pumilio), is present.
2. A large area of poorly known forest between the Lualaba and Lomani Rivers, in southern Haut-Zaîre, to the south of Kisangani. The fauna of this area is unknown but probably is similar to that of the Salonga Forest.
3. **Abumonbazi Forest.** This area of forest lies north of the Zaîre River near Lisala, in northern Equateur. It is scheduled for the CIDA/SPIAF forest inventory in 1983 which may lead to cutting under a government program. The area lies in the range of the Okapi (*Okapia johnstoni*), a little studied forest-living relative of the giraffe. Although rare, the Okapi is not considered threatened by the IUCN (1978).
4. Swamp forests near Mbandaka, western Equateur, lying along the floodplain of the Zaîre River and extending into the People's Republic of the Congo. These are almost uninhabited by man and totally unstudied. They may be expected to contain a specialized swamp forest fauna with water-loving species such as Sitatunga.
5. **The Ituri Forest,** in eastern Haut-Zaîre, is better known, due to ongoing studies of the relationships between the resident pygmies and the fauna, on the one hand, and the Mangbetu, to whom they supply meat, on the other. According to Dr. George A. Petrides (pers. comm., 1981) the Ituri pygmies are being pressured by their Mangbetu counterparts to provide increasing amounts of game, which is then sold on the commercial market.

MAJOR FOREST AND SAVANNA REGIONS

MAP 3



6. **Maniema Forest.** This tract of forest in central Kivu apparently is scheduled for CIDA/SPIAF inventory in 1985.

Verschuren also identified some 20 areas of savanna and miombo woodland, both within and outside of the national park and game reserve system, that still (1975) contain considerable wildlife populations.

1. **Plateaux of Bateke.** This area is so close to Kinshasa that it is under heavy preassure for fuelwood exploitation. The good road connections with the capital provide easy access for poachers and render the transport of meat to market easy. Verschuren (1975) reported that lions could still be found in this area.

2. The southern part of the Kwango Subregion of Bandundu. This area also is threatened by poaching. It contains a rare subspecies of buffalo, the Simpson buffalo (*Syncerus caffer simpsoni*)

3. An open sparsely-populated section of southern Kasai Occidental (3) and northwestern Shaba (4) contains some rare wildlife forms, including the East African Eland (*Taurotragus oryx pattersonianus*).

5. Upemba and Kundelungu National Parks, in Shaba, are known for high densities of large mammals. Kabala (1976) provides a list of the mammal, fauna which is rich in the large cats and antelope. He notes also that Upemba is subject to illegal intrusions in the northern sector, resulting in considerable poaching pressure. The fauna of Kundelungu was severely reduced during the civil disturbances of the early 1960's, but is reported to have largely recovered (Kabala, 1976).

7. Large papyrus swamps in south-central Shaba to the east of the Lualaba River between Bukema and Malemba-Nkulu (7) and along the Lufira northeast of Likasi (8) are reported to contain large populations of Elephant and Sitatunga.

9. Along the border with Zambia, between Lakes Tanganyika and Moero, there evidently are substantial wildlife populations, due largely to the undeveloped lowlands between the lakes in Zambia.

10. Miombo woodland in central Kivu east of the Lualaba-Zaîre River, in the region of Kindu, Kibombo and Kasongo, is reported to contain substantial numbers of Elephant. No population studies have been made.

11. The Luama Valley east of Kasongo in extreme southern Kivu, is a relatively inaccessible area that supports high densities of Elephant, Puku (*Kobus vardoni*) and other mammals.

12. A long area in the far northern part of Haut-Zaîre, along the border with the Sudan and the Central African Republic, contains a sparsely settled savanna rich in wildlife. At the eastern end of the area is the Garamba National Park (4,910 km^2) and in the west a much larger area, in excess of 15,000 km^2, designated as the future Ango National Park. Both areas contain good numbers of the endangered White Rhinoceros (*Ceratotherium* simum), but the proximity of the borders of the Sudan and the Central African Republic makes poaching difficult to control.

15. An area of savanna between Mushie and Bandundu, in northern Bandundu Region, is reported to contain good wildlife populations. If so, the area deserves study, for its proximity to Kinshasa (250 km) makes poaching for the commercial meat market an attractive proposition.

16. The Ruzizi Plain, to the north of Lake Tanganyika, where, according to Verschuren, the once abundant fauna "has been almost entirely exterminated." Crocodiles and hippos may survive.

Verschuren notes that wildlife has been entirely exterminated wherever the human population has altered the vegetation. In eastern Kivu, intensive agriculture has displaced the larger animals, although good populations survive in the protected national parks such as Virunga, Maiko and Kahuzi-Biega.

Rare and Endangered Animals

The Red Data Books of the International Union for the Conservation of Nature and Natural Resources (IUCN, 1972–78) are the universally accepted lists of wildlife species considered in danger of extinction. Not all animals treated in the Red Data Books are in immediate danger; some are classified as "vulnerable" or "threatened." The designations, and the recommendations that accompany them, are based on the

best available information on each species' distribution, numbers, ecology, behavior and recent history. The African Elephant, for example, is widespread and is believed to number at least 1,300,000 individuals. It is legally protected throughout most of its range, yet is heavily hunted for its ivory and its numbers are diminishing in most areas. The species is listed as "threatened."

The 1970's saw the drawing up of several international agreements to curb the trade in endangered animals and animal products. These agreements, each a "Convention on International Trade in Endangered Species," or CITES, obligate the signatory nations to take steps to reduce their imports and exports of live animals, skins, horn, ivory and other products that result from the hunting of endangered species.

Zaîre is signatory to all three CITES conventions. Under this agreement 20 species or subspecies of mammals, birds and reptiles occurring in Zaîre are protected from international trade (Table II-11). Only eight of these are considered vulnerable, threatened or endangered by the IUCN; the remainder have been designated by Zaîre for protection under CITES-II.

Chimpanzee, *Pan troglodytes.* This animal, described as a "wide-ranging, adaptable primate "by the IUCN (1972) is under heavy hunting pressure throughout its range", despite legal protection in almost every country where it occurs. The IUCN (1972) considers it "vulnerable." In Zaîre, the subspecies *P. t. schweinfurthi* occurs in Virunga, Garamba and Kahuzi-Biega National Parks (Kabala, 1976), as well as some other forested areas (Verschuren, 1975). There appears to be no information on populations of Chimpanzee in Zaîre.

The chimpanzee inhabits a wide variety of vegetative formations from humid lowland forest to montane forest at 3,000 m and open wooded savanna. The reasons for its decline are illegal hunting, including the killing of adult females to procure live young for zoos and scientific research (even pets), and cutting of the forest habitat.

Table II-11

ZAIRIAN ANIMALS COVERED UNDER CITES CONVENTION a/

Nom Latin	English Name	Nom Français c/
Pan troglodytes b/	Chimpanzee	Chimpanze
Pan paniscus b/	Pygmy Chimpanzee	Chimpanze nain
Gorilla gorilla b/	Gorilla	Gorille
Manis temmincki	Scaly Anteater	Pangolin
Lycaon pictus b/	African Wild Dog	Lycaon
Felis serval	Serval	Serval
Panthera pardus b/	Leopard	Leopard
Acinonyx jubatus b/	Cheetah	Guepard
Loxodonta africana	African Elephant	Elephant africain
Orycteropus afer	Aardvark	Orycterope
Ceratotherium simum b/	Square-lipped Rhinoceros	Rhinoceros blanc
Diceros bicornis b/	Black Rhinoceros	Rhinoceros noir
Cephalopus monticola	Blue Duiker	Cephalophe bleu
Kobus leche b/	Lechwe	Lechwe
Falco peregrinus	Peregrine Falcon	Faucon pelerin
Sterna balaenarum	Damara Tern	Sterne des bleiniers
Osteolaemus t. tetraspis	African Dwarf Crocodile	Crocodile nain africain
O. t. osborni	Zaîrian Dwarf Crocodile	Crocodile nain zaîrois
Crocodilus cataphractus	African Slender-snouted Crocodile	
Crocodilus niloticus	Nile Crocodile	Crocodile du Nile

a/ Source: Convention on International Trade in Endangered Species of Wild Fauna and Flora, Appendix 1, List of endangered Animals.

b/ Vulnerable, threatened or endangered in Red Data Book (IUCN, 1972-78).

c/ Mammal names from Kabala (1976); Bird names from Serle and Morel.

Pygmy Chimpanzee, *Pan paniscus.* This smaller version of *P. troglodytes* is endemic to Zaîre. It is a shy forest animal and is vulnerable (so designated by the IUCN) to habitat loss and hunting by man. Kabala (1976) lists it as occurring in Virunga and Salonga National Parks and an area of uncut forest in the Lopori-Bolombo-Lomako area of Equateur. This region was recommended for protection by the IUCN (1976). following a study by Kano (unpublished), in 1974. Verschuren (1975) notes that meat hunters do not distinguish between this species and monkeys, which are taken by the thousands. The Red Data Book reports that the Pygmy Chimpanzee has been exterminated in Salonga due, in part, to hunting by park guards. The IZCN has reported that the scarcity of this species in Salonga is due to the marginal nature of the habitat (Dr. Onfine Katiese, 1982, pers. comm.).

Gorilla, *Gorilla gorilla.* This largest of primates is conventionally divided into two subspecies, the Western (or Lowland) Gorilla, *G. g. gorilla*, and the Eastern (or Mountain) Gorilla, *G. g. beringei*. The distribution and status of the western form are somewhat uncertain, but it appears to be rare in Zaîre, although substantial populations evidently exist in Cameroon, Gabon and the People's Republic of the Congo.

The Mountain Gorilla is found primarily in the dense montane forests of bamboo and *Hagenia*, venturing into second growth areas to feed on low vegetation. In Zaîre's national parks (Virunga, Kahuzi-Biega and Maiko) it appears to be fairly well protected from hunting and disturbances by man. The reason that the subspecies is considered "endangered" by the IUCN is that the numbers are low and uncertain, the total population is fragmented, and the animal is extremely sensitive to disturbances by man. Verschuren notes that isolated groups of Gorillas also occur in small islands of forest in Kivu and Haut-Zaîre (Maniema). Young Gorillas are worth more than $10,000 on the international market, despite the fact that no reputable zoo would purchase a wild-caught Gorilla.

In 1974, the Gorillas inhabiting Virunga National Park and neighboring forests of Zaîre numbered 275 individuals (IUCN, 1976) and subsequent estimates were lower and decreasing. The population in Kahuzi-Biega was believed to be stable at 200–250. A figure of 500 animals in Zaîre, Rwanda and Uganda appears to represent the total population of the Mountain Gorilla.

Scaly Anteater, *Manis temmincki.* The pangolins, or scaly anteaters, are widespread family of insect-eating mammals characterized by their covering of bony plates. They are killed for food in many areas but the reason for concern for *M. temmincki* appears to be that it is frequently hunted to be taxidermically mounted for sale to tourists.

African Wild Dog, *Lycaon pictus.* The social wild dog of Africa is considered "vulnerable" by the IUCN because it is widely killed by livestock owners and because many of its prey animals, the grazing mammals, are also depleted.

The Wild Dog inhabits the savannas of Africa south of the Sahara. In most of the national parks where it exists it is fairly well protected, as the old attitudes toward this highly efficient hunter are changing. Recent scientific research (viz) Sinclair and Norton-Griffiths, eds, 1979) has shown this species to be an important element of the plains ecosystem that keeps the populations of large grazing animals in balance.

Serval, *Felis serval.* This medium-sized cat, widespread in wooded savanna of east and central Africa, is heavily hunted for its fur. It is found in most of the savanna areas of Zaîre but no information exists on its populations. It is designated as protected under CITES-II.

Leopard, *Panthera pardus.* Although the most widespread of the large cats, the leopard is under heavy hunting pressure throughout its range. The IUCN considers it "vulnerable". It is hunted for its skin, which is still made into coats in some European countries and it is considered vermine in most parts of rural Africa. Even in nations that have endorsed the CITES documents, enforcement often is hampered by indifference on the part of politicians and administrators, some of whom are actually engaged in the skin trade. The international demand for the skins of spotted cats remains high and efforts by the International Fur Trade Federation to control the traffic in the endangered and vulnerable species have met with mixed success. France, Italy, Spain, Sweden and Japan have consistently refused to abide by the restrictions imposed by the IFTF (IUCN, 1976).

In Zaîre, where substantial leopard populations still exist in equatorial forest and miombo woodland, densities of one individual per three to five square kilometers of habitat are reported (IUCN, 1976). Leopard numbers in miombo woodland vary greatly, depending on poaching pressures and prey numbers. The use of the leopard as a national symbol for Zaîre, with the skin worn by the President, probably does not aid in the conservation of the species.

Cheetah, *Acinonyx jubatus.* The African race of this graceful cat is believed to number less than 15,000 individuals, dispersed thinly in savanna regions over the entire continent south of the Sahara. No real census figures are available, but the IUCN (1976) estimates "300 or less in Zaîre." The Cheetah is limited to areas of short-grass savanna and scrubland, where it subsists on the smaller herbivores. Its population is decreasing throughout its range, leading the IUCN to consider it "threatened." Its decrease is believed due to a combination of habitat loss, prey species population declines, competition with other carnivores and, especially, hunting by man. The last factor is generated by the belief among many ranchers that the cheetah kills livestock (which it rarely does) and by the high price brought by its skin on the international market.

Kabala (1976) lists the cheetah as present in Upemba and Kundelungu National Parks but absent from Virunga and Garamba. Of all the animals that may be seen by the tourist, this species is more sought than any other and adds much to the tourist value of an area.

Elephant, *Loxodonta africana.* Although still quite abundant throughout much of its range, the elephant is under heavy pressure from poachers, agriculturists and land developers generally. The greatest short-term threat, especially to the savanna race (*L. a. africana*) comes from killing for ivory. Even countries signatory to the CITES agreements have difficulty in suppressing the illegal ivory trade and in Zaîre ivory is openly marketed. And well-organized illicit ivory trade continues to flourish in the country despite periodic attempts to control it (see Chapter IV, below).

Ironically, the protection of savanna elephants in national parks poses other problems, inherent in the ecology of the species. As they become numerous, elephants tend to destroy their own habitat, uprooting and breaking down trees at a rate faster than the vegetative community can produce them. Although this situation probably has always existed and exerted a natural, density-dependent control on elephant populations, in park situations the ecosystem usually is too small to absorb such destruction and in an uncontrolled situation would go into strong, long-term fluctuations. Without active control of their numbers, park elephants may move outward into agricultural areas, causing considerable destruction. The response to such excursions usually is "cropping," the controlled shooting of selected individuals to reduce the population to that which the ecosystem can carry.

Aardvark, *Orycteropus afer.* The "earth-pig," as its name implies, is a mild-tempered, burrowing mammal. It is widely distributed in savannal areas of Africa. Its inclusion in the CITES II agreement comes from concern over generally declining populations. In Zaîre it occurs in Virunga, Garamba, Upemba and Kundelungu National Parks (Kabala, 1976) and does not appear to be in great danger.

Northern Square-lipped Rhinoceros, *Ceraterotherium simum cottoni.* The Square-lipped, or White, Rhinoceros comprises two subspecies. The Southern form, *C. s. simum*, was nearly exterminated in the 19th century but has been so effectively protected and managed (including reintroductions from captive stock) that it is now considered out of danger.

The Northern Square-lipped Rhinoceros is considered "endangered" by the IUCN. Its range includes parts of the Sudan, the Central African Republic, Uganda and Zaîre. Recent estimates (IUCN, 1976) indicate a total population of 500–1,000 individuals, of which 400 are in Garamba National Park. Uganda is believed to have about 100, in the Ajai Game Reserve and in Kabalega National Park; populations in the Shambe Reserve, Sudan, and in the Central African Republic are believed to be small.

The main threat to rhinoceroses of all species is poaching for the horn, which has an incredible value in Asiatic countries, where it is believed to be an aphrodisiac. In certain Arab countries the horn is highly esteemed for dagger handles and the affluence arising from high oil prices has elevated this demand.

Black Rhinoceros, *Diceros bicornis.* This species, which suffers the same hunting pressures as the Square-lipped Rhinoceros, for the same reasons, is more widely distributed in Africa and generally less endangered. It is considered "threatened" by the IUCN. Apparently, it has not been seen in Zaîre since 1954 (Institut National pour la Conservation de la Nature, in IUCN, 1978).

Blue Duiker, *Cephalophus monticola.* The duikers are a group of tiny, shy forest antelope. Little is known about their populations and ecology. Inclusion of the Blue Duiker in the CITES-II list is based on its strong decrease in several of the eight African countries where it occurs. It status in Zaîre is unknown, but one may assume that its numbers will reflect the amount of tropical forest left standing. Verschuren reports that the duikers are very abundant in Zaîre's forest.

Lechwe, *Kobus leche.* Two subspecies of this wetland antelope might occur in Zaîre: the Red Lechwe (*K. l. leche*) which occurs largely to the south and west of Zaîre (Angola, Botswana, South West Africa, Zambia) and the Black Lechwe (*K. l. smithemani*) which is limited to Bangweulu Swamp and nearby wetland in Zambia, possibly also around Lake Moero, but Verschuren believes that it is absent from Zaîre.

Verschuren (1975) reports that aerial surveys between 1970 and 1974 turned up large concentrations of Red Lechwe (5,000 to perhaps 10,000 or even 15,000) in an area of about 100 km^2 near Kabengele and around the Lualaba lakes.

Both subspecies of lechwe inhabit wet or flooded margins of lakes, habitat that is vulnerable to both overflooding and drying out. According to IUCN (1972) there is no quantitative information on the status of the species in Zaîre.

Peregrine Falcon, *Falco peregrinus.* This falcon, worldwide in distribution, underwent a population slump during the 1950's that led to its being declared endangered. Many ecologists attributed its decline to the widespread use of pesticides, in particular the chlorinated hydrocarbons, but other factors also appear to have been involved. The species occurs in Zaîre on migration and is unlikely to be severely affected by present agricultural practices.

Damara Tern, *Sterna balaenarum.* This small tern breeds in colonies along the southwest coast of Africa. It apparently occurs only rarely along Zaîre's short coastline.

Dwarf Crocodiles, *Osteolaemus t. tetraspis* and *t. osborni.* The nominate race is widespread in Africa south of the Sahara in freshwater streams and lakes; the Zaîrian form (*O. t. osborni*) is found only in the northeastern part of the country. Both are relatively small crocodiles, but are hunted for hides, meat and eggs. Habitat destruction, through heavy use of freshwater lakes, and the attendant increased exposure to man, are contributing factors to the decline of the species, which is considered by the IUCN to be "endangered."

African Slender-snouted Crocodile, *Crocodylus cataphractus.* This poorly known crocodile, considered by the IUCN to be "endangered," is sparsely distributed in estuaries, lakes and streams from Senegal to Angola. In the last 20 years it has become rare throughout its range, largely due to overhunting for its meat and hide. Like most crocodiles, it is considered a pest over most of its range. Nevertheless, it is protected as a Class B species by the African Conservation Convention and is listed in CITES-I.

Nile Crocodile, *Crocodylus niloticus.* In many African states, reports the IUCN (1975), the Nile Crocodile has no legal protection, except where it occurs in wildlife parks. Yet the IUCN considers it "vulnerable," like most other crocodilians, because its numbers have declined throughout its range. The cause of the decline is largely overhunting for the world leather market. Crocodile populations undoubtedly can sustain a substantial annual harvest, but studies are needed to determine the numbers that can be taken without depleting the stocks.

Fish Fauna

The fish fauna of the Zaîre River and its tributaries still remains only partially described, but includes on the order of 1,000 species. Roberts (1973) has summarized the fish fauna of the Zaîre River basin as one of the richest in the world. Taxonomically, it is dominated by the Ostariophysi, particularly the superfamily Characoidea (15 percent of recorded species), Siluroidea (catfishes; 23 percent) and Cyprinoidea (16 percent). The Rift Lakes are biologically famous for their cichlid fauna, which includes many highly specialized forms found nowhere else. Lake Tanganyika is noted for biologically interesting and commercially important species such as *Stolothrissa tanganicae* and *Limnothrissa miodon.* As described by Beadle (1974), environmental stability over a relatively long period of time, a wide range of habitats, and prolonged periods of isolation have been characteristics of the basin and its fauna and have led to the evolution of a large endemic fish fauna. Thus, in the slow-flowing Cuvette Centrale portion of the river the elephant snout fishes (family Mormyridae) are the dominant group. In the extensive swamps of the region, the lungfishes (*Protopterus*) are particularly well adapted and correspondingly abundant. The many waterfalls and extensive sections of torrential flow (eg. Stanley Falls, the falls and rapids below Kinshasa, Portes d'Enfer and many others) have resulted in a number of special adaptations to life in this type of habitat and development of endemic species in seven families (Kneriidae, Cyprinidae, Amphiliidae, Mochokidae, Clariidae, Cichlidae and Mastacembelidae) according to Beadle. Suctorial mouths, flattened bodies, enlarged fins, loss of accessory air breathing organs (in the Clariidae) and, in some species, loss of eyes are among the structural adaptations to be found

among the members of the families exploiting the torrential flow habitat.

The upper Lualaba-Zaîre system is isolated by falls and rapids from the main Zaîre River and contains many endemic species of fish, as well as large number of Zambezian species, explained by past connections of this portion of the system with the upper Zambezi Basin. In addition, several species exist in the upper Lualaba-Zaîre Basin which are identical to Nile River fish, indicating a past connection with the Nile drainage. It is possible that Portes d'Enfer was the point of capture of the Lualaba-Zaîre by the Zaîre River as a result of the unwarping and volcanic action which was responsible for the formation of the Western Rift, probably during the Pliocene. There are, of course, also elements of the Soudanian (Nile) fauna in Lake Tanganyika.

The Ubangi River, a major tributary to the Zaîre from the north, contains species common to the Chad Basin, while the Kasai River, to the south, shows evidence of past intermittent connections with the upper Zambezi River, in a manner similar to that of the upper Lualaba-Zaîre.

The summary, the sheer size and temporal stability of the Zaîre River Basin, combined with past geological events and intermittent connections with other systems, has resulted in a fish fauna second in complexity only to that of the worlds largest river system, the Amazon. This fauna is of the utmost importance as a natural resource of Zaîre, both from a scientific point of view and as a food resource for the people.

Fisheries

As would be expected in a country with such a large inland water resource, Zaîre's inland fisheries are of major importance. For convenience, the fisheries resources of Zaîre may be divided into the following categories:

1. Marine Fisheries
2. Riverine Fisheries - Zaîre River and tributaries
3. Floodplain Lake Fisheries - e.g., Lakes Tumba, Mai-Ndombe, Upemba. Lake Moero can be included here.
4. Artificial Lake Fisheries - e.g., Lakes Nzilo and Mwadingusha.
5. Rift Lake Fisheries - Lakes Tanganyika, Kivu, Amin and Mobutu.
6. Fish Culture Producti on

This study has been provided data by the Office National de Peche (ONP), which is being reorganized and transferred to DECNT. The ONP estimates the fisheries potential from all inland waters to be at least 375,000 metric tons per year, while the potential production from Zaîre's marine waters is estimated at 20,000 MT/yr. The potential yield from aquaculture is not included in these estimates, since aquaculture is not fully developed. The ONP estimates the potential and actual production from the six categories of fisheries as shown in Table II-12.

Table II-12

POTENTIAL AND ACTUAL PRODUCTION FROM ZAIRE FISHERIES

Resource	Estimated Production (MT/yr)	Potential Production (MT/yr)
Marine	1,000	20,000
Riverine	60,000	120,000
Floodplain Lake	13,500	43,500
Artificial Lakes	6,000	8,500
Rift Lakes	30,000 - 35,000	203,000
Fish Culture	?	?
Totals	110,500 - 115,500	395,000

It is evident that none of these fisheries resources are currently exploited fully. In terms of the percent of the potential currently being exploited, the marine and rift lake fisheries appear to be the most underutilized. This is significant. They represent the largest and the fourth largest of the six identified fisheries resources and were once the most highly developed fisheries. The riverine fishery represents a special case, for not only is the potential yield of this complex resource poorly known but the figure for present production is little more than an educated guess. Much of the fishing done in the rivers is for domestic consumption or is semi-commercial, highly localized, and practically impossible to evaluate quantitatively. It is clear, however, that, although the riverine fisheries are not well studied, their potential production is great.

Two recent, detailed analyses have been made of the fisheries resources of Zaîre by consultants (Aubray, 1976, and Bard, 1973). These studies form the basis for the discussion below.

Figure 2. Salted fish (*Tilapia*) drying in the sun in the fishing village of Vitshumbi on the eastern shore of Lake Idi Amin.

Marine Fisheries. Zaîre has a very short coastline, 40 km long, and most of the nation's coastal waters lie in the deep trench cut by the Zaîre River. This area is less productive for artesanal fishermen than the continental shelf areas of neighboring countries. Unfortunately, the recent extension of national waters to 200 miles (300 km) denies the productive continental shelf waters to Zaîrian fishermen.

Aubray cites six genera (Table II–13) as the most important marine fishes exploited in Zaîre.

At one time a fleet of 11 trawlers operated out of Zaîre, ranging in length from 20 to 60 meters. The operation was run by the Societe des Peches Maritimes du Zaîre. By 1981, however, only one was left in operating condition (ONP, pers. comm.).

About 300 artesanal fishermen operate in coastal waters off Banana and Vista, using pirogues, gill nets, and beach seines.

Table II–13

MAJOR GENERA OF COMMERCIALLY IMPORTANT MARINE FISHES

Genus	French Name	English Name
Arius	Machoirons	Sea Catfish
Murgus	Dorades roses	
Pomadys	Dorades grises	
Polynmus	Capitanes	Threadfish
Cynoglossus	Soles	
Otolithus	Bars	

Riverine Fisheries. The fishery of the Zaîre River system is diffuse, varied and conducted on a subsistence or semi-commercial level. Weirs, traps, hand lines and seines are used. It is estimated that at least 50,000 people fish on a com-

mercial basis (Kaplan, 1979). The major species taken are listed in Table II–14.

Floodplain Lakes. The lakes of the Kamelondo Depression are reported by Bard (1973) to support a population of more than 8,000 artesanal and commercial fishermen, with some 50 motorized boats and more than 4,000 pirogues. Seines, gill nets, dip nets and hand lines are employed. The major fish taken is Tilapia, which is marketed salted or smoked, mainly in Lubumbashi. Bard estimates the total catch at 4,000 MT/yr.

Lakes Tumba and Mai-Ndombe are reported by Aubray (1976) to be major sources of fish, but no information is given on production, species taken, numbers of fishermen, or gear used.

Lake Moero is reported to have once had a fish production of as much as 18,000 MT/yr, of which 65 percent (perhaps 12,000 MT/yr) was taken in Zaîrian waters (Aubray, 1976). Some 2,000 fishermen, mostly with pirogues, fished Lake Moero, using gill nets, hand lines and dip nets. The majority of the catch comprised fish of the genera *Tilapia, Alestes, Chrysichthys, Hydrocyon, Auchenoglanis, Barbus, Labeo* and the mormyrids. The catch was sold fresh, smoked or salted, the major market being the Lubumbashi area.

Table II–14

COMMERCIALLY IMPORTANT FRESHWATER FISH SPECIES

Scientific Name	Local Name	English Name
Mormyrops deliciosus	Nzanda	
Hydrocyon goliath	Mbenga	
Distichodus faciolatus	Mboto	
Citharinus congicus	Lompongo	
Caecobarbus sp.	Mbrokoso	
Labeo velifer	Elolo, Mompongo	
Labeo lineatus	Monganza	
Gephyroglanis congicus	Mosombo	
Eutropius grenfelli	Lilangwa	
Lates niloticus	Nzabi, Kapeteni	Nile Perch
Tilapia sp.	Mabundu	
Crysithis wagenaari	Nkamba	
Auchenoglanis occidentalis	Mpoka	
Protopterus dolloi	Nzombo	Lungfish
Citharinus gibbosus	Mayanga	
Clarias lazera	Ngolo	

Artificial Lakes. According to Bard (1973), Lake Mwadingusha supports some 400 fishermen, who take an estimated 450 MT/yr, mostly *Tilapia*. The catch is sold in Likasi, mostly fresh. Lake Nzilo is estimated to produce about 153 MT/yr, although the work force also comprises about 400 fishermen. Their catch is sold fresh or smoked, mainly in Kolwezi.

Rift Lake Fisheries. The fisheries in the Rift Lakes have been more intensively studied than any other sector of the inland aquatic resources of Zaîre. In the past the lakes supported a heavy commercial fishery, but production in Zaîrian waters has dropped off considerably in recent years.

Lake Tanganyika has a highly diverse fish fauna, with more than 200 species, but the fishery is based almost entirely on two small members of the herring family, **Clupeidae,** *Stolothrissa tanganicae* and *Limnothrissa* miodon, both called "ndakala," and on their predators, larger fishes of the genus *Lates* Ndakala are plankton feeders with short life cycles (about 6–18 months) and movements around the lake apparently are geared to seasonal peaks of phytoplankton.

Ndakala are fished at night, using a light to attract them. The gear includes scoopnets, liftnets and for industrial-level fishing, purse seines. The traditional method is using a scoopnet from a pirogue and this is still widely done. Some improvements in catch are realized by making a catamaran out of two pirogues and employing a liftnet.

Industrial purse seines, with boats of 12 meters or longer, were introduced on Lake Tanganyika in 1958 and by 1975 numbered 16 units in Zaîrian waters. In 1975 the boats were nationalized, according to Aubray, and the number now operating is much reduced (Hall, ed., 1975).

Ndakala are sold either fresh or dried. Most of the catch from the Uviva area, at the north end of the lake, is sold fresh, while at Baraka and Fizi it is dried in substantial quantities (Hall ed., 1975). Aubray (1976) estimates the 1975 catch at 22,000 MT/yr, while the ONP gives a figure for the current catch at 14,800 MT/yr.

Lake Kivu, with its highly mineralized water and large mass of anoxic, methane-producing, hypolimnetic water, historically supported only a limited fishery and was not considered an important resource. Both species of ndakala were introduced in the lake during 1958, 1959 and 1960, however, (Collart, 1974) and

Limnothrissa is now well established. Bard (1973) reported that only a few domestic or artesanal fishermen were active, taking mostly Tilapia and occasionally, with dip nets, some ndakala. According to the ONP, the ndakala fishery is improving, due in part to the commercial extraction of methane. An annual production figure of 1,700 MT is given.

Lake Idi Amin (Lake Edward) is reported to produce between 1,500 and 3,000 MT/yr (ONP; Aubray, 1976; Bard, 1973) with about 300 fishermen working the Zaîrian waters. Some of these inhabit village enclaves within the Virunga National Park. The principal species taken are *Tilapia nilotica, Barbus altianalis, Bagrus docmac, Clarias lazera,* and *Protopterus* aethiopicus.

The boats include pirogues (with and without outboard motors) and barges powered by inboard engines. Gill nets are used by the smaller boats, large seines by the barges.

Lake Mobutu produced 10,000 MT of fish in 1959. In addition to about 600 family pirogues, there were 14 industrial units, each with five to ten boats, which were towed each night to specific fishing spots. Gill nets, 500–1000 m in length, were used. The predominant species in the catch were *Lates* species, *Hydrocyon* species, and *Alestes distichodus.*

Recent estimates of Lake Mobutu fish production suggest only a slight decline, to about 9,000 MT/yr. Aubray (1976) estimates that about 18,000 fishermen work the Zaîrian waters of the lake.

Fish Culture. In 1960 Zaîre had about 4,200 ha of fish ponds, which produced a total of about 1,300 MT of fish (an average of about 300 kg/ha). Production in those ponds apparently fell during the 1960's and 1970's, due to lack of government support. Only recently have new fish culture programs been instituted, with good success.

In the mid–1970's U.S. Peace Corps volunteers began the development of fish ponds in the

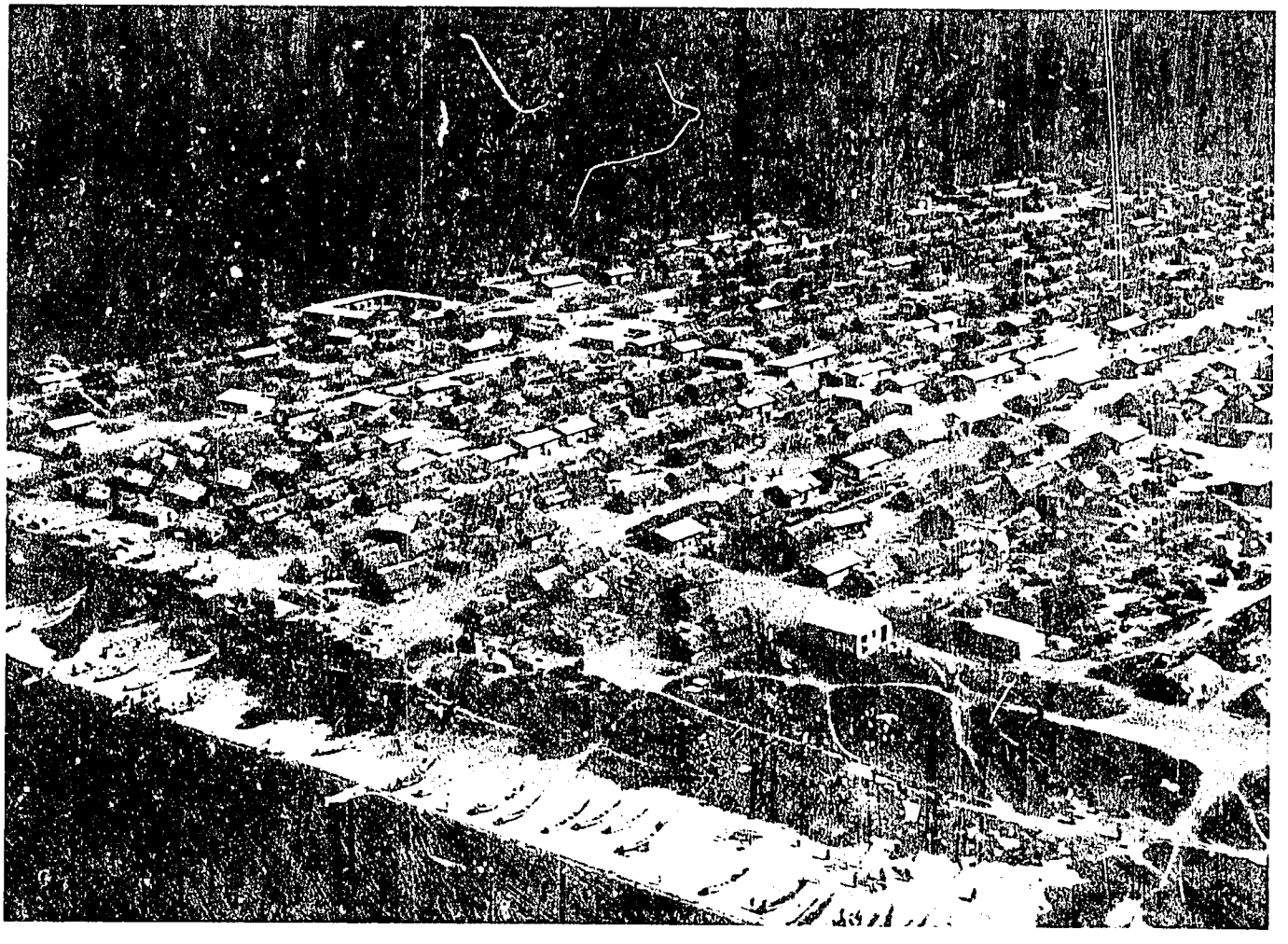


Figure 3. Fishing village of Ishango, on the south shore of Lake Idi Amin, within Virunga National Park.

Bulungu area of Bandundu Region. Following early successes the program was expanded, with USAID funding, to other parts of Bandundu and Kasai Occidental. Currently the program continues to enjoy success and further expansion is planned, with extension assistance, into the Kinshasa area, Kasangulu, Madimbu, and Mbanza-Nyumgu. Zaîrian extension agents are being trained in order to gradually replace the Peace Corps personnel. The program is called Project Pisciculture Rural and rests in the Departement de l'Agriculture et de Developpement Rural of the Ministry of Agriculture. A training and research center is being established at Gandajika, Kasai Oriental.

Although no figures have been located for the number of fish culture ponds that have been developed as a result of this project, and production data also are lacking, yields of the ponds are reported to be good and established fish farmers have no trouble selling the fish produced beyond their own needs, even at pondside. Project staff reports that when one successful pond has been developed in an area neighbors often construct ponds of their own.

National Parks and Reserves

The national parks, with their attractive scenery and dense populations of large animals, form the mainstay of Zaîre's attraction for foreign tourists, as well as providing, to a highly variable degree, protection for the country's dwindling wildlife and some areas for scientific research. The system of national parks and hunting reserves is extensive and well established, having begun in 1925 with the establishment of Albert (now Virunga) National Park, followed within five years by Garamba (1938) and Upemba (1939). At Independence, Zaîre's national park system totaled 23,000 km^2, but four additional parks were established in 1970, bringing the total area to 70,260 km^2, which was increased two years later to 70,800 km^2 with the increase of Kahuzi-Biega National Park from 60 to 600 km^2.

The locations of the seven parks are shown on Map 3 and their characteristics are given in Table II–15.

Administration of the national parks and reserves is the responsibility of the Institut Zaîrois pour la Conservation de la Nature (IZCN), which is under the "tutelle" of DECNT. The parent agency establishes administrative guidelines relating to numbers of staff, salaries, and the management of real estate. The IZCN was created in 1978 (Ordinance-Loi 78–190) as successor to the Institut National pour la Conservation de la Nature (INCN). The predecessor organization was formed in 1967 (Ordinance-Loi 67–514) with the following responsibilities:

- to assure the protection of the nation's flora and fauna.
- to establish and manage scientific centers for research relating to conservation and tourism.

The IZCN is headed by a Delegue General, assisted by an Administrative Council and a Management Committee. The work of the Institute is carried out by four directorates, for finance, administration, science and technology, and personnel.

Parc National des Virunga. Located in the Virunga Mountains at the edge of the Rift Valley, Virunga National Park is the oldest such park in Africa, having been established in 1925, as Albert National Park. The original park comprised the present 8090 km^2 of the Zaîrian park and a smaller contiguous area now in Rwanda.

Table II–15

NATIONAL PARKS OF ZAIRE

Name	Region	Year Established	Legal Basis	Area, km^2
Virunga	Kivu	1925	Decree	8,000
Garamba	Haut-Zaîre	1938	Decree	5,000
Kahuzi-Biega	Kivu	1970	O-L 70/316	600
Kudelungu	Shaba	1970	O-L 70/317	1,200
Maiko	Kivu	1970	O-L 70/312	10,000
Salonga	Equateur	1970	O-L 70/318	36,000
Upemba	Shaba	1939	Decree	10,000
			Total	70,800

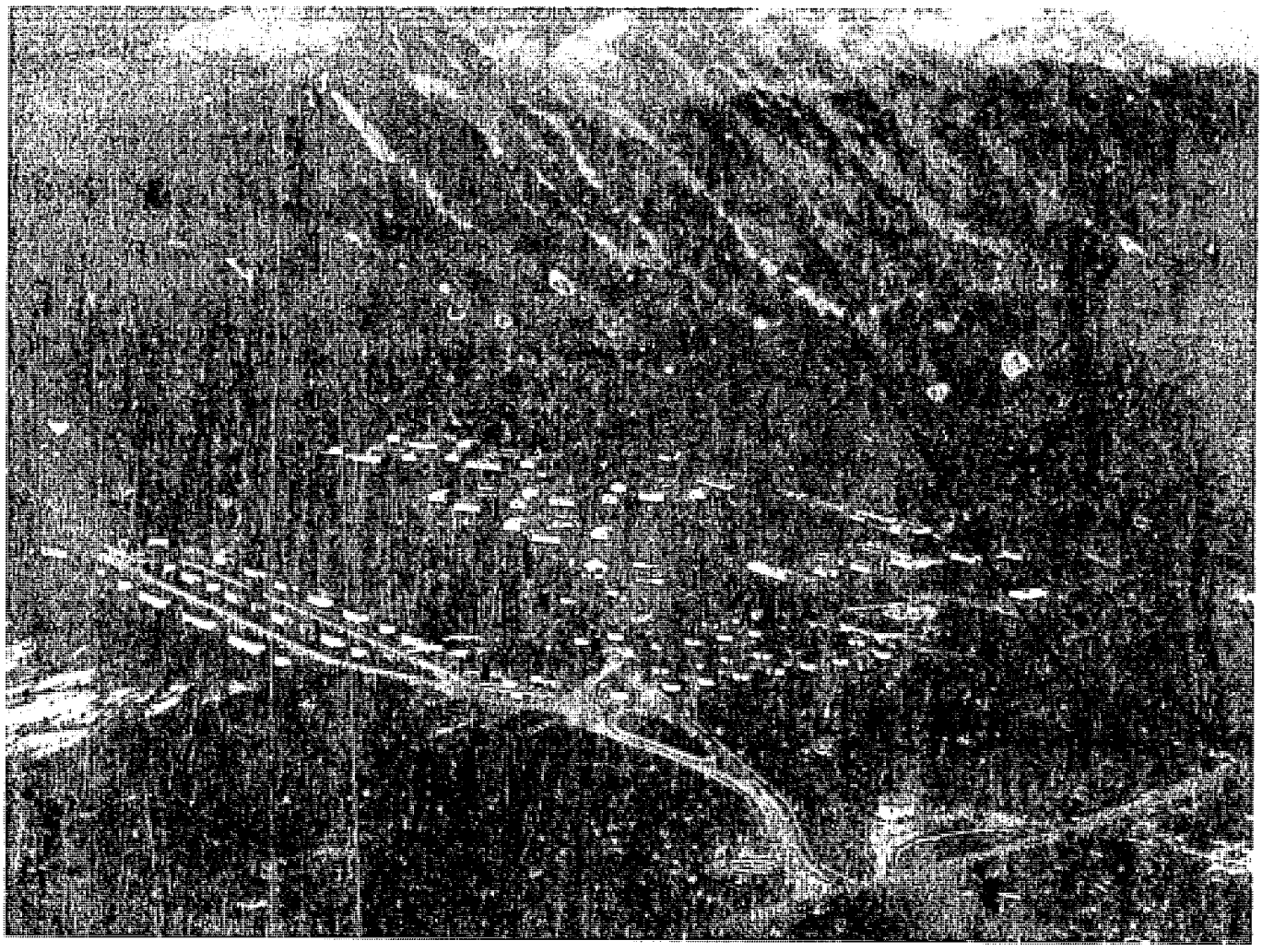


Figure 4. Tourist camp at Rwindi, Virunga National Park. Visitors must bring their own vehicles but are provided excellent accommodations and the services of game scouts.

Virunga is widely considered one of the world's most beautiful parks. It contains active and extinct volcanoes, lava fields of various ages, the Ruwenzori Mountains, which reach elevations of 5,000 m, and a variety of plant formations. The large amount of altitudinal variation, combined with the location of the Ruwenzoris at the meeting of the Sudano-Guinean and East African vegetation zones, results in interesting and varied plant species, many of them endemic to the region.

The vegetation varies from the southern end of the park, where it is largely savanna with riverine forest incursions, to the north, where there is a closed dry forest dominated by *Euphorbia dawei*. The animal and plant life of Virunga is its main attraction, both for tourists and for scientists. Von der Becke (1977) listed more than 70 species of large mammals occurring in the park. Some of these, such as the Mountain Gorilla and many of the cats, are infrequently seen by tourists, but others form the core of the tourist experience. The plant formations and their resident mammals have been studied by Verschuren (1975) and Mankoto (unpublished). Kabala (1976) gives the populations of major mammals shown in Table II–16. Kabala's figures must be taken as rough estimates, since they are not based on actual counts. Mankoto (1981, pers. comm.) suggested the population of Kob is around 40,000, but this too is an educated guess.

Tourism facilities are fairly well developed but the tourist without independent means of transportation finds transportation extremely expensive. An excellent modern hotel at Rwindi, near the southern end of the park, provides a comfortable base for excursions on the park roadways and footpaths. The requisite game scouts are available at low cost to guide

Table II-16

MAMMAL POPULATIONS IN VIRUNGA NATIONAL PARK a/			
Species	Southern Plain	Semliki Plain	Northern Forests
Mountain Gorilla	---	---	300
Lion	300		
Elephant	800	500	2,000
Hippopotamus - total of all regions - 30,000			
Warthog	3,000		
Forest Hog	1,000		
Antelope (All spp)	15,000	3,000	
Buffalo	10,000	1,000	

a/ Source: Kabala (1976)

and protect visitors. In addition to the Rwindi center, there are stations at Rumangabo, further south, and at Mutsora, at the north end of the park. There is also a research station at Lulimbi, on the eastern shore of Lake Amin, which serves as the research headquarters for the entire national park system. Ongoing (1981) studies at the Lulimbi Research Station include a vegetation survey and grassland ecology study, population studies of hippopotamus and studies of local and migrant birds. The bird work, in its twelfth year, has provided valuable data on the migration of Eurasian birds, through the capture of marked birds from the northern hemisphere and the banding of birds that are subsequently recaptured on their breeding grounds. To date, more than 40,000 birds have been marked at Lulimbi.

Parc National de la Garamba. One of the three original national parks, Garamba is located in the northeast corner of the country, along the Sudanese border. Its 4,910-km^2 area supports wooded savannas and dense thickets. Along the Uele River and its tributaries are fine stands of gallery forest.

Garamba is rich in many species of plains wildlife, including several endangered species. The most important, from the point of view of world conservation, is the Northern White Rhinoceros (*Ceratotherium simum cottoni*). In 1963, shortly after Independence, a census indicated a population of 3,000 individuals (Kabala, 1976). Four years later Curry-Lindahl estimated that no more than 50 remained, a number that Kabala has questioned. Whatever the actual figure, authorities agree that poaching and the civil disturbances of the 1960s took a heavy toll. A census in 1972 indicated a population of 121. In 1976, however, an FAO survey of the park produced an estimate of 400, which is probably more than half the total population of the subspecies. A large number of calves was seen in the 1976 census, indicating a healthy and expanding population (Savidge, Woodford and Croze, 1976 in IUCN, 1978).

The 1972 census of Garamba produced the figures for the larger mammals provided in Table II-17 (Kabala, 1976):

The numbers produced by the 1972 census must be accepted cautiously, since they appear to favor animals such as elephant and buffalo, that are most conspicuous. The significance of

Table II-17

MAMMALS OF GARAMBA NATIONAL PARK		
Colobus Monkey	Colobus polykomos	14
Baboon	Papio doguera	64
Lion	Panthera leo	73
Leopard	Panthera pardus	7
Spotted Hyena	Crocuta crocuta	33
Elephant	Loxodonta africana	5,033
Hippopotamus	Hippopotamus amphibius	24
Warthog	Phacochoerus aethiopicus	1,335
Square-lipped Rhinoceros	Ceratotherium simum	121
Giraffe	Giraffa camelopardalis	284
Roan Antelope	Hippotragus equinus	69
Kob	Kobus kob	1,809
Defassa Waterbuck	Kobus defassa	1,639
Bubal Hartebeest	Alcelaphus buselaphus	2,094
Reedbuck	Redunca redunca	209
Oribi	Ourebia ourebia	141
Buffalo	Syncerus caffer	9,130

the census lies in the substantial populations of certain species, such as Giraffe and Square-lipped Rhinoceros, that are found nowhere else in Zaîre, and in the presence of several endangered or threatened species, Rhinoceros, Leopard and Elephant.

Garamba National Park is relatively infrequently visited by tourists, receiving usually less than one-tenth the number visiting Virunga and one-third the number going to Kahuzi-Biega (Office National du Tourisme, 1980). Nevertheless, it is considered by Kabala to hold considerable potential as part of a northern park circuit that would include the Ituri Forest, Lake Mobutu and the Kisenyi Plain.

Parc National de Kahuzi-Biega. Although the smallest of Zaîre's national parks, Kahuzi-Biega ranks second, after Virunga, in tourist attendance. Located in Kivu Region about 50 km from Bukavu, the 600-km^2 park enjoys the combination of accessibility, attractive vegetation, and a wealth of large mammals. Its foremost attraction certainly is its population of Mountain Gorilla, some groups of which have become sufficiently accustomed to human presence to allow close approach (see, for instance, the account by Matthiessen, 1981). The total population of gorillas in this park has been estimated at 250 and is believed to be stable (IUCN, 1975).

A study of the Mountain Gorilla was begun in 1978, funded by the World Wildlife Fund, African Wildlife Leadership Foundation, Fauna and Flora Preservation Society, and Peoples Trust for Endangered Species.

Kahuzi-Biega is better staffed than most of the larger parks, having 40 full-time, on-site staff. There are no hotel facilities in the park (it being close to Bukavu) but there is a base camp for guards and guides.

Parc National des Kundelungu. In Shaba, about 170 km from the city of Lubumbashi, lies the 2,200-km^2 wooded grassland park of Kundelungu. It consists of a series of high plateaux cut by the Lofoi River and its tributaries. The principle vegetation is the wooded savanna called "miombo," with gallery forest along the rivers. Scenic vistas are provided by 400-meter cliffs along the edge of the Lufira valley and by falls on the Lofoi 342 m high.

The fauna of Kundelungu is quite well known (listed by Kabala, 1976) and includes the African Wild Dog (*Lycaon pictus*), Leopard (*Panthera pardus*) and Cheetah (*Acinonyx jubatus*), all listed as "vulnerable" by IUCN (1978). The ungulates also are especially well represented, as are the primates. Kundelungu is the only park in Zaîre with substantial populations of Zebra (*Equus burchelli boehmi*). It also has large and varied populations of antelope.

The close proximity to the major urban center of Lubumbashi, the open nature of the vegetation, and the substantial numbers of game animals have made Kundelungu attractive to commercial hunters (IUCN, 1975). To date the park staff has been neither numerous enough nor well enough equipped to control poaching.

Tourism has been low in recent years. Kabala (1976) reported that more than 300 tourists visited the park in 1972, whereas ONT reported only 42 and 96 for the years 1978 and 1979, respectively. The apparent drop could be an artifact of the record keeping system, but whichever figures are correct, this large park is clearly underutilized.

Parc National de la Maiko. This large and relatively undeveloped park, about 10,000 km^2 in area, is located on the border of Kivu and Haut-Zaîre. Kabala (1976) has called this one of a half-dozen blocks of primary forest remaining unspoiled in all of Africa. It is primarily dense humid forest of low to medium altitude (700–1300 m) that is intermediate between the lowland rainforest of the Cuvette and the montane forest of the Eastern Highlands.

The total lack of roads, extremely high rainfall — there is no dry season — and distance from population centers have protected Maiko and its fauna from most human incursions. The fauna contains significant populations of Zaîre's three rarest animals: the Mountain Gorilla (*Gorilla g. beringei*), Okapi (*Okapia johnstoni*) and the Congo Peacock (*Afropavo congensis*). Other animals represented are the small forest antelope (duikers) and the forest forms of elephant and buffalo.

There are no tourist facilities in the park, but there are scientific stations near Epulu and at Gangala na Bodio.

Parc National de la Salonga. This large, forested park, approximately 36,000 km^2 in area, is located at the extreme southern edge of Equateur Region and the northern parts of Bandundu and Kivu Occidental. It consists of two sections, separated by a zone about 40 km wide. The northern section lies between the Lomela and Loile Rivers and consists of a slightly dissected plateau that slopes from 530 m elevation in the east to about 350 m in the west.

The southern section is bounded by the Luilaka and Lula Rivers and slopes from about 700 m elevation in the southeast to about 350 m in the northwest.

The park is essentially covered with equatorial forest, which falls into three distinct types: swamp forest, riverine forest, and dry forest (IUCN, 1975). The northern section is characterized by a grassland vegetation occupying clearings that may be several hundred hectares in extent and are known locally as "botokadjoku" or "elephants' bath." The southern section contains more open grassland known as "esobe."

The fauna of Salonga contains many species adapted for forest habitat. Noteworthy among these are:

- Pygmy Chimpanzee, *Pan (troglodytes)* paniscus. This species is found only in Zaîre, where it inhabits primary and secondary forest. The IUCN (1976) reports it as extinct in Salonga but Kabala (1976) reports it present.

- Forest elephant, *Loxodonta africana* cyclotis. This subpecies of the African Elephant is smaller than the nominate *L. a. africana* and differs from the latter in head slope and in the size and position of the tusks.

- Pygmy Elephant, *Loxodonta africana* pumilio. The taxonomic status of this form is extremely uncertain, as are its ecology and distribution. Dorst and Dandelot (1969) suggest that *L. a. pumilio* may represent only the smaller individuals of the Forest Elephant, but Kabala (1976) regards the Pygmy Elephant a separate species and lists it as being particularly numerous in the southern section of Salonga.

- Congo Peacock, *Afropavo congensis*. Although not considered endangered or threatened by the IUCN, this little-known member of the pheasant family is rarely seen. Matthiessen (1981) found few people in Zaîre who had ever seen this shy bird. The IUCN (1975) lists it as present in Salonga National Park.

There is relatively little tourism development at Salonga and the ONT listed no tourist visits for 1978 and 1979. Accessibility is limited and movement within the park is hindered by the lack of roads. Surveillance by the administration is performed largely by river, using pirogues equipped with outboard motors. The headquarters for the northern section is at Mondjoku, a small town near the Loile River; the headquarters for the entire park and the southern section is at Monkoto. The park reported a staff of 52 in 1974 (IUCN, 1975), which included the Conservateur, Chef de Poste, 30 guards and 20 workers.

Parc National de l'Upemba. The large national park of Upemba, founded in 1939, is located in the central part of Shaba Region. The park comprises about 10,000 km^2 (9,500 according to IUCN, 1971) of which most of the terrain is savanna, with gallery forest along the watercourses. Substantial areas of miombo woodland also occur. The large, shallow Lake Upemba lies at the northwest edge of the park, about two-thirds of it being outside the park. With other lakes of the Kamolondo Depression, the lake provides the park with a vast system of wetlands. The Lufira River flows through the center of the park, dividing it into the Kibara Plateau, to the northwest, and the Biano Plateau, on the southwest.

Human Population

The people of Zaîre, representing more than 200 linguistic and ethnic groups, possess a rich, varied, and often conflicting ethnic, religious, and cultural heritage. Exact population size and characteristics are not known and estimates are varied and contradictory. The official source of current national population data is an administrative census conducted in 1970, the most recent demographic survey having been conducted in 1955–57. The 1980 population of Zaîre is estimated at 26,377,000 (Boute and de Saint Moulin, 1978). The growth rate is itself increasing rapidly, from an annual rate of about 2.0 percent in the early 1950's to about 2.8 percent in 1981. By the year 2000, it is expected that the population will have increased about 80 percent, to some 44 million people.

Distribution and Movements

Population density, averaged over the entire area of Zaîre, 2,300,000 km^2 (905,000 mi^2), is relatively low, a mean of approximately 12 persons per square kilometer in 1980. This represents a significant increase over the 1970 figure of 9.2. Distribution of the population, however, is so irregular as to render averages meaningless. There are wide disparities not only between urban and rural areas, but among rural areas in different regions.

Most of Zaîre is thinly populated. Areas of poor soils, high heat and high humidity are estimated to contain no more than five persons per square kilometer. These areas include swampy parts of the Cuvette Centrale, heavily forested equatorial regions, the northern upland savanna of Haut-Zaîre, and parts of the southern savanna. More densely populated, with over 25 persons per square kilometer, are the southern upland savannas, from the Atlantic coast to the center of the country at Mbuji-Mayi, in western Kasai Oriental.

Another area of dense rural settlement occurs in the Eastern Highlands of Kivu, where rich volcanic soils and favorably distributed rainfall combine to produce high yields from traditional farming systems. Fertile soils and a temperature climate made this area attractive for Europeans and competition for prime land appeared early in the colonial period, further increasing population density. Appropriation of much of the prime farm and pasture land by large plantations and agro-industrial firms, combined with pressures to cash crop, led to land shortages, soil loss through erosion, and malnutrition among the peasantry. By 1937, there were already more than 100 persons per square kilometer (Bashizi, 1978).

The trend toward higher densities is nowhere more felt than in the cities. Even at Independence in 1960, Zaîre was one of the most industrialized countries of Sub-Saharan Africa, and one of the most urbanized, with approximately one million workers — about 13 percent of the male work force — in salaried employment. Population growth in the cities greatly exceeds that of the country today as a whole. Urban populations presently are increasing at 6–8 percent annually, several times the national growth. Rural to urban migration is a major factor, but lower urban infant mortality rates also are implicated as a cause of the disparity. In 1973 about 25 percent of Zaîre's population lived in cities, and even optimistic projections, assuming a 60 percent decrease in the rate of urban growth, place some 47 percent, about 14.8 million, of the country's nearly 50 million people in urban areas by year 2000 (Boute and de Saint Moulin, 1978).

Ethnicity and Language

The precise number of ethnic groups and spoken languages in Zaîre is a matter of considerable debate among scholars. The "Carte Ethnographique du Congo" (Boone, 1967) identifies 250 languages; Mafuta (1974) finds 450. The great variety of cultures have been grouped into 12 "cultural clusters" (Vansina, 1966). Four major linguistic groupings of the Great Niger-Congo family are found in Zaîre (Greenberg, 1971): Bantu languages, spoken by the vast majority of Zaîrians (about 80 percent),and Adamwa-Eastern, Eastern-Sudanic and Central Sudanic, spoken in the northeastern part of the country.

Four Bantu languages are widely spoken and are official national languages, used exclusively in the first two years of state primary school in their respective areas. French, the fifth official language, is introduced in the third year. The Bantu languages are:

- **Lingala,** a trade lanuage originating on the Zaîre River in Equateur, is the official language of the armed forces and is widely spoken in the capital and in Haut-Zaîre.
- **Kikongo,** the language of the ancient Kongo Kingdom, which extended from Angola to Congo-Brazzaville, is widely spoken in Bas-Zaîre, Bandundu and the capital.
- **Tshiluba,** the language of the populous Luba group, is spoken in the Kasais and in the Shaba copper belt. It also is the language of the closely-related Kiluba speakers of central and northern Shaba.
- **Swahili,** the oldest of the trade languages, is spoken in the eastern region of Haut-Zaîre, Kivu and Shaba. It is also widely understood in the Kasais, as a result of return migration from the copper belt. While the local dialect Kingwana, is markedly different from East African Swahili, mutual intelligibility facilitates international communication.

Two exceptions to the above occur: in the Sankuru Subregion of Kasai Oriental the local language, Kitetela, is used in the schools, and in Mbandaka, capital of Equateur Region, Lomongo is the language of instruction.

The major cultural clusters, peoples sharing features of social structure, material culture and world views, include:

- The Mongo people of the central Zaîre basin.
- The Lega cluster in Maniema, Kivu.
- The agro-pastoralists of the Eastern Highlands.

- Peoples of eastern Shaba: derived from the Bemba, Hemba and Lunda.
- The Lunda themselves.
- The Luba in upper Kasai and Shaba.
- The Tio and Kuba clusters in lower Kasai.
- The Yaka, Mbala, Pende and Lenda clusters in the Kwango-Kasai area.
- The Kongo of Bas-Zaîre.
- Non-Bantu peoples in Haut Zaîre, of three linguistic groups, Zande, Mangetu and Alur.
- Remnant Pygmy groups, whose ancestors are believed to have been the original inhabitants of the equatorial and montane forests.

Cultural traditions remain strong in all groups, even after dislocation from the ancestral areas. Among urban dwellers whose families have been city dwellers for several generations, family and community celebrations mark culturally significant passages such as births (especially the birth of twins), marriages, funerals, graduations and communions. Such occasions call for extensive gatherings of relatives and social ties are combined with economic exchanges of many kinds.

Many aspects of modern Zaîrian culture are based on ancient traditions. Precolonial social structures included groups organized into territorial states and autonomous village societies based on kinship. The so-called "matrilineal belt" of Central Africa cut across southern Zaîre; societies in the north were mainly patrilineal in their assignment of group membership. The extent to which differences of age, sex, wealth and descent were reflected in differences of social status varied among the different groups. All except the Pygmies engaged in agriculture, for the most part based on long fallow rotation cycles. Some were pastoralists and certain riverine and lacustrine groups specialized in fishing. Crafts were the work of specialized artisans. In some groups a long-distance trade in metals, salt, fish, cola nuts and other products existed from ancient times. Metallurgy of iron and copper was highly developed.

In some groups the status of women was quite high, particularly in matrilocal groups such as the Belemba of southeastern Shaba, where women remained with their natal kin following marriage. Not only were there women chiefs and counsellors, but common women were permitted to take part in discussions.

Health and Disease

The people of Zaîre suffer from the diseases and parasites common to most tropical African countries. The national health care system, like many other government services, is underfunded, lacking information on disease distributions and prevalence, and poorly staffed. Modern medical care is accessible to only a minute fraction of the urban poor and even fewer of the rural poor.

The burden of disease and parasites is often compounded by malnutrition, which raises the mortality rates of many diseases, especially among infants and elderly people. Not only is the average caloric intake below the minimum level recommended by nutritionists, but the percentage of protein in the diet often is extremely low.

The CEP team found no recent figures on the prevalence of any disease in Zaîre and were repeatedly told that any figures that were found would be loose estimates. The following picture of disease and parasite levels is drawn from Hunter et al. (1976) and from the Phase I Report (LC, 1979).

Malaria. A least three species of malaria are present in Zaîre, with *Plasmodium falciparum* being the most prevalent. Both urban and rural areas are heavily infected. The CEP Team was told that the rate of infection is more than 20 percent, nationwide. Mosquito control programs are infrequent and currently are focused on domicile spraying with DDT. Fortunately, in Zaîre resistance to chlorinated hydrocarbons has not been reported in the mosquitoes and chloroquin-immune strains of *Plasmodium* also have not been found.

Trypanosomiasis. "Sleeping sickness" is widespread in Zaîre, with foci in eastern Bas-Zaîre, Equateur, Haut-Zaîre, the Kasais and northern Shaba (LC, 1979). The taxonomy and the epidemiology of the disease organism are complex, controversial and incompletely known (Ormerod, 1976). The infectious protozoan, *Trypanosoma gambiense* (according to Hunter et al., 1976; but *T. congolense*, according to Ormerod) is transmitted by several species of tsetse fly (principally *Glossina palpalis* and *G. tachinoides*). A second species of trypanosome, *T. rhodesiense*, occurs in savanna areas of Tanzania, Zambia and several other East African countries and may be presumed to occur in comparable areas of Shaba. It is transmitted by *G. morsitans*, *G. palidipes* and *G. swynnertoni*. The Gambian form has no

known animal reservoirs; the Rhodesian form has been found in sheep, monkeys and antelope.

Trypanosomiasis is a progressive nervous system disease in which the patient declines over a period of months, or occasionally years, from mild fever and lymph system involvement to nervous system deterioration, coma and death. The actual cause of death may be malnutrition brought on by or exacerbated by the effect of the disease.

Schistosomiasis (*Bilharzia*). Zaîre has the dubious distinction of harboring three schistosome-caused diseases: intestinal schistosomiasis (caused by *Schistosoma mansoni*), urinary schistosomiasis (by *S. haematobium*) and the intercalatum form (by *S. intercalatum*). The three maladies differ somewhat in pathology but have similar life cycles. Other schistosomes, such as *S. mattheei* and *S. rodhaini*, whose normal hosts are bovines, rodents and dogs, are known to infect man on occasion, sometimes at high rates. Cases have been reported from Zaîre (Hunter et al., 1976). Schistosomes are blood flukes that cause severe tissue damage and ultimately death, severe cases resulting from multiple infections of the worm.

The life cycles of the three major schistosome species are similar. Eggs shed in urine or feces of the infected person hatch in fresh water into free-swimming "miracidia." These must find an aquatic snail of the appropriate species within about 24 hours. The miracidia burrow into the tissues of the host snail and become transformed into "mother sporocysts," each of which produces a large number of "daughter sporocysts." These migrate to the gonads of the snail, where each produces hundreds of thousands of free-swimming, fork-tailed "cercariae." These leave the snail and remain in the water, attached to the surface film or resting on the bottom, until taken out of water on the skin of a person. The cercariae burrow into the skin and enter the peripheral venules of the blood system. They are carried to the larger blood vessels and to the liver. After a period of rapid growth the male and female join and copulate. Eggs are shed into the urinary or excretory system to continue the cycle.

Schistosomiasis is difficult to control without a comprehensive program that combines snail control, sanitation and treatment of clinical cases. Hunter et al. (1976) report that surveys have demonstrated infection rates in Zaîre of well over 50 percent. Many types of development are known to increase the risks of schistosomiasis, by improving ecological conditions, or by increasing the likelihood that persons will wade or bathe in water containing schistosome contaminated snails.

Onchocerciasis. River blindness, as the disease caused by the filarial worm *Onchocerca volvulus* is commonly known, is transmitted by the bite of a blackfly, usually *Simulium damnosum* in tropical Africa. These insects are found near well oxygenated small rivers and streams. The disease is widespread in some villages in Kasai Oriental (LC, 1979). The actual rate of blindness is a percentage of infected individuals. Anderson et al. (in Hunter et al., 1976) reported that up to half of the adults in a heavily infected Guatemalan community may be blind. Since the disease becomes progressively more severe as more of the filarial parasites are accumulated in the body, the older adults are more likely to be blinded than the young.

Bancroftian Filariasis. The most common manifestation of this widespread tropical disease, severe swelling of the limbs, has given it the common name of "elephantiasis". In fact, this is merely one of the more conspicuous, but rarer, symptoms of the disease when it has reached its clinical phase. The parasite, *Wuchereria bancrofti*, is transmitted by the bite of any of about 70 species of mosquitoes. Initial symptoms appear within about three months of infection with the parasite and often pass unnoticed or are attributed to some other disease; they consist of stiffness of a limb, swelling, pain or redness of the limb or of the scrotal region. Usually the lymph system is involved and it is this progressive blockage of the lymph system, and the body's response of producing new tissue, that leads to swelling of the legs, scrotum or breasts.

The extent of infection by *W. bancrofti* in Zaîre is not known, but it probably is high, since the mosquitoes are widespread and little attempt is made to identify or isolate cases. Victims of elephantiasis may be seen begging on street corners in Kinshasa.

Leprosy. The term Hansen's Disease is favored by many doctors for this progressive disease of the skin, nerves and mucous membranes, caused by the bacterium *Mycobacterium leprae*. It is widely distributed in the tropics and subtropics and is hyperendemic in Zaîre, where a 1968 figure of 11.6 percent infection is reported by Hunter et al. (1976). This figure is substantially higher than the incidence of 0.15–0.20 percent given in the Phase I Report (LC, 1979).

Leprosy has inspired fear among uninfected

people from the earliest historic times. Recent studies have shown, however, that the disease is far less contagious than generally believed. It does spread primarily by direct contact, and persons with open skin sores (like the majority of children in Zaîre) are liable to contract the disease if they come in contact with the "leproma", the granular skin lesion of the leper. The onset of the disease may be so gradual and free of exterior symptoms as to make diagnosis difficult. Leprosy is rarely fatal of itself, but secondary diseases such as pulmonary tuberculosis and nephritis are frequent related causes of death.

Yaws. Hunter et al. (1976) describe yaws as "an acute and chronic relapsing, infectious, contagious, nonvenereal, spirochaetal disease caused by *Treponema pertenue*." It is common in most areas of tropical Africa where medical facilities are poor or lacking. Yaws is primarily a disease of the skin but it may involve degeneration of the bone and cartilage in its later stages. Although rarely a primary cause of death, the condition contributes to the vulnerability of the body to other infections, due to the presence of open lesions.

Other Bacterial Infections. Dysentery and other enteric diseases are widespread, and gastroenteritis (or diarrhea) is a major cause of death in infants.

Plague is endemic but infrequently reported. The disease has two forms: murine, with reservoirs in domestic rodents (principally rats), and sylvatic, with reservoirs in wild rodents. The bacterium *Yersinia* (formerly *Pasturella*) *pestis* is transferred to man by rodent fleas and may be transferred from person to person by the human flea (*Pulex irritans*).

Typhoid and paratyphoid fevers are widespread in tropical Africa, including Zaîre. Their occurrence often is associated with unclean domestic water or food, the bacteria (*Salmonella typhi* and *S. paratyphi*) being excreted by infected individuals.

Tuberculosis is especially prevalent in crowded urban conditions, where it is transmitted directly from person to person by coughing. Ten percent mortality is reported (LC, 1979). Like leprosy, tuberculosis is caused by a *Mycobacterium*, of which there are a dozen or more other species known to be highly pathogenic to man.

Measles. Among Zaîrian children under five years of age, measles is one of the four major causes of mortality. Pulmonary complications are the major direct cause of death, but malnutrition, especially kwashiorkor (protein deficiency) is a usual contributing factor. Most deaths are found in children below the tenth percentile of weight for their age group (Hunter et al., 1976).

Yellow Fever. This viral disease, transmitted by mosquitoes of the genus *Aedes* and some other genera, is uncommonly reported from Zaîre, perhaps because it is primarily the "sylvan" form that occurs and it is not common in urban areas. Zaîre is in the zone of endemic yellow fever and may be expected to have many cases, since there is no widespread vaccination program.

Other Viral Infections. Rabies is endemic in tropical Africa with cases reported in Zaîre every year (Hunter et al., 1976). Infectious hepatitis is a poorly diagnosed disease also widespread in the region.

III. RESOURCES MANAGEMENT

Administration

Natural resource management in Zaîre has gone through many phases, during and after the colonial period, ranging from uncontrolled exploitation to regulated use. In this section, we will look at the present administrative structure for resource management and identify some trends and future needs.

Present Situation

In late 1981 the management and protection of Zaîre's natural resources was in a state of change. The Departement de l'Environnement, Conservation de la Nature, et du Tourisme (DECNT) was acquiring additional responsibilities through the addition of some departments from other agencies.

DECNT was established in 1975, under Ordonnance-Loi No. 75–231, as the central agency responsible for natural resource conservation and management. It was an outgrowth of the Institut National pour la Conservation de la Nature, formed in 1969 under Ordonnance-Loi 69-041, primarily to protect wildlife.

With recent and continuing reorganization, DECNT has acquired responsibility for many resource management activities formerly carried out by other agencies, such as the Departement de l'Agriculture and the Ministry of Public Works. By late 1981, DECNT was responsible for:

- Water Resources
  - Fisheries, both marine and fresh water
  - Domestic use and water quality
- Land Resources
  - Soils
  - Forestry
  - Wildlife
  - National Parks and Reserves
  - Greenbelts, Reforestation and Plant Nurseries
  - Housing and Urban Planning
  - Rural and Urban Sanitation
  - Industrial Pollution Control

Many of these resource related responsibilities were held by other agencies until 1981, when they were transferred to DECNT. Notable were the areas of wildlife management and protection, now performed by the Institut Zaîrois pour de la Conservation de la Nature (successor to the INCN), fisheries, in the Office National de Peche, forestry, in the Office National de Bois, and tourism, in the Office National du Tourisme. By bringing all of these responsibilities into a single agency, the government hoped to streamline administration and increase the communication among these related areas.

Continuing Problems

The consolidation of most natural resource management activities under DECNT is expected to cure many of the problems that previously existed due to the fragmentation of responsibility, but many problems remain. Foremost among these are the following:

- **Funding.** Budget inadequacies severely hampered the abilities of many agencies to fulfill their assigned responsibilities before consolidation into DECNT. These funding inadequacies continue but DECNT is exploring resource-based funding, such as taxing forest products.

- **Training.** There continues to be a shortage of qualified administrative and technical personnel, particularly in the field. Short-term solutions to this problem are being sought by some foreign aid agencies, such as FAO, USAID and the Peace Corps, but a long-term program of education in resource management and administration is needed.

- **Communication.** The exchange of information within DECNT and between DECNT and others that influence natural resources remains sluggish, but the problem has been recognized and some efforts are being made to remedy it.

- **Resource Information.** Lack of knowledge of the size and composition of most resources and of the rates of exploitation is a major barrier to establishing management programs. Some programs, such as the SPIAF forest inventory, are addressing this problem; many more are needed.

- **Priorities.** Resource management, often perceived as reducing the extraction or other consumptive uses of resources, seems to conflict with short-term socio-economic gains. This con-

flict may be real when measured in terms of individual profits for a small segment of the population, but few administrators would disagree with the view that effective management of renewable resources is necessary to avert more widespread hardships for a large part of the population on the longer term. The only solution to this problem appears to lie in educating both the public and the responsible officials in the hard truths of resource exploitation, exhaustion and replacement.

Education

Overall Management

Responsibility for educational planning and administration rests with two government agencies, the Departement d'Enseignement Primaire et Secondarie and the Departement d'Enseignement Superieur et de la Recherche Scientifique. Within their respective areas they are responsible for planning, allotment of funds, and operation of schools and universities.

Primary and Secondary Schools

In 1971 an estimated three million children, 65 percent of those in the population of primary school age, were enrolled in primary schools. By 1975 the number was given as 3.5 million, about the same percentage. Since the reported increase is proportional to the estimated increase in population during the four-year interval, the figure may be an approximation extrapolated from the general population estimates, rather than an empirically based figure. Enrollments in secondary schools are reported to have risen from 264,350 to 446,000 during the same period, approximately eight percent of the secondary school age children.

The best rated schools remain those of the missions and these are heavily concentrated in Kinshasa and the regional capitals. The rural schools tend to be self-help buildings of local materials, lacking in amenities.

In 1962 the literacy rate for French was estimated at 31 percent of the adult population; by 1979 that number dropped to 15 percent (Kaplan, 1979). Instruction in the primary schools begins in the local African language and French is introduced in the third year. Subject material in primary school is aimed a qualifying the student for secondary school, while the secondary school curriculum is aimed at university admission. In 1980, on the realization that many students were not capable of finishing the complete liberal arts course of 12 years, a law was passed introducing into the school curriculum a technical course designed to train skilled workers, rather than "intellectuals." Those who follow the complete "humanities" cycle may go on to higher education. This cycle comprises six sections, or divisions, of the "humanities:" agronomic, biochemical, literary, teaching, math-physics, and social sciences.

In general, there is little practical instruction in hygiene or health matters at any level and none at all in natural resources or conservation.

Teacher training varies greatly from place to place, but in general the quality of teachers at all levels is reported to be low. Secondary school graduates, and even those with as little as four of the six years of secondary school completed, may become primary school teachers.

Secondary school teachers are trained in special centers, the Instituts Superieurs Pedagogiques, and at the national university, with three to five years of post-secondary education. Teacher salaries are low and payment irregular in many areas.

Higher Education

Prior to independence there were three universities in the Congo, Lovanium, in Kinshasa, run by the church, the Universite Officielle du Congo, in Lubumbashi, and the Universite Libre, in Kisangani. These were united in 1971 to form the Universite Nationale du Zaîre (UNAZA). The various campuses were topically specialized and each was prohibited from offering courses in the fields assigned to the other campuses. Law, medicine and economics were located in Kinshasa; veterinary medicine, engineering, art and letters, geology, and social and political sciences in Lubumbashi; and agriculture, biology and pedagogy in Kisangani. Also included in the UNAZA system were the "instituts superieurs", located in many smaller cities and in the university cities.

Administrative problems resulted from trying to centralize a university whose campuses were located more than a thousand kilometers apart. These, plus a desire for autonomy on the part of the campus administrators, led to dissatisfaction with the divided system and in 1981 the Executive Council decreed that the three campuses would be autonomous. Each is now undertaking to reestablish a complete curriculum, faculty and supporting facilities, a task that will take some years. Unfortunately, all of the universities are badly underfunded and there are frequent accusations of mismanagement of funds.

Admission to the university, which for some time was based on test scores, is now based on secondary school grades, a student achieving grades of 60 or more (out of 100) being automatically eligible for university admission. In practice, however, this criterion is not strictly applied, some applicants being admitted with less than 60 and others refused who have higher grades.

Two types of diploma are awarded in areas relevant to natural resources management, a three-year graduate diploma and a five-year license diploma, the latter consisting of the three-year cycle plus two years of specialized study. These degrees pertain to agriculture, biology and rural sociology. Engineering, medicine and veterinary degrees are offered through six-year programs.

At present (1981), several facilities offer courses of study that include ecology, conservation of natural resources, land use, and public health. The narrow tracking system of the UNAZA curriculum restricts these areas to a minority of students, however, rather than providing them as parts of a broader consideration of public policy issues that might be of benefit to all. In fact, there is no broad course concerned with these subjects.

Law students at the Kinshasa campus in 1981, for example, could select in their first license year an elective course on "Le domaine de l'Etat, l'Amenagement du Territoire et de l'Urbanisme." In their final year they could take an elective course in environmental law. Pharmacy students are required to take a course in public health and hygiene in their second "graduat" year.

In fields more directly related to the environmental sciences, course offerings in 1981 were more oriented toward resource management. Geography students at Lubumbashi took a course on "la Protection des Versants et la Conservation des Sols," in their third year, and during their studies toward the license they could specialize in ecology or natural resource conservation. Sociologists and anthropologists were exposed to ecology and urban planning in their third year and rural sociologists were offered an elective in ecology and agrarian systems in their fourth or fifth year. In the curriculum for veterinary medicine ecology and climatology were studied in the first year; conservation, immunology, and problems of the animal-human interface were studied in the second year.

A new post-license program of interdisciplinary studies in the environmental sciences was approved by the Commissaire d'Etat de l'Enseignement Superieur et de la Recherche Scientifique in mid-1981. Originally proposed by the Belgian Cooperation group, this group program was under development for five years, during which the Belgian funding ceased to be available. New financial support is being sought. The program is a two-year evening course in environmental management ("Cours du Soir en Gestion de l'Environnement") under the direction of a scientific council at UNAZA/Kinshasa, with representatives from the Kisangani campus, IBTP and other organizations. Its aim is to produce specialists in nonenvironmental fields able to apply environmental perspectives to a variety of planning and management functions.

The Institut des Sciences Agricoles at Yangambi, Haut-Zaîre, offered the broadest curriculum in the environmental sciences found in the country in 1981, apart from the geography courses. It included soil conservation, general ecology and conservation, and applied animal ecology. The Institut de la Construction et des Travaux Publiques provided courses in urbanism and sanitation and the Institut Superieur de Techniciens Medicaux (ISTEM), gave courses in public health as part of a paramedical curriculum.

Forest technician training, formerly provided at UNAZA/Kinshasa, was transferred to the Institut des Sciences Agricoles in 1978. Lack of qualified teachers resulted in a virtual cessation of forestry training. CIDA has started a program of training Zaîrian forestry students in Canada, but this has not yet corrected the shortage of forest technicians. Until trained staff are available, it will be impossible to implement a forest management plan.

Several foreign universities, governments and private foundations have technical cooperation and exchange agreements with UNAZA, among them the United States Fulbright Program, the Rockefeller Foundation and several universities working with USAID grants. The Belgian, French, German and other governments have substantial programs in various fields. There are also some programs of technical cooperation with other developing countries.

The United States and Canadian programs in the fields of fisheries and forestry, respectively, have been mentioned above. The fisheries assistance, carried out by Peace Corps volunteers with USAID financial assistance, is largely field training. The forestry program of CIDA/SPIAF includes formal training in Canada and on-the-job training in Zaîre.

IV. ENVIRONMENTAL PROBLEMS

Introduction

Zaîre's major environmental problems fall into two general categories: those that affect present day human life and resource use and those which will exert a detrimental effect on future use of resources if corrective measures are not taken soon. To these may be added a third set of problems, the underutilization of certain resources. While not usually exerting a directly detrimental effect on a resource, underutilization of one natural resource often leads to excessive pressure on another resource to meet the same demand, thus creating a secondary environmental impact.

The identification of environmental problems involves applying a set of priorities to resource utilization, for there is no universal set of values that establishes the importance of a resource or a "best" level of development. In this report, we will attempt to evaluate resource problems in the context of Zaîre's national objectives, as these have been portrayed in the press and by Zaîrians who have assisted us in the study. Within this framework, we can identify two widespread environmental problems, deforestation and illegal hunting, that currently are severely affecting the nation's resources, although in each case fulfilling a demand for a natural product. We can also identify several problems, somewhat more local in distribution but nevertheless important to those persons affected; these are water quality degradation, and soil erosion. In the third category, underutilization of resources, we will discuss difficulties that affect the effective utilization of Zaîre's rich fisheries resources.

Certain aspects of Zaîrian society have surfaced repeatedly as constraints on effective resource utilization and management. These factors will be mentioned in connection with individual problems, but it is worthwhile to mention them in general terms before looking at them specifically.

- **Transportation.** The lack of an effective means of surface transportation, due to deficiencies in the road network, in numbers of vehicles, and in maintenance, is a major impediment to both effective resource utilization and to the enforcement of regulations. The ineffectiveness of the national airline and river transport systems contributes to these difficulties.

- **Lack of Planning.** The tendency to commence projects before adequately examining alternatives and without identifying all of the requirements leads to costly developments that are inappropriately placed, understaffed, and/or rendered inoperable by the unavailability of critical components.

- **Lack of Resource Data.** The characteristics of most of Zaîre's natural resources — the mineral resource is a notable exception — are poorly known and the rate of their use or degradation even less known. Without improved knowledge of resources, effective management plans are impossible.

- **Corruption.** President Mobutu Sese Seko has called corruption "le mal Zaîrois" (Anon., 1981a). The widespread misappropriation of funds and other illegal practices affect more than the projects directly involved; knowledge that funds are likely to be misspent causes honest administrators to shy away from worthy projects that they cannot directly control. The pervasive nature of corruption, reaching high political officials (see below, under poaching, for example) renders this aspect of resource mismanagement particularly difficult to rectify. Moreover, the governmental red-tape involved with acquiring and safeguarding funds consumes time that should be spent planning and executing projects.

- **Laws and Decrees Without Funding.** The Government of Zaîre has exhibited a tendency — in common with governments everywhere — to take legislative or administrative actions, such as the establishment of agencies, passing of regulations or the designation of restricted land uses (e.g., national parks), without dedicating the financial support to ensure the success of the actions. One may argue that it is best to have the laws on the books and the lands in reserved

status, but world experience shows that complacency is created on the part of government officials, who point with pride at paper projects while ignoring the realities of resource loss and degradation.

Specific Problems

Water Pollution

Problems in the quality of natural waters usually are localized near the cities; elsewhere they rarely are of sufficient magnitude to prevent the usual uses of the water. Near the cities and in them, however, contamination is the rule rather than the exception and is a major source of disease.

A few industry-related water pollution problems should be mentioned, since they illustrate what should be expected whenever water-using industries develop in a new area. The Lufira River, between Likasi and Lake Mwadingusha is reported to be badly contaminated with mine wastes, as are some stretches of other rivers in Shaba. According to Kabala (1976), the petroleum refinery at Kinalo has produced some water quality problems. Industrial/urban pollution also has been noted at Maluku, on the Zaîre River below Kinshasa.

The most pervasive and relatively unnoticed water quality problem, present in virtually all the urban areas of the country, is the combination of enrichment and contamination of small rivers and streams by human waste, discharged untreated from open surface drains. Direct urination and defecation into small streams also is a problem, since these same waters are used by downstream residents for washing, bathing and even drinking.

The urban water quality problem, exacerbated by rapid uncontrolled growth of the cities, is common to most developing countries. The urban infrastructure has not been substantially expanded to meet the health requirements of the poor. They are drawn to the cities by the vision of better jobs and greater monetary wealth, but they end up crowded into unhealthy "cites" without access to safe drinking water or sewage disposal. Vector-borne and water-borne diseases run rampant in such conditions and are major causes of mortality among both children and adults. Nor are unsanitary conditions limited to the poor; even in the residential quarters formerly reserved for the wealthy there are open drains, clogged sewers and standing contaminated surface water.

Soil Erosion

Many land use practices currently widespread in Zaîre create high risks of soil erosion. In an area of relatively high rainfall the removal of dense vegetation, farming of steep slopes, and building roads without adequate drainage all may be expected to cause severe erosion. Some soil erosion does occur, especially in the steep hills of the Eastern Highlands (around Bukavu, for instance), but it does not yet constitute a major problem. The reason appears to lie in the nature of the rainy season, which begins gradually in most parts of the country. This allows dormant seeds to form root systems to hold soil against the heavier rains that follow.

In savanna areas subject to annual burning, erosion occurs on level or slightly sloping surfaces through the action of rain on exposed soil between the grass clumps. As the rainy season progresses, the clumps regrow and may even fill in some of the eroded areas.

Deforestation

When one considers the immensity of the forest resource in Zaîre, it is difficult to appreciate the importance of deforestation as an environmental problem. Several aspects of the forest exploitation currently in practice make the picture for the future more serious than it appears at first glance: For example:

- Tropical high forest, although generally considered a renewable resource, regenerates so slowly under natural conditions that for practical purposes it must be considered lost, once cut.
- Under certain conditions of soil and rainfall, erosion may so alter deforested land as to render it permanently unusable. Such conditions are found in the Eastern Highlands.
- Where equatorial forest is cut, the removal of biomass and the subsequent leaching of soil nutrients serve to delay recovery of the vegetative community.
- Brush fires, set by local populations for a variety of reasons, prevent the establishment of tree seedlings. The first few fires after the initial clearing destroy the results of natural seeding and lock the

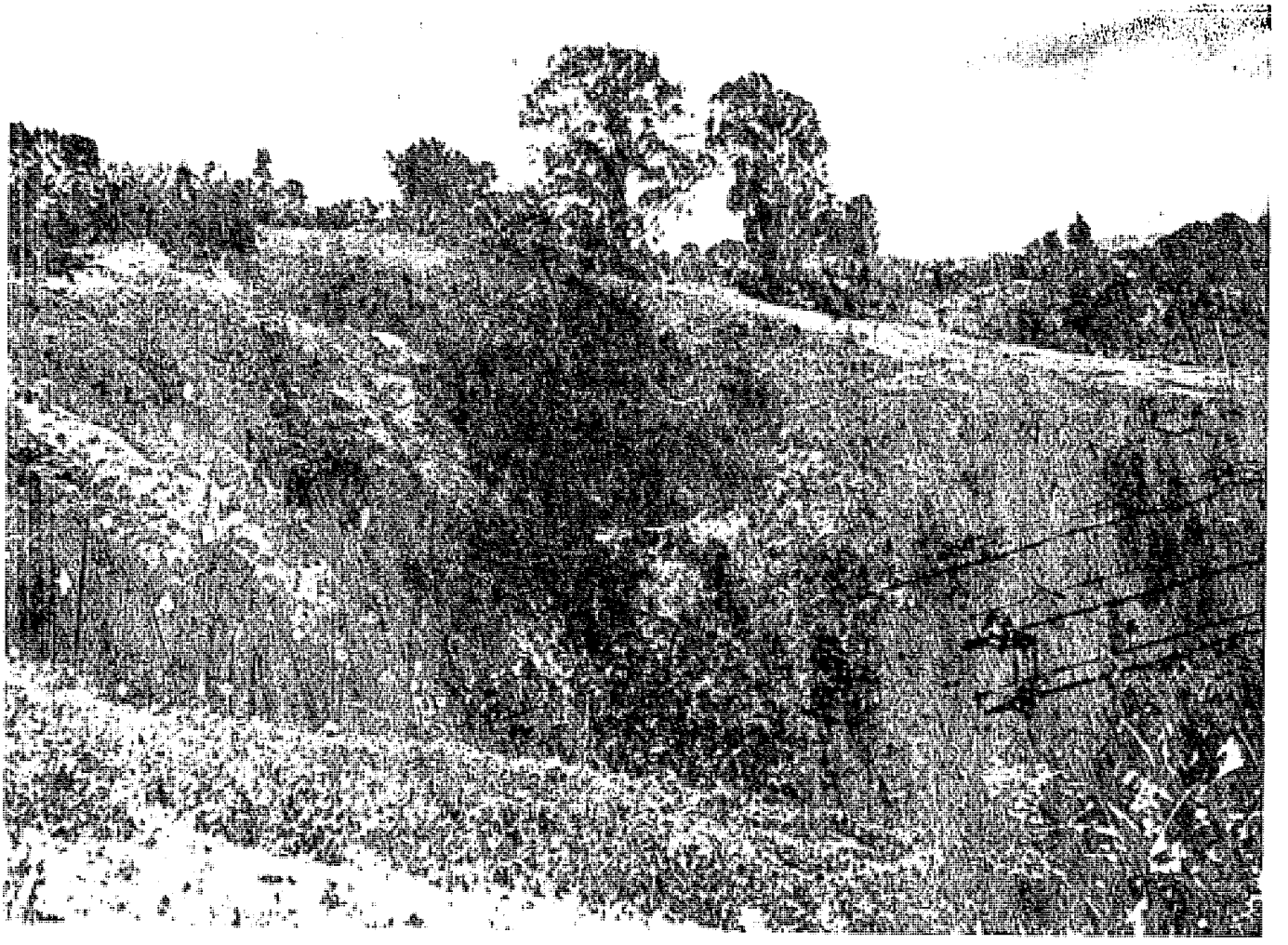


Figure 5. Incipient erosion in Kivu. Steep slopes cleared for crops are likely to wash away at the next heavy rain.

vegetation into fire-resistant brush and grasses.

- Overgrazing and the burning of grasslands to produce new growth tend to prevent natural reforestation where livestock is raised.

- The relative distribution of population and forests, with the highly concentrated demand for fuelwood in the cities, has resulted in a belt of virtually treeless land around every population center. Continued cutting of woody vegetation prevents regeneration and extends the radius of deforestation.

Of the aspects mentioned above, the loss of the fuelwood resource clearly presents the most immediate and least soluble problem. The radius of nearly total deforestation now extends about 100 km from Kinshasa. Within this perimeter, woody regrowth meets a small fraction of the population's energy needs. As the city grows (Table II–9) and total demand increases, fuelwood suppliers will cut wood further and further from the city. Increased transportation costs will favor the sale of charcoal, a lighter fuel but a more expensive one in terms of caloric yield. The rising cost of fuel, competing with food, clothing and other necessities for the city dweller's income, will impose additional hardship on the urban low and middle income population.

Loss of Wildlife

The most serious problem affecting Zaîre's wildlife resources unquestionably is illegal commercial hunting, or poaching. The phenomenon is so widespread geographically and so deeply ingrained in the culture that one cannot be optimistic about its control in the near future. Indeed, within a few decades, the larger mammals will cease to exist outside of the national parks

and, without a substantial increase in protection, within some of them.

No medium to large-sized bird or mammal in Zaîre is totally immune to hunting, but the larger species bear most of the pressure and are the first to disappear. Poaching can be divided into three basic categories, which have separate forms of motivation, largely different targets, and distinct control measures.

Subsistence Hunting. The use of wild game as a basic protein source is a deep-seated tradition among many of Zaîre's cultural groups. When population density was low and game habitat widespread, natural animal populations could sustain a considerable hunting harvest without severe depletion. With increased population, combined with diminution of natural habitat, hunting pressure on the remaining animals has increased beyond the level that can be sustained by game populations.

Habitat destruction usually occurs initially with the objective of agriculture or other land use change. The second growth that springs up during fallow periods is inferior habitat for most game animals, but some species will utilize it. Even these animals may be under heavy hunting pressure. In some areas the vegetation is burned by local residents for the purpose of driving out game, even the smallest animals (Ngoma, Tsasa, Service National de Reboisement, pers. comm., 1981). In addition, this second-growth vegetation is continually degraded through the cutting of fuelwood and clearing for agriculture.

It is doubtful that subsistence hunting seriously affects wildlife populations in undisturbed areas free of commercial poaching. The scarcity of firearms among the rural population and the high cost and scarcity of ammunition restrict the amount of pressure on native game animals. Wildlife populations are more likely to be decreased by habitat loss than by light subsistence hunting.

Commercial Meat Hunting. We have been told repeatedly that market hunting is a major cause of wildlife depletion, that a major portion of the meat thus derived is sold in the larger cities, and that well organized commercial hunters enjoy the backing and protection of high-ranking political figures. As in most other areas of natural resource management in Zaîre, neither the sizes of animal population nor the extent of poaching are known on a quantitative basis. Kaplan (1979) states that 80,000 tons of wild game are consumed annually, but gives no source of that estimate. Presumably, this also includes subsistence hunting. The figure is not beyond belief and may, in fact, be low, since it would yield a per capita consumption figure of only about three kilograms per year. The figure of 80,000 tons would mean the killing of more than a million medium-sized (Kob) antelope per year.

Market hunting is a lucrative, low-overhead business. Unlike the cattle rancher, the market hunter has no investment in range management, livestock breeding, or veterinary problems. He requires only a small staff, a few vehicles, and firearms. His fringe costs may include bribes for local officials, but these are minor compared with his profits.

In addition to commercial hunters who provide meat for Zaîre's cities, there are hunters entering from outside the country, especially Angola, Sudan, and the Central African Republic, to take Zaîre's wildlife and escape over the border. Garamba National Park and the subregion of Bas-Uele, in Haut-Zaîre, are especially vulnerable to such incursions (Mankoto, pers. comm., 1981).

Specialized Poaching. One of the most regrettable forms of illegal hunting is that done for special animal products. These include skins, rhinoceros horn, ivory, and live animals. The animals sought include some of Zaîre's rarest mammals, such as the White Rhinoceros and the Mountain Gorilla. Usually, the hunter takes only a small part of the animal, leaving the remains to feed the scavenging birds and mammals.

Rhinoceros horn has two qualities that give it great international value: it is highly valued as an aphrodisiac in China (in powdered form), and it is sought for dagger handles in Arab countries. The economics of the situation are complex, since the two markets are unrelated and competing. Newly rich young oil sheiks, in order to display their wealth, pay thousands of dollars for daggers with rhino horn handles. Both rhinoceroses are considered endangered by the IUCN.

Ivory poaching invariably involves elephants, since other forms of ivory do not have high commercial value. Although substantial elephant populations still exist in many parts of Zaîre, no census has ever been made and the high figures given must be considered guesses. Nor are figures available on the number of elephants killed annually or the amount of ivory exported.

The skin trade is more openly conducted, although all of the animals offered are taken illegally. In a 1981 visit, we found rugs and vests made from the skins of Colobus Monkeys, Servals and antelope openly offered on the streets of Goma, Kivu Region. We were told that the animals had died "natural deaths."

Basis for the Problem. We have noted that hunting is an ancient cultural tradition for many Zaîrians, a valued occupation for males in rural areas (Kaplan, 1979). The general shortage of protein in the diets of urban and rural people alike provides a rational justification for the consumption of game.

Much illegal hunting, especially that directed at nonmeat products, has a strong economic basis; simply put, it is extremely profitable. Markets exist, internationally or within Zaîre, for the animal products being taken. If game meat in Kinshasa sells for Z 5 per kilogram, the 80,000,000 kg of meat, if paid for by the consumers (not always the case) would have a market value of Z 400,000,000. Even allowing for meat that is not marketed, the figure indicates a major industry.

The involvement of high-ranking politicians, military officers and other well-connected persons in commercial hunting makes control of this activity especially difficult. In a recent case, Cit. Mbenza-Thubi, Governor of Haut-Zaîre Region, and several associates were publicly accused of soliciting the killing of elephants and arranging the sale of ivory (Essolomwa,1981). The scheme, which was to produce 350 kg of ivory but actually resulted in only 211 kg, involved a special contract between the governor and a rice planter named Shako, advance payment, provision of rifles for the hunters, permits for the transport of ivory, and the use of a police vehicle

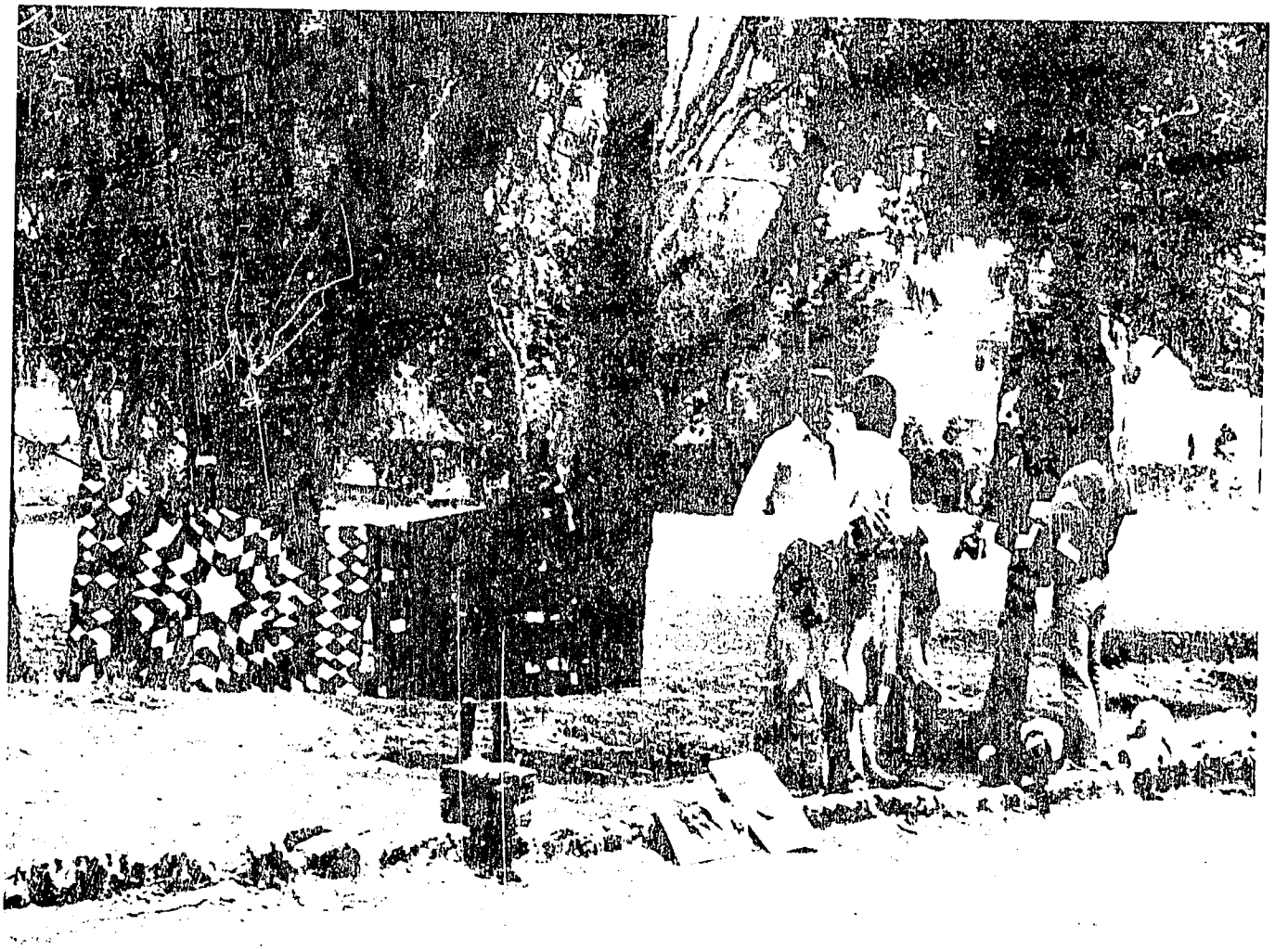


Figure 6. Skins of protected animals openly for sale in the center of Gama, Kivu Region. The black and white rug against the tree was made from the skins of Lolumbus Monkeys. The men at the right are offering the tanned skins of caracal.

for the transportation. As of September, 1981, no penalties had been exacted for these crimes.

Illegal hunting on a major scale has important ecological consequences, since all of the larger mammals affect their ecosystems and each other in complex ways only barely understood (Sinclair and Norton-Griffiths, eds., 1979). Moreover, Zaîre's aspirations to develop a tourist industry based on the national parks rest on the abundance and diversity of the visible fauna.

Enforcement of hunting regulations outside of a few well-staffed national parks is simply not possible at present. To achieve even a modest degree of protection would require substantial inputs of technical and material assistance from the international community. The priorities within Zaîre are directed toward other aspects of national development (e.g, the transportation network, public health) and one can hardly claim that these are less important than saving the White Rhinoceros. Despite this disparity of priorities, Zaîrians should be made to realize that the wildlife resources that are being squandered today may hold greater value for national development and enjoyment by the individual Zaîrian in the future.

Fisheries

There are few environmental problems that either affect the fisheries industry seriously or originate in it. The "industry" as such is practiced at a level only slightly above the artesanal one and the constraints on effective development of the resource are logistic, economic and social, rather than environmental in the narrow sense. The Office National de Peche (ONP) has pointed out to us some of the problems that beset the fisheries industry:

- Lack of basic materials, such as nylon for the manufacture of nets and salt for preservation of fish. These problems are logistic, not economic; the materials are in short supply.
- Shortage of boats, marine and fresh water, and lack of spare parts to repair the boats on hand.
- Problems in obtaining fuel.
- Lack of credit for the fishing industry and disinterest on the part of potential investors.
- Absence of any central organization of artesanal and industrial fishermen; ie., there is no cohesive marketing system.
- Lack of methods and materials for the preservation of fish during transport to markets.
- Lack of facilities for storage and transport to markets.

To the above list may be added the lack of reliable catch statistics, making planning and resource management difficult. The only facts that seem incontrovertible are that present fisheries production is substantially lower than in the past.

Of the problems mentioned above, those applying to the artesanal fishery are fairly simple: lack of basic materials (nylon net line or reasonably priced nets, especially) and lack of reliable access to local and regional markets.

For the industrial fisheries the situation is more complex. Equipment problems also are important, but on a larger scale; the worst problems are nonfunctional boats and lack of spare parts. Management problems are more profound. There is a severe shortage of trained fisheries personnel, inability to manage cooperatives, lack of private sector interest, and difficulties in market access.

Land Use and Urban Growth

Population growth and the associated phenomenon of urban growth are complex problems with ramifications in all aspects of human life. The social, political and economic components of these problems and their historical bases are beyond the scope of this report, but there are effects on land use and resource management which fall with the definition of "environmental" set out at the start of this study.

Urban growth occurs through two means: migration from rural areas and differential birth-death rates. In most parts of Zaîre the cities appear to rural cultivators to offer improved living standards and employment opportunities. Stagnation of a highly extraverted economy based primarily on mining, and wide social inequalities in the distribution of resources have resulted in increasing poverty for the majority of Zaîrians. The rural poor see greater advantages enjoyed by the cities. Kinshasa and, to a slightly lesser extent, Lubumbashi and the other copperbelt towns, receive a disproportionate share of the financial resources devoted to education, health services and other amenities. For

example, Kinshasa absorbs the major share of the nation's public health budget and is home to most of the country's physicians. This disparity is reflected in a lower infant mortality rate, which contributes to the higher population growth rate in the cities.

A bus service recently inaugurated between Lubumbashi and Likasi makes no scheduled stops en route, a slight seen by the rural people as evidence of development favoring the cities.

The dilemma of the government is that actions to improve the quality of urban life cannot fail to make the cities even more attractive to the rural poor. The answer is to improve the quality of government services and increase the financial returns for labor in rural areas. This would require major shifts in government priorities and would meet with opposition from the wealthy urban residents who control the government.

There is evidence that urban areas and most rural communities contain some affluent citizens who can afford to pay for public services to improve their environment and who would be willing to do so. Unfortunately, there usually are no accountable local government agencies able to undertake responsible resource management. The existing administrative structure is highly centralized and is vulnerable to all types of financial diversion.

The Man and Biosphere Program

The designation of reserve boundaries under the MAB program appears to have favored large extractive industrial firms and powerful individuals at the expense of peasant communities. The social anthropologist on the CEP Team was told by community leaders that the livelihood of several thousand local peasants was threatened by interdictions proposed by the MAB staff. In addition, there are reported to be plans to introduce untested modifications of the local farming system without reference to existing knowledge of environmental, economic and cultural constraints to which the present farming system has adapted over the years. These deficiencies apparently stem from the failure of the MAB planners to provide for inputs from a qualified human ecologist, either from within the UNAZA system or from the international consultant community.

V. RECOMMENDATIONS

Priorities

The allocation of funds in any society is based on priorities established by those in power. No major country, developed or developing, has sufficient financial or human resources for all of the worthy programs that planners can conceive of. Programs that those in government deem most important, for whatever reasons, receive the most funding; other programs, lower in perceived importance, receive less or none.

In this report we are recommending actions by the Government of Zaîre that we feel are crucial to future resource utilization or to the future well-being of its people. Many of the nation's problems, such as the growing shortage of fuelwood, are widespread in the developing world. Solutions to the most serious of resource problems are being sought by many governments and international agencies, with mixed success. Technical solutions exist for virtually all of the environmental problems of the developing world. The success or failure of a given program usually depends on the individual country's social and economic make-up and on the planners' understanding of these factors.

We avoid stating categorically that one or another program should be started immediately. Some are long overdue. Certain of Zaîre's resource problems will worsen regardless of when corrective measures are undertaken and would be worsening today even if action had been taken a decade ago. This merely underscores the urgency of beginning as soon as possible those programs, such as reforestation, that require several decades to mature. In order to avoid crash programs, which frequently suffer from hasty planning and inefficient use of funds, resource management programs should be started as soon as a problem is recognized and should be enlarged to meet realistic goals as soon as the inevitable early difficulties have been corrected.

Specific Recommendations

Surface Water

Several programs to improve the condition of surface waters should be implemented.

- The Government should establish a program to bring safe domestic water to urban and rural residents. Such a program will require decades. It should commence with the cities, where the water quality is worst, but should not neglect rural areas, especially where specific water quality problems have been identified.

- The Government should begin a long-term program of planning and constructing collection and drainage networks for the major population centers. This program would set realistic target dates for the correction of the worst trouble spots. Laws requiring wastewater collection systems in new housing developments, now frequently ignored, must be enforced.

- The Government should establish a reliable, though not intricate, water quality and hydrologic network. In addition to substantial planning to ensure that existing sampling stations are incorporated, the system will require substantial training of technicians and administrators.

- The Government should perform a cost/benefit analysis of water pollution by the mining industry, in order to determine whether some level of wastewater treatment would pay for itself in lower environmental damage, reduced land loss and improved public health.

- The Departement d'Enseignement Primaire et Secondaire should introduce into the school curriculum the teaching of personal hygiene and safe water use. This would involve the publication and distribution in rural areas of educational pamphlets.

- The Government should expand the existing use of small hydroelectric plants as energy sources in rural areas and for small cities. Small hydroelectric stations have proven highly effective in Zaîre, especially when local labor is used. As fuelwood becomes more scarce, electricity will become an increasingly cost-effective source of heat energy.

Soil Erosion

Reducing soil erosion need not be extremely costly when its causes are poor agricultural practices. In Zaîre, however, some soil erosion occurs through the burning of vegetation, overgrazing, and poor road design. Programs to change rural attitudes toward deforestation, land use, road construction and urban drainage also will reduce soil erosion.

Vegetation

The degradation of Zaîre's forest resource, including the areas of brush and woodland that are exploited primarily for fuelwood, has been in process for decades, so it will take considerable effort and many years to reverse. Some corrective steps already are in progress, however, and further steps will pay themselves in improved production.

Inventory and Classification. The CIDA/SPIAF inventory is producing a good catalogue of the existing forest resource in selected areas. The Government should extend this inventory and supplement it with remote sensing studies in order to determine the rate of deforestation in various parts of the country. Following this, the Office National de Bois should classify forest lands by use capabilities.

Management Planning. The cutting of forest for timber in the inventoried sections should be done only according to forest management plans that ensure continued forest production. These plans should specify that areas cut should be reforested, naturally or artificially, and protected. Cutting should be done only under a contract, between the timber company and the Government, that would provide for:

1. Access road placement and design.
2. Continuum liability of the company to guarantee reforestation.
3. Control of fires.
4. Limits on the in-migration of workers.

Plan Implementation. Cutting of timber under a management plan should be monitored by the government to ensure that the contractor follows all stipulations in the plan, including limitations on the area cut, species and volume taken, worker safety, road placement and construction, and reforestation. Field inspectors must be supported by their own agency, by a police system with power of arrest, and by a judicial system that will prosecute and punish offenders.

Agency Augmentation. The ONB will require additional administrative and field staff and vehicles to carry out the programs recommended here. Training programs at UNAZA/Kisangani may be needed if the technical personnel are to be available when needed.

All this will cost money. With proper control of funds the program will be able to support itself through the cutting charges in the timber contracts.

Public Awareness. Reduction in widespread abuse of the forests can only be achieved through public education. This will require educational programs in the primary and secondary schools (through brochures provided to teachers and students) and extension education to reach adults. Spot announcements on radio and television also would help.

Training and Education. The CIDA-financed forester training program will be useful in providing some trained foresters in Zaîre. In order to continue the entry of trained foresters into the profession, the Government, through the ONB, should established a comprehensive forestry program at one campus of UNAZA.

Reforestation. The recent United Nations Conference on New and Renewable Sources of Energy, held in Nairobi in August, 1981, underscored the seriousness of the fuelwood problem in tropical Africa and elsewhere (Unasylva, 1981). Some successful and some unsuccessful case histories were described by participants. In general, the attempts that succeeded involved intensive education at the village level. Protection of woodlots from cutting by villagers usually poses the most difficult problem. At present, the magnitude and immediacy of the fuelwood problem do not appear to be understood by most of the staff of DECNT.

Local reforestation projects, at the community or individual level, would demonstrate to the population that this sort of enterprise is financially feasible.

Along with extension assistance for individuals and communities wishing to begin fuelwood plantations on a commercial basis, the ONR should develop and distribute fire prevention instructions so that communities and individuals can protect their woodlots.

We regard the reforestation project on the Plateau of Bateke as a pilot-scale effort that has proven the techniques for raising several species of trees. It is now time to make it a true reforestation project by increasing the area planted to at least 5,000 hectares per year. This will require substantially expanding and improving all aspects of the nursery, as well as many other aspects of the operation. Funding for the project might be forthcoming from the UNDP or other international agency.

The Bateke Project should function as a regional forest resources center, providing extension assistance to individuals or villages wishing to start their own woodlots. These private enterprises could eventually provide fuelwood and charcoal for the Kinshasa market.

Wildlife

Wildlife management programs must compete for government funds with health services, agriculture, education, civil works and many other much needed programs. It is unrealistic to expect substantial increases in funding for national parks, wildlife protection, and scientific research before a general improvement in living standard is achieved and the general population changes its attitude about wildlife. We believe that, until such changes occur, wildlife policies should be based on the following principles.

- On the short term, emphasis should be placed on protecting and strengthening the gains in wildlife conservation made in the last two decades, rather than on expanding the amount of land set aside for national parks and wildlife. Any expansion of the national park system performed in the present economic climate of Zaîre is sure to be underfunded and would result in weakening the already insufficient protection afforded the existing parks. One exception would be the establishment of a day-visit national park near Kinshasa.
- For long-term changes in public attitudes, the Government should implement a comprehensive program of conservation education, with at least the following components:
  - Teaching of conservation principles in primary and secondary schools. This would require teaching the teachers, perhaps through the use of illustrated pamphlets.
  - Articles in the national and local press to make adults conscious of the nation's wildlife values and of conservation problems.
  - Reestablishment of the journal "Leopard," formerly published by the INCN. A change to larger format would result in some economies in printing. The journal "Zoo-Leo" of the Kinshasa Zoo also merits attention.
  - Upgrading of the zoological garden in Kinshasa. A facility that draws nearly 200,000 visitors a year deserves better support. Funds are required for animal food, now sorely inadequate, replacement of animals, an improved water system (a storage cistern), veterinary supplies, cage and enclosure construction, and park maintenance.
  - Alternatively, the presidential zoo at the west end of Kinshasa should be opened to the public and should absorb the downtown zoo. This would provide visible evidence of the Government's interest in wildlife conservation.
- The Institut Zaîrois pour la Conservation de la Nature should develop a long-term plan for the management of natural resources. The plan should identify, at least:
  - Research needs, such as population studies of the rare animals. These programs should be seriated on the basis of urgency and importance.
  - Management problems, such as control of illegal hunting. Solutions to these problems may lie outside the jurisdiction of IZCN, but these should be identified if possible.
  - Staffing problems, such as the shortage of trained mid-level managers or educational gaps that could be remedied.
  - Future land acquisitions, seriated on the basis of urgency.

Fisheries

In view of past failures to develop large-scale fisheries, causes of which have been recognized but not corrected, we recommend that for the immediate future the DECNT shift the focus of development projects toward:

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- Supporting smaller, less-ambitious projects aimed at the domestic, artesanal or semi-industrial fisherman, with improved gear, more available equipment and better market access.
- Obtaining reliable baseline data on catch size and type, processing and marketing, especially for the riverine fishery.
- Placing additional emphasis, in all fisheries projects, on careful pre-project analysis of local social and economic constraints.

The importance of socioeconomic considerations cannot be over-emphasized. The resource is large, the technology for its exploitation is well-known, and the demand for fish is great. The tailoring of the technology to local conditions is not so simple, but it can determine the success or failure of the effort. The constraints on development, from fisherman to consumer, are primarily socioeconomic.

Human Resources

If the Man and Biosphere program is to achieve its objectives with a minimum of environmental impact, the following principles should be adopted:

- MAB research should conform to international practices regarding research on human subjects; these norms require the fully informed consent of the subjects.
- Researchers should avoid using administrative measures to oblige people to follow recommendations, especially when the latter have not been tested under local conditions.
- Expansions and alterations of farming

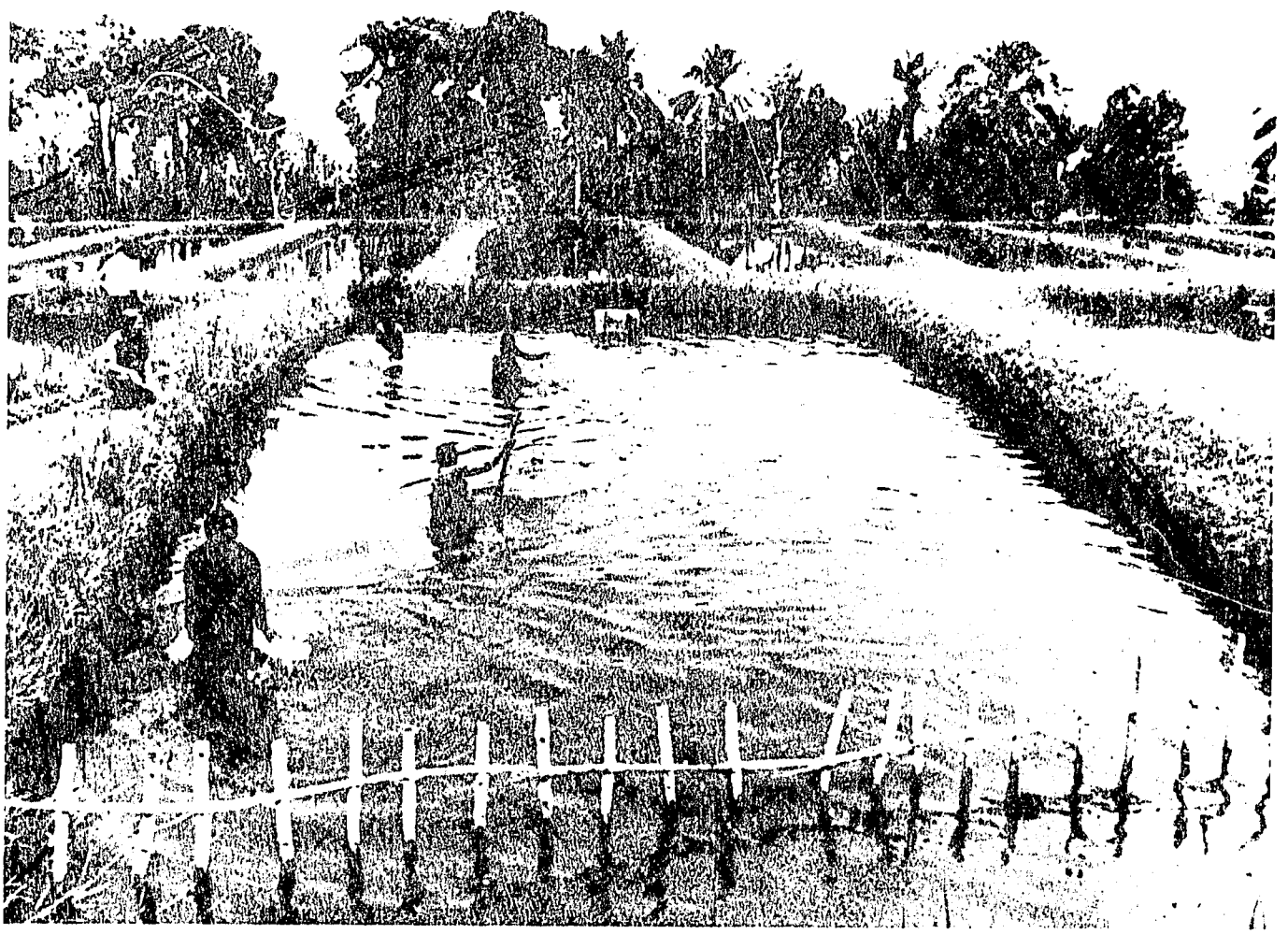

Figure 7. Peace Corps Aquaculture Project. The two men near the center of the pond are using a seine to sample the fish stock. The two near the edge are splashing to frighten the fish into the net.

systems should begin with participation of the local population at the problem identification stage, continuing through implementation.

- When it is necessary to move people from the "central" and "tampon" zones of an MAB reserve, their participation should be secured in identifying new home sites. Their consent to the move should be obtained by making the new areas attractive and by providing them with transportation, land clearing assistance or equipment, food building materials and seed. This support must be sufficient in amount and duration to ensure their well-being until the new crops mature.
- Future MAB reserves should be established only through ample public discussion among those involved. The rights and concerns of local inhabitants should be respected in planning and their suggestions and observations taken seriously.
- Administrators and researchers in nonecological disciplines should attend training programs in human ecology and farming systems.

The thrust of these recommendations is that the people most affected by the planning and execution of the MAB program should have a voice in all aspects of the program. The frequently-heard argument that local inhabitants and their leaders "have a low level of education and do not understand the problem" (Makwa, 1981) should not be invoked to avoid the use of responsible modern planning methods. Public participation has proven successful in community planning by a UNAZA team in the Lufira Valley of Shaba (Schoepf and Schoepf, 1980) and, apparently by another group in the Yangambi Reserve area.

Bibliography

Anonymous. 1981a. Zaîre: Don't underestimate Mobutu. Newsweek 33:14 (17 Aug 81).

_____ 1981b. Back to charcoal. The Economist 280 (7194) (17 Jul 81).

Aubray, R. 1976. Les peches du Zaîre. FAO, Rome.

Aubreville, A. 1933. La Fôret de la Cote d'Ivoire. Buil. Com. Afr. occid. fr. 15:205-261.

_____ 1950. Flore fôrestiere soudano-guineene. Paris, 523 pp.

Bard, J. 1973. Analyse de la production de poissons de certaines eaux continentales de la Republique du Zaîre. SATEL, BDPF, CTFT, Zaîre.

Bashizi, C. 1981. Le probleme foncière au Kiru: paysanerie et Salariat Agricole Rural au Bushi (ancien territoire de Kabare, Province du Kivu), 1920-1960.

Beadle, L. C. 1974. The inland waters of tropical Africa. Longman, London.

Boone, O. 1967. Carte ethnographique du Congo. Musée Terveuren, Ann. 37.

Boute, S. and L. de Saint Moulin. 1980. Perspective demographique regionale, 1975-1985. Gov't. de Zaîre, Dept. du Plan, Kinshasa.

Bureau du President 1974. Perspective demographique provisoire pour la Republique du Zaîre. Kinshasa.

Collart, A. 1974. Etude pour la preparation du projet "Jeunes Pecheurs Zaîre." Rapport a l'UNICEF sur la situation des peches au Zaîre (Kivu) et les groupements de jeunes pecheurs. UNICEF.

Departement de l'Agriculture et du Developpement Rural. 1980. L'agriculture zaîroise: situation courante et constraints. Bur. d'Etudes, Kinshasa, 62 pp.

Departement de l'Environnement, Conservation de la Nature et Tourisme. 1979. Principaux problemes de l'environnement au Zaîre, et strategie de gestion integree des milieux et des ressources. Conseil Executif, DECNT, 11 pp.

_____. 1980. Le tourisme en 1979. Off. Nat. du Tourisme, DECNT, 49 pp.

Dors , J. and P. Dandelot. 1969. A field guide to the larger mammals of Africa. Boston, 267 pp.

Essolomwa, N-e-L. 1981. Grave affaire de trafic des pointes d'ivoire et du cafe. Elima, Kinshasa, 26 May 81, p. 1,7.

Greenberg, J. H. 1971. Nilo-Saharan and Meroitic. pp. 421-442 in Sebeok, T. A., ed. "Current Trends in Linguistics. Vol. 7. Linguistics in Sub-Saharan Africa." The Hague.

Hall, G. E., ed. 1975. An evaluation of proposed USAID project for improvement of Lake Tanganyika fishery resource in Zaîre. USAID Proj. Rpt.

Hecky, R. E. 1981. Relationship between primary production and fish production in Lake Tanganyika. Trans. Amer. Fish. Soc. 110:336-345.

Hunter, G.W., J. C. Swartzwelder and D. F. Clyde, eds. 1976. Tropical medicine. 5th ed., Philadelphia, 900 pp.

International Union for the Conservation of Nature and Natural Resources (IUCN). 1972-1979. Red Data Books. Morges, Switzerland.

Vol. 1 Mamalia
Vol. 2 aves (two Parts)
Vol. 3 Amphibia and Reptilia

_____ 1977. World Directory of National Parks and Other Protected Areas. Two vols. Morges, Switzerland.

Kabala, M. 1976. La conservation de la nature au Zaîre. Kinshasa, 312 pp.

Kaplan, I., ed. 1979. Zaîre, a country study. Washington, U.S. Gov't, Area Handbook Ser., 332 pp.

Library of Congress (LC). 1979. Phase I environmental profile of the Republic of Zaîre. Report for USAID, mimeo, 87 pp.

Lind, E. M., and M. E. S. Morrison. 1974. East African vegetation. London, 257 pp

Mafuta, M. 1974. Untitled communication. Actes du Colloque sur la Linguistique au Zaîre. UNAZA/Lubumbashi.

Mabiala-ma-Khete, C. Noel and G. Mercier. 1980. Stratification fôrestiere au territoire. SPIAF, Kinshasa, Cahier No. 2, 1ère Pt., 59 pp.

Makwa P. 1981. Les activites humaines, leurs incidences et l'attitude da la population vis-a-vis de la Reserve de la Piosphere Valee de la Lufira. Doc No. 11, Colloque du MAP, Lubumbashi.

Malaisse, F. 1978. The miombo ecosystem. pp. 589-606, in UNESCO/UNEP/FAO, "Tropical Fôrest Ecosystems," Paris.

Marlier, G. 1973. Limnology of the Congo and Amazon Rivers. pp. 223-238 in Meggers, B. J., E. S. Ayensu, and W. D. Duckworth, "Tropical Fôrest Ecosystems in Africa and South America: A Comparative Review." Smithsonian Inst. Press, Washington.

Matthiessen, P. 1981. Peter Matthiessen's Africa. Book Three: Zaîre. Audubon Mag. 83(5):82-95 (Sept., 1981).

Ormerod, W. E. 1976. Ecological effect of control of African Trypanosemiasis. Science 191(4229): 815-821 (27 Feb 76).

Richards, P. W. 1952. The tropical rain fôrest: an ecological study. Cambridge University Press, 450 pp.

Roberts, T.R. 1973. Ecology of fishes of the Amazon and Congo Basins. pp. 238–254 in Meggers, B.J., E.S. Ayensu, and W.D. Duckworth, "Tropical Fôrest Ecosystems in Africa and South America: A Comparative Review." Smithsonian Inst. Press, Washington.

Schoepf, B. G. and C. Schoepf. 1980. Beyond farming systems research. Paper presented at Ann-Mtg. Amer. Anthro. Assoc., Wash. D.C.

Sinclair, A. R. E. and M. Norton-Griffiths, eds. 1979. Serengeti: Dynamics of an ecosystem. Univ. of Chicago Press, 389 pp.

Unasylva. 1981 Wood Energy. Special Edition, Pt. 1, 33(131); pt. 2, 33(133).

Vangu-Lutete, L. M. 1979. Le Zaîre et le probleme des combustibles ligneux. SPIAF, 75 pp.

Vansina. J. 1966. Introduction a l'ethnographie du Congo. Editions Universaires du Congo, Kinshasa.

Verschuren, J. 1975. Wildlife in Zaîre. Oryx 25-33, 149-163.

Von de Becke, J. P. 1977. Situation de gorille de montagne dans les volcans eteints Virunga. Leopard No. 5, INCN.

World Bank. 1975. The Economy of Zaîre. 5 vols., Washington, D.C.

_____ 1980. World Development Report 1980. Wash., D.C.

Appendix A

CLASSIFICATION OF COMMERCIALLY VALUABLE TREES

Categories of Timber Trees

This list is based on a publication by the Office National du Bois, "Classification des Essences Fôrestieres du Zaîre" (1979). Four quality classes are designated, on the basis of the following criteria.

- Physical and mechanical properties, which translate into commercial value
- Availability, in connection with the extraction of primary timber
- Market value, a function of the level of development of the wood products industry

The four classes of commercial timber are defined as follows:

Class I. All timbers exploited in Zaîre for the furniture and construction industries and more on the international than the domestic market. These woods are generally destined for the cabinet industry, their technological value thus constituting the primary basis for classification.

Class II. Certain timber trees used primarily within Zaîre, although known on the international market and sometimes exploited on a short-term basis for the export trade.

Class III. Timbers known on the international market but not of major economic importance and not commercially promoted. Nevertheless, they are available and in use locally.

Class IV. Trees generally unknown to commerce, not through lack of economic value, but simply due to the absence of structural and technical studies or, in cases where the studies have been done, to inavailability of the data.

Scientific Name	Commercial Names
Class I	
Chlorophora excelsa	Kambala iroko
Diospyros agrossis	Ebene
Diospyros alboflavescens	Ebene
Diospyros laurentii	Ebene
Diospyros mannii	Ebene
Diospyros mayombensis	Ebene
Diospyros yangambiensis	Ebene
Entandrophragma angolense	Tiama
Entandrophragma candolei	Kosipo
Entandrophragma cylindricum	Sapelli
Entandrophragma utile	Sipo
Gossweilerodendron balsamiferum	Tola
Khaya anthotheca	Acajou d'Afrique
Khaya grandifolia	Acajou d'Afrique
Khaya nyasica	Acajou d'Afrique
Milletia laurentii	Wenge

Scientific Name	Commercial Names
Morus mesozygia	Kankate ou difou
Nesogordonia leplaei	Kotibe
Nesogordonia papaverifera	Kotibe
Oxystigma oxyphyllum	Tshitola
Pericopsis elata	Afrormosia ou kokrodua
Terminalia superba	Limba

Class II

Afzelia bipendensis	Doussie
Afzelia pachiloba	Doussie
Albizzia adiantifolia	Musase
Albizzia antunesiana	Musase
Albizzia coriaria	Mussase
Albizzia ferruginea	Musase
Albizzia gilandinii	Musase
Albizzia glabrescens	Musase
Albizzia grandibracteata	Musase
Albizzia gummifera	Mepepe
Albizzia harveyi	Mepepe
Albizzia intermedia	Mepepe
Albizzia lebbecq	Mepepe
Albizzia shimperiana	Mepepe
Albizzia versicolor	Mepepe
Albizzia zygia	Mepepe
Amphimas ferruginea	Bokanga
Amphimas pterocarpoides	Bokanga
Aningueria robusta	Aniengre
Anthonotha macrophylla	Kassusu
Autranella congolensis	Mukulungu
Ceiba pentandra	Fromager
Fagara aftissimi	
Fagara homblei	
Fagara kivuensis	
Fagara macrophylla	
Fagara mildbraedii	
Gambeya africana	Longhi
Gambeya lacourtiana	Longhi
Gambeya macrocarpa	Longhi

Scientific Name	Commercial Names
Gambeya oxyphyllum	Longhi
Gilbertiodendron dewevrei	Limbali
Guarea cedrata	Bosse ou bossasa
Guarea thompsonii	Bosse ou guarea diambi
Lebrunia bushei	
Nauclea diderrichii	Bilinga
Nauclea trilesii	Bilinga
Nesogordonia dewevrei	Kotibe
Ongokea klaineana (gore)	Angeuk
Paramacrolobium coeruleum	
Pterocarpus castelsii	Padouk
Pterocarpus soyauxii	Padouk
Pterocarpus tinctorius	Padouk
Staudtia gabonensis (stipitata)	Niove

Class III

Alstonia boonei	Emien
Alstonia congensis	Emien
Alstonia gilletii	Emien
Alstonia sp	Emien
Antrocaryon nannanii	Onzabili
Antiaris africana	Kirundu
Antiaris welwitschii	Ako
Blighia welwitschii	Axonog
Bosqueia angolensis	
Brachystegia laurentii	Bomanga
Canarium schweinfurthii	Aiele
Celtis brieyi	Diana
Celtis soyauxli	Ohia
Cleistopholis glauca	Sobu
Cleistopholis patens	Sobu
Copaifera mildbraedii	Bubinga ou waka
Corynanthe paniculata	Tsania
Cynometra hankei	Nganga
Dacryodes buettneri	Igangaga
Dacryodes edulis	Igangaga
Dialium corbisieri	Eyoum
Dialium pachyphyllum	Eyoum

Scientific Name	Commercial Names
Diogoa zenkeri	
Drypetes gossweileri	Kasinga
Entandrophragma palustre	
Erythrophleum suaveolens	Tali
Guarea laurentii	Diambi
Guibourtia arnoldiana	
Gulbourtia demeusei	Bubinga
Hexelobus crispiflorus	Owui
Irvingia grandifolia	Olene
Julbernardia seretii	Mubangu
Klainedoxa gabonensis	Eveus
Laonea welwitchii	Kumbi
Lovoa trichilioides	Dibetou
Mammea africana	Oboto
Maesopsis eminii	Esenge
Mitragyna stipulosa	Aubura
Newtonia leucocarpa	
Parinari congolana	Sougue
Parinari excelsa	Sougue
Parinari glabra	Sougue
Parkia bicolor	
Pausinystalia pynaertii	
Pentaclethra macrophylla	Mubala
Petersianthus macrocarpus	Essia
Piptadeniastrum africanum	Dabema, ou singa-singa
Polyalthia suaveojens	Molinda
Pycnanthus angolensis	llomba
Ricinodendron heudelotii	Essessang ou grimado
Scorodophloeus zenkeri	Divida
Sterculia tragacantha	
Strombosiopsis tetrandra	Botaka
Symphonia globulifera	Namil
Tessmania africana	Wamba
Thureanthus africana	Lusamba ou avodire
Triplochyton scleroxylon	Obeche
Uapaca guineensis	Bosenge

Class IV

All other commercial timbers