This is to certify that the

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AN ECOLOGICAL SURVEY OF THE ST. FLORIS

NATIONAL PARK, CENTRAL AFRICAN REPUBLIC

presented by

Kenneth B. Barber

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AN ECOLOGICAL SURVEY OF THE ST. FLORIS NATIONAL PARK, CENTRAL AFRICAN REPUBLIC

By

Kenneth B. Barber

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ABSTRACT

AN ECOLOGICAL SURVEY OF THE ST. FLORIS
NATIONAL PARK, CENTRAL AFRICAN REPUBLIC

By

Kenneth B. Barber

A base-line ecological survey was conducted in the St. Floris National Park, located in the northeast corner of the Central African Republic, in 1977 and 1978. There is a single wet season extending from late May to October and the park is located between the 1100-1200 mm long-range isohyettes. The vegetation bore greatest resemblance to the Sudan savanna zone although northern Guinea plaints were found in southernmost areas. Seven vegetation types were differentiated and described in relation to a parent soil/vegetation catena. Large mammal population surveys were conducted, and population estimates, based on these censuses and general observation, were presented. The status, behavior, and herd size and age structure of 22 mammalian species were discussed. Partial species-lists of mammals, birds, reptiles, fish and plants were included. Recommendations were given for management and future development of the park.

To those rare far-sighted individuals who have set as their highest personal priority the preservation of significant natural communities in the Central African Republic—the essence of the nation's heritage and its most perishable resource.

ACKNOWLEDGEMENTS

Without the assistance of many persons in the CAR and the United States, it would have been impossible to conduct the research reported herein. In the CAR, I wish to thank the Eaux et Forêts personnel assigned to the Vakaga and Bamingui-Bangoran Prefectures for their help during all aspects of the study. The Office de la Recherche Scientifique et Technique Outre-Mer (ORSTOM) rendered invaluable assistance by allowing me access to their laboratory and scientific library in Bangui. Mr. Michel Cabaille was of great help due to his previous experience in St. Floris and knowledge of the history of the region. Dr. Clive Spinage, Michael Loevinsohn, and Joseph N'Douté of the FAO project CAF/72/010 aided in planning research and they generously allowed me to serve as an observer during the 1978 aerial census of St. Floris and its environs. I am deeply indebted to Mr. and Mrs. Jean-Luc Temporal, Willy Donati and the personnel of Ex-Safarafric for the pleasant stay while working out of the Gounda camp. Mr. Donati assisted in keeping the project vehicle in running order throughout the project. Due to his extensive knowledge of the Manovo-Gounda Reserve (now part of the St. Floris—Manovo—Gounda National Park), Mr. Temporal proved instrumental in providing information concerning animal distribution and movements, effects of poaching, and tourism possibilities for the region. In addition, he donated his artistic expertise in the form of the vegetation catena drawing. Mr. Michel Mazade, Professor of Botany at the Jean-Bedel Bokassa University in Bangui, donated his valuable time towards the identification of many of the plants collected in St. Floris. Special thanks are due to the personnel of the FAC St. Floris project for their assistance in all facets of the ecological survey. I cite in particular: Jean-Paul Thomassey, Project Director; Ernest Betibangui, Project Co-director and Ingenieur Technique Forestière, Specialiste en Faune Sauvage; Remi LeFrançois, Chef de Chantier; and Luis Gonikai, Specialiste en Faune Sauvage for their invaluable assistance throughout the project.

Special thanks are also due to the American Embassy and Peace Corps staff in the CAR, notably Ambassador Anthony C. E. Quainton, DCM William Swing, Peace Corps Director Karen A. Woodbury, and Associate Directors Joe D. Kimmins and James B. Seyler. I also wish to express my appreciation to the Smithsonian/Peace Corps Environmental Program, and in particular to Dr. James A. Sherburne, for their material and technical assistance. I am deeply indepted to Ambassador Robinson McIlvaine and the African Wildlife Leadership Foundation for the research grant that made the study possible. My most sincere appreciation is given to Peter F. Galbreath and Stuart A. Buchanan who worked with me during the 1977 and 1978 field seasons respectively. Their understanding, hard work, and professional attitude were instrumental toward the completion of the field work.

Finally I wish to thank the members of my Graduate committee, my major advisor Dr. George A. Petrides and also Drs. Stephen N. Stephenson and Rollin H. Baker for their help in preparing the text. Moreover, Dr. Petrides was very instrumental in obtaining the research grant and lending support to the program when the need was greatest.

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INTRODUCTION

I. 1 MANDATE

A wildlife research project of the St. Floris National Park was initiated in February 1977 following a letter of request No. 579 MPTTECP/CAB from the Central African Prime Minister to the American Peace Corps Director. Jointly financed by the African Wildlife Leadership Foundation (AWLF) and the U. S. Peace Corps, this study was designed to coincide with an on-going FAC (Fonds d'Aide et Cooperation) development project also in St. Floris. The job description stipulated by the above letter requested biologists to undertake large mammal studies especially aimed at assessment of populations, distribution patterns, and herd structures, in addition to the completion of a vegetation map of the park. During the course of the project, it became apparent that additional studies could be conducted, and the decision was made to effectuate a general ecological survey of St. Floris.

In addition to the project funds donated by AWLF ($6,000), support in the form of research materials was also provided by three other sources. The Smithsonian/Peace Corps Environmental Program provided binoculars, a range finder, identification manuals, mist nets, and small mammal traps. Aerial photos, binoculars, compasses, and a telescope were generously donated by FAC. In 1978, in order to study small rodents and bats, a large quantity of mist nets and snap traps were received from the Carnegie Museum of Pittsburgh, Pennsylvania.

I. 2 LOCATION AND ACCESS

The St. Floris National Park has a surface area of 2,643 square kilometers (Loevinsohn et al. 1978) and is situated approximately between latitudes 9° 13' N and 9° 48' N and longitudes 20° 54' E and 21° 41' E. The park boundaries are formed in the north by the Bahr Kameur river from the Djoulou to its confluence with the Gounda. The western boundary is formed by the Gounda river south to the Goro river and along the Goro to its intersection with the N'Délé-N'Diffa foot path. The southern boundary follows this foot path in a general northeastern direction between the Goro and Vakaga rivers. In the east, the boundary is formed by the Vakaga river north to its confluence with the Ouandjia river and a line from this point due north intersecting the Gordil-Mélé road on the western edge of the Eaux et Forêts camp one kilometer west of Gordil. The border follows this road to a point 1.5 kilometers south of Mélé, thence on a line due west three kilometers, and then due north 2.3 kilometers to its intersection with the Mélé-Haraze road to the Djoulou river and along this seasonal waterway to the Bahr Kameur. In March 1979, following the completion of this study, the park was incorporated into a larger national park composed of the Manovo-Gounda Reserve (Ex-Safarafric), hunting sector 11, and St. Floris. This park has been provisionally named the St. Floris-Manovo-Gounda National Park.

St. Floris is reached by travelling 850 kilometers by road using the itinerary: Bangui-Sibut-M'Brès-N'Délé-Koumbala-Gounda-Gordil. Although the park is accessible by other roads, this is the most practical and direct route. However, due to wet season flooding, St. Floris is only accessible by road from December to June. Two airstrips serve the park: the first at the Gounda camp and another located six kilometers east of Gordil.

I. 3 HISTORY

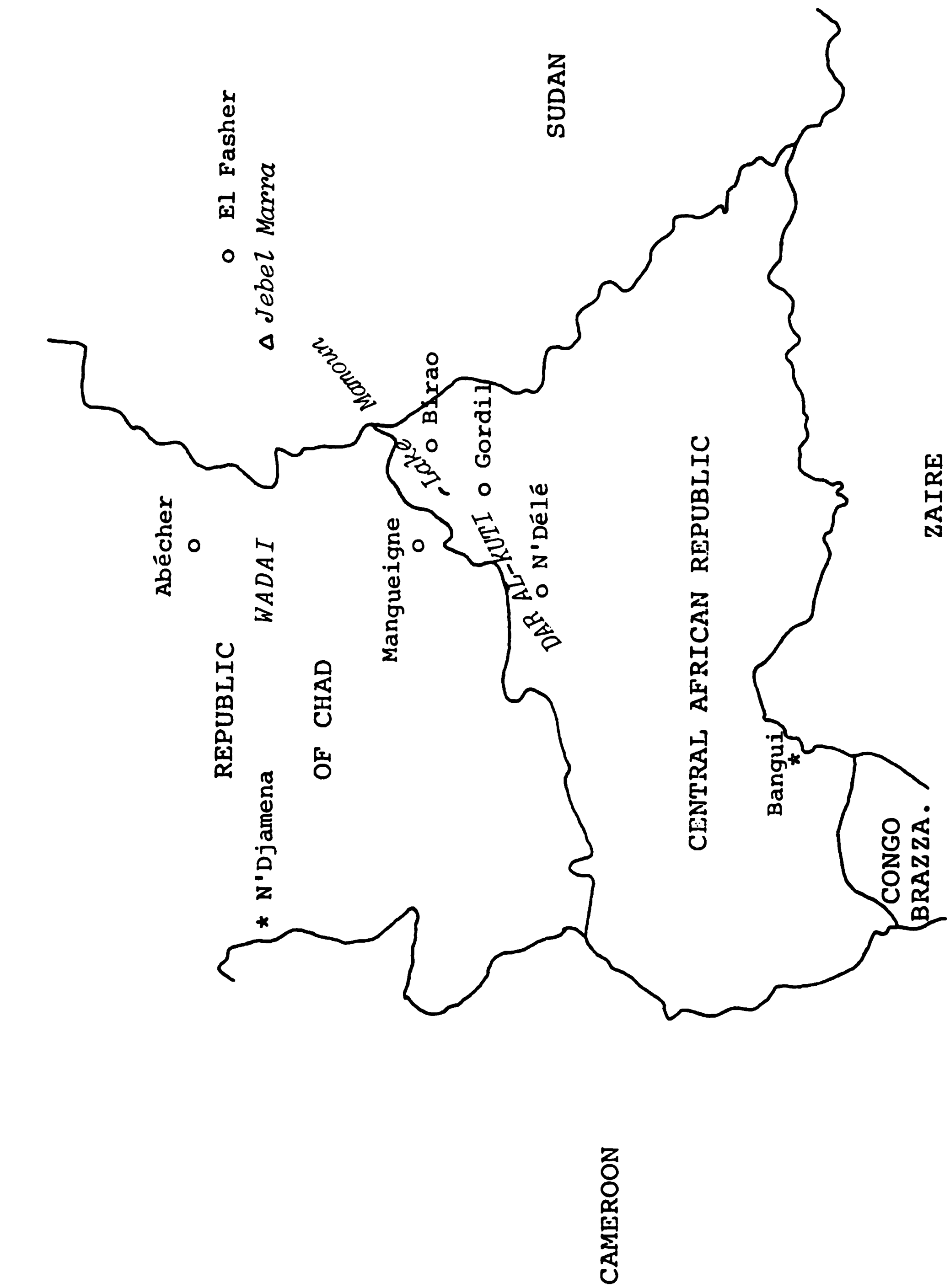
The recent human history of the St. Floris region is predominately influenced by its position on the Islamic frontier. During the second half of the 19th and beginning of the 20th Centuries, slave raiders from Chad, Sudan, and N'Délé (CAR) depopulated the northeastern part of the present day Central African Republic. The effects of this activity are still apparent as the region supports one of the sparsest human population densities in Africa.

From what information is available, members of the Goula tribe arrived in the park area in the middle 1800's after a long sporadic migration beginning in the 17th or 18th Century from the area of the Blue Nile near the Ethiopian frontier. The small group of Goula men settled with a closely related people, the Kara, who had previously undertaken a similar migration and set up villages near Jebel Marra southwest of present day El Fasher, Sudan. There, the Goulas intermarried with Kara women before moving to Lake Mamoun in the early 1800's. Later after some altercations with the Helmat Arabs at Mamoun, part of the Mamoun Goulas moved south to set up villages along the Ouandjia river probably not far from present day Gordil (Boucher 1934). Additional villages were later constructed at Mélé, Ninion, and Matoumara (near Gata). The area in or near the present day park was well suited for the Goulas due to the abundance of fish and the fact that the region was uninhabited on their arrival: a comfortable situation of short duration.

The tranquility did not last long for the Goula, Banda, Kreich, Rounga, Youlou, or Kara who lived within a 200 kilometer radius of the present day park. Beginning in the second half of the 19th Century, Arab slave raiders moved south during the dry season to gather slaves and other articles of trade. Slave raiding activity peaked during the period 1890-1911 when Rabih and Mohammad Al-Senusi staged numerous raiding missions in the park area, capturing slaves and plundering villages (Boucher 1934). Mortality at the hands of these and other lesser known slave raiders was staggering both during raiding operations and the transport of captives for sale or incorporation into the capturing army (Cordell 1977). By 1905, the region approached complete depopulation as the indigenous peoples either fled or were captured or killed. Many, especially the Goulas who were the most harassed tribe in the area, sought protection in N'Délé and Abaché, seats of the respective sultanates of Dar al-Kuti and Wadai (Figure 1). There, often meeting with tribal members previously captured, the new arrivals were either incorporated into the societies of the two capitals or were sold into slavery. The Goulas returned to reinhabit their former villages in the park area and Lake Mamoun after the defeat of the two sultanates at the hands of the French: Dal al-Kuti in 1911 and Wadai in 1916. Six additional villages were established between the Gounda-Goro confluence and Gata (Cornet 1916).

The next two decades were characterized by a period of general peace and relocation. In the period following the defeat of Dar al-Kuti, the French military, in order to facilitate defense, relocated Goula villages situated inside the present park boundaries to areas along established routes. Although relocation was often unpopular with village

Figure 1. Generalized map of Central Africa showing cities and landmarks important to the past history of the region. Modern African nations contiguous to the Central African Republic are also shown.


REPUBLIC
OF CHAD
* N'Djamena
Abécher
WADAI
Mangueigne
Lake Mamoun
El Fasher
Jebel Marra
SUDAN
Birao
Gordil
DAR AL-KUTI
N'Délé
CENTRAL AFRICAN REPUBLIC
Bangui
CAMEROON
CONGO
BRAZZA.
ZAIRE

chiefs, the process was completed by 1930 and a general peace reigned in the region. Few changes have taken place in the last fifty years. The Goula population has doubled and the area receives a dry season influx of cattle from Sudan and Chad. The Goulas continue to fish and cultivate millet, peanuts, and some cassava.

The St. Floris National Park had its origin in 1933 as the result of explorations by Henri Bouvard for the purpose of finding suitable locations for national parks in what is now the CAR (Cabaille 1960). His original designation was the "Parc National de la Mare de Matoumara," a rectangle 15 kilometers long and 9 kilometers wide near Gordil. The principal reason for the park's establishment was to protect the hippopotamus whose numbers had declined dramatically since the turn of the century. This area now holds the highest density of hippopotami in the Central African Republic.

Since 1933, the surface area of the park has been enlarged several times. The Parc National de la Mare de Matoumara became a wildlife reserve in 1935 only to be changed back into a national park later in the same year. In 1940, Blancou enlarged the park and fixed boundaries that closely approximate those found today in the northern sector. He also named the park St. Floris in memory of its founder (St. Floris was novelist Henri Bouvard's pen name). During the 1940's, cattle invaded from Chad and Sudan seeking pasturage in the park. In 1949, Mr. Andre Félix, Chef du District and Lieutenant de Chasse in Birao, initiated measures to combat the detrimental effects of illegal grazing and poaching in the park. He was assisted in his duties in 1954 when Mr. Michel Cabaille was appointed as "protector" of St. Floris. Félix was killed by a buffalo early in 1955 and Cabaille replaced him as Inspecteur de

Chasse in Birao where he remained responsible for the administration and management of the park until 1963. In 1960, St. Floris was enlarged to 922 square kilometers by incorporating the "Bois de Matoumara," a wooded area between Gordil and Mêlê, into the park as delineated by Blancou in 1940. Cabaille proved to be a serious and determined manager and, for the first time, poaching and illegal grazing were brought under control. In addition, a tourist camp was constructed by the Service de Tourism in 1961 and tourists were received at this camp situated at Dongolo in 1962 and 1963. The camp was rented and managed by a Swiss entrepreneur until tourism was outlawed in 1964. Stangenec replaced Cabaille and although he undertook a protection program, the Dongolo camp was destroyed by vandals and the fauna suffered heavily from poaching between 1964 and 1966. In 1967-1968, the camp was rebuilt and a small number of tourists were accommodated before the camp was destroyed by a bush fire in December 1969. In 1974, the hunting sector number 7 bordering to the south was added to the park to give a total of 2643 square kilometers.

The early 1970's were the most detrimental period for the fauna in the park's history. Poaching and cattle herding went unchecked and populations of many species of wildlife (especially giraffe, buffalo, and elephant) declined dramatically. A French-funded project, designed to create the necessary infrastructure (roads and lodging for game guards) for the protection of St. Floris, became operational in 1976. As result of this initiative, the first serious attempt since 1964 toward the control of poaching and cattle herding was launched in 1977 by this project's co-director, Mr. Ernest Betibangui.

I. 4 LEGAL STATUS AND ADMINISTRATION

For the most part, St. Floris lies within the prefecture of Bamingui-Bangoran although it is administered by the Cantonnement in Gordil, part of the Vakaga prefecture. The Chef de Cantonnement in Gordil is primarily responsible for the park's management and protection.

The legal status of St. Floris as a national park is defined by: Law 60/140 of August 19, 1960; Order 1892 of November 19, 1960; and Order 485 of March 1, 1962. These statutes define the reasons for the park's creation as well as policy concerning human use and visitation. Boundaries are described in Annex 3 of Law 60/140 and Ordinance 74/098 of August 29, 1974: the latter defining the annexation of the southern sector.

THE ENVIRONMENT

II. 1 CLIMATE

The climate of St. Floris is classified as tropical semi-humid, sudano-guinean. It is characterized by a mean yearly rainfall of 950-1700 mm and a single rainy season alternating with a hot dry season. The meteorological station closest to the park is Mangueigne, Chad (150 kilometers north of the park's center) although insufficient data from this source are available for analysis. The next closest stations, located in N'Délé and Birao, possess complete records for the last several decades. Birao, 180 kilometers northeast of the park's center, is located in the dry tropical, sudano-sahelian zone. N'Délé, situated 150 kilometers south-southwest of the park, while part of the same generalized climatic zone as St. Floris, is characterized by higher rainfall and cooler mean temperatures. Although the park's climate bears closer similarity to the Birao station, it is probably best to visualized it as situated on a gradient between these two stations.

II. 1. 1 Rainfall

Billon et al. (1974) places St. Floris between the 1100 and 1200 mm long-range isohyettes occuring in a region of a single peak rainy season. The wettest months are July, August, and September when 58 and 73 per cent of the yearly rainfall was recorded for N'Délé and Birao respectively (Figure 2). The length of the dry season varies from year to year with Birao having the longer dry period. The mean monthly rainfall,

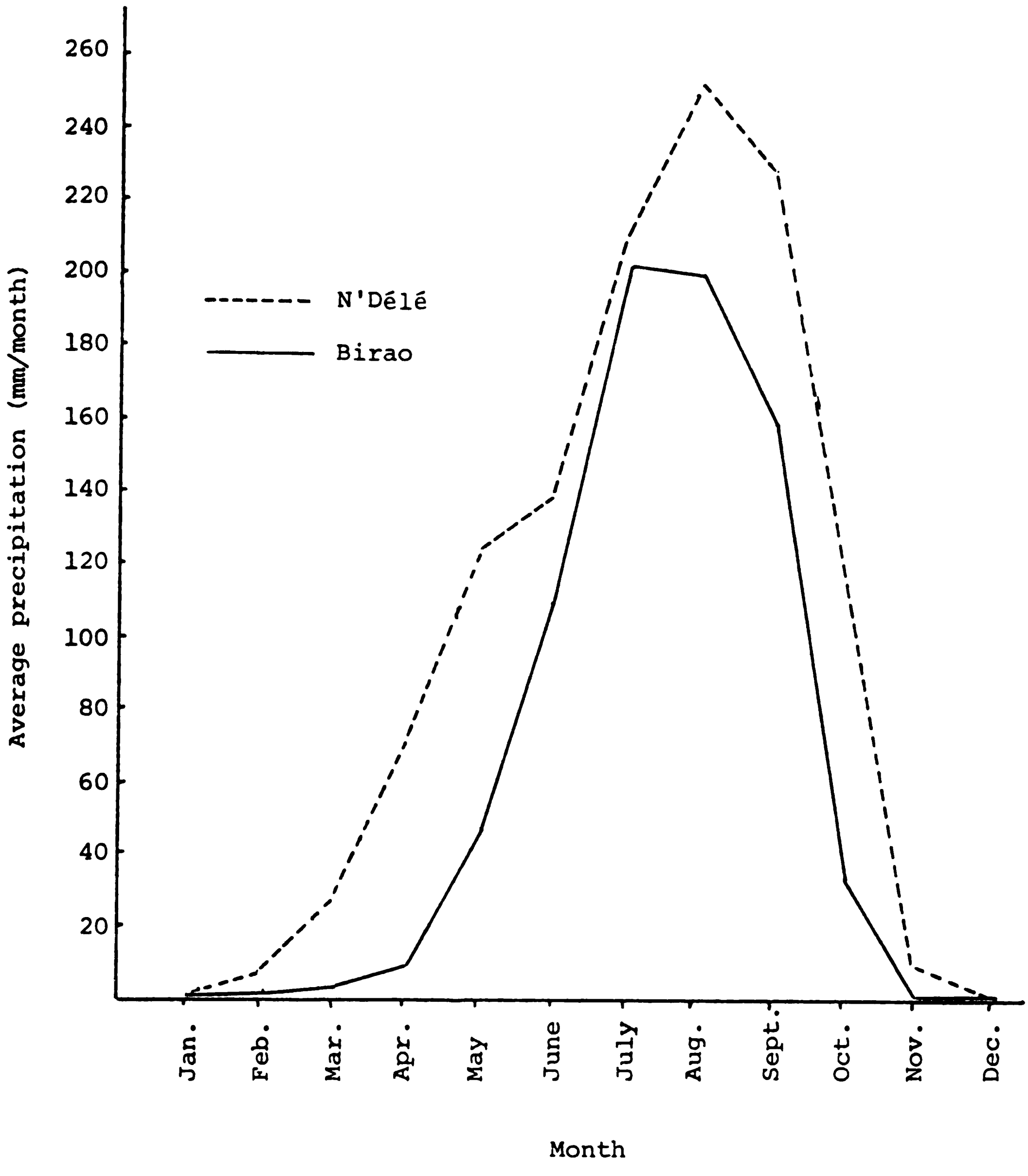


Figure 2. Average monthly rainfall for the Central African towns of N'Délé and Birao computed from data gathered from 1967 to 1976 by the Agence Centrafricaine pour la Securite de la Navigation Aerienne (ACESNA).

compiled from data recorded between 1967 and 1976 show Birao with six months of less than 25 mm of rain and N'Délé with five.

The rainy months of May to September are influenced by a southwesterly wind which brings humid air up from the Gulf of Guinea. The little rain that falls during the remaining months comes with dry northeastern winds from the Sahara.

Annual rainfall totals were plotted from N'Délé (1949-1976) and Birao (1951-1976) plus linear regression lines (Figure 3). The regression lines show marked declines in rainfall over this long period: 15.8 per cent for N'Délé and 24.6 per cent for Birao.

II. 1. 2 Temperature

The Birao station exhibits the greater temperature variation with the higher maximums and lower minimums as compared to the more even-temperature differential at N'Délé. The hottest month (mean maximum temperature) is March in N'Délé (37.1°C) and April in Birao (39.3° C) while coolest temperatures (mean minimum) are recorded for both stations in December: 17.7° and 11.9° C respectively. Yearly mean temperatures are slightly higher in N'Délé (26.8° C) as compared to Birao (26.6° C): the latter station having the higher monthly means from April to October.

The diurnal range is highest in December at both stations (22.4° C in Birao and 16.8° C in N'Délé) and lowest at Birao in August (10.6° C) and July and August in N'Délé (8.6° C).

Graphs plotted from these monthly averages (Figure 4) show two cold periods for the Birao region: one in July-August caused by the rains and another in December-Jaunary under the influence of the Saharan winds. N'Délé shows only one such dip in its monthly averages caused by maritime

Figure 3. Total annual rainfall for the Central African towns of N'Délé (28 years) and Birao (26 years) compiled by ACESNA.

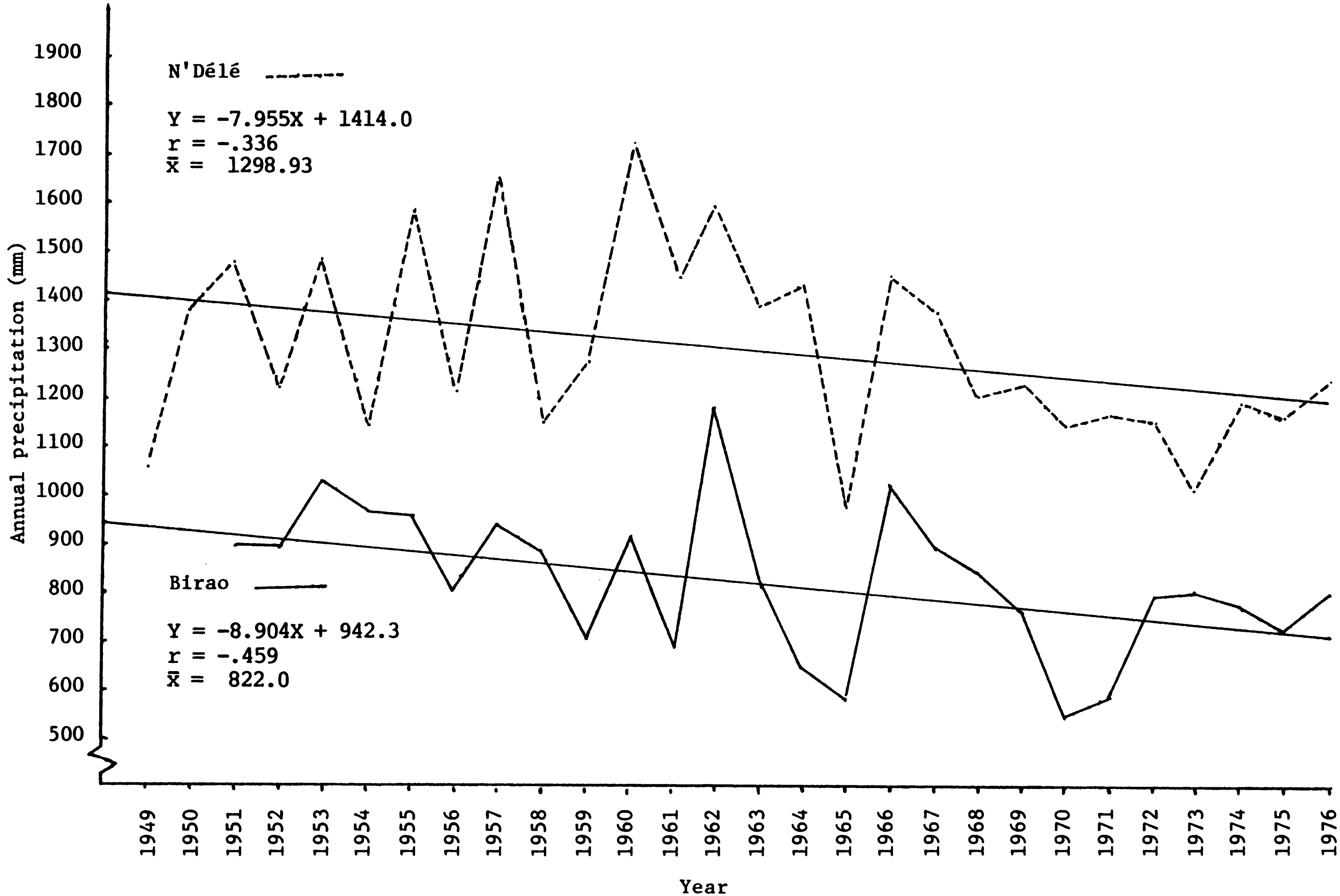
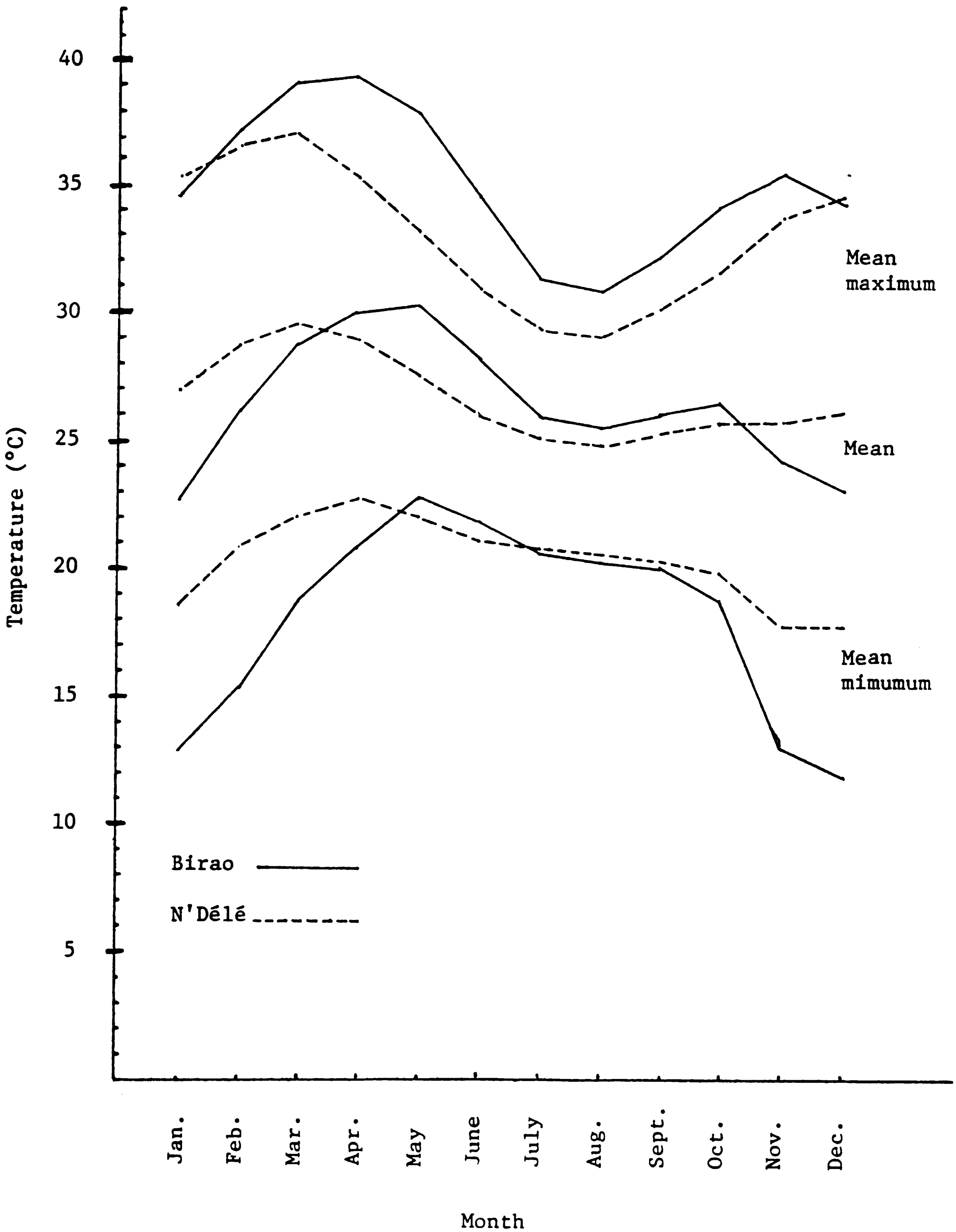

N'Délé
Y = -7.955X + 1414.0
r = -.336
x̄ = 1298.93
Birao
Y = -8.904X + 942.3
r = -.459
x̄ = 822.0
Annual precipitation (mm)
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
Year

Figure 4. Average monthly temperatures for the Central African towns of Birao and N'Délé compiled by ACESNA during the period 1968 to 1977.



40
35
30
25
20
15
10
5
Temperature (°C)
Mean maximum
Mean
Mean mimumum
Birao
N'Délé
Jan.
Feb.
Mar.
Apr.
May
June
July
Aug.
Sept.
Oct.
Nov.
Dec.
Month

air in July and August. However, the Saharan winds in December-January do cause a drop in mean minimum temperatures.

II. 1. 3 Humidity

The minimum and maximum relative humidity readings for Birao and N'Délé show the effect of the two prevailing winds over the course of the year (Figure 5). Humidity is highest in July and August at both stations under the influence of humid maritime air currents. The month of lowest relative humidity is February when the Sahara sends dry air southward into the CAR. Minimum monthly means are lower in Birao in all months reflecting its more northern latitude. Yet its mean maximum humidity readings slightly surpass those of N'Délé from August to February.

II. 1. 4 Winds

Prevailing winds in the St. Floris area vary seasonly but are extremely light (Figure 6). From November through March, the winds come out of the Sahara reaching Birao from the east-northeast. By the time these winds arrive at N'Délé, they are rather dispersed. Gradually, they change direction from northeast in November to southeast in March. These winds bring dry air from the Sahara tending to be cool during the period November to January gradually turning into a warmer, dust laden "harmattan" wind when force is strongest in February-March. No monthly average velocity at either N'Délé or Birao exceeded 2.5 meters/second during the period 1970 to 1976.

The rainy season from May to October is influenced by maritime air currents from the southwest. These humid air currents have the opposite effect of the saharan winds, giving a more constant breeze in N'Délé and

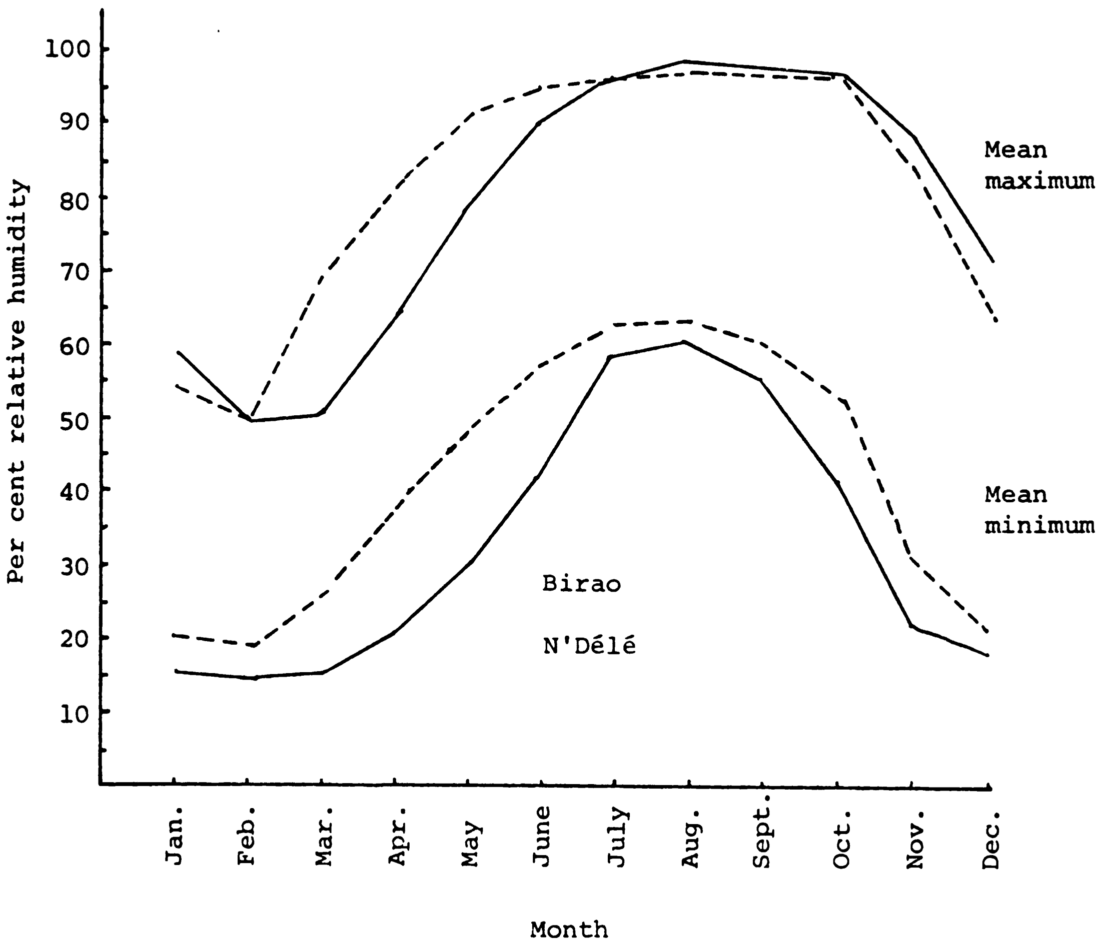
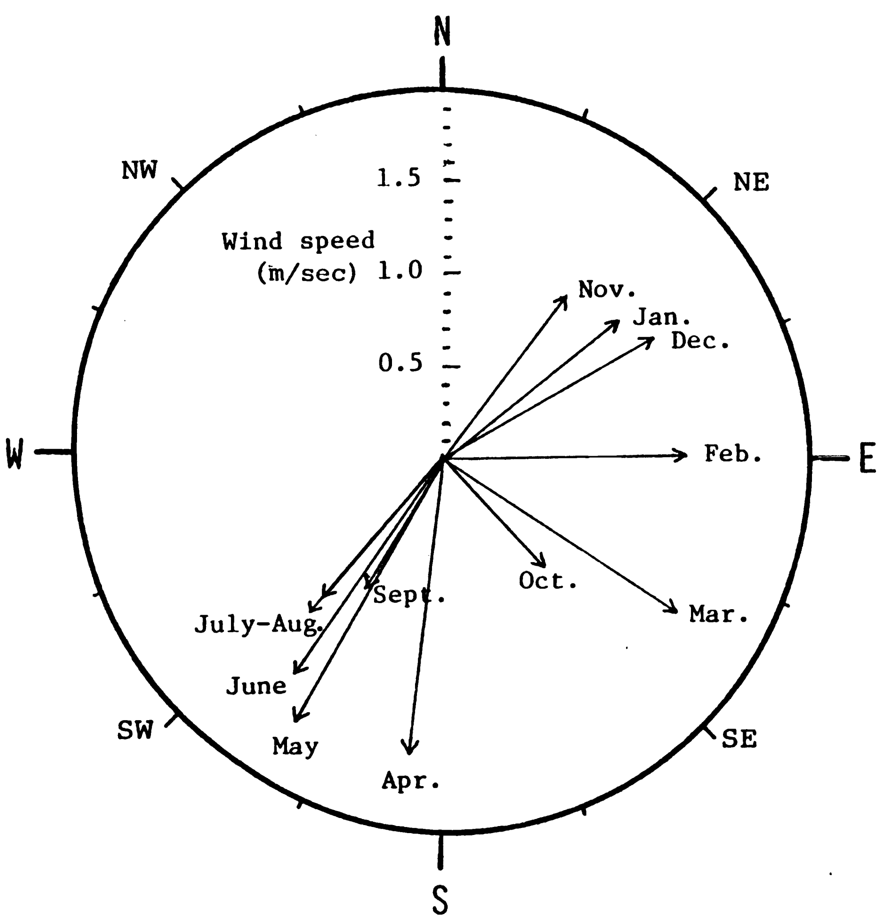


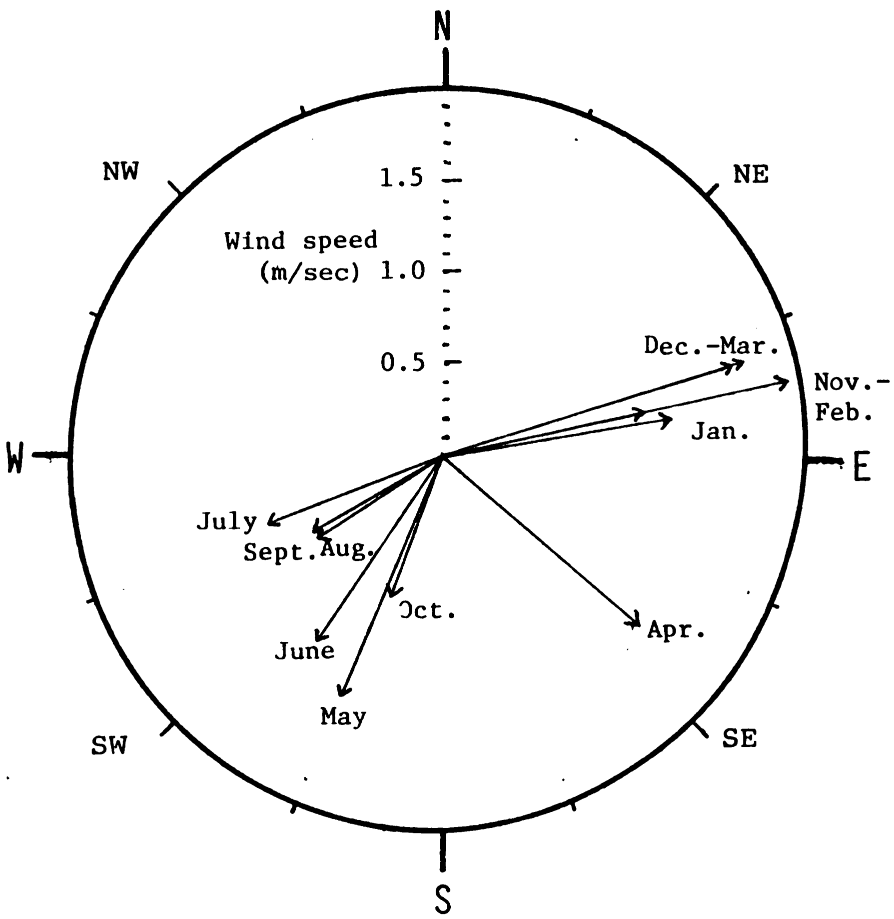
Figure 5. Mean maximum and minimum monthly relative humidity for Birao and N'Délé computed from data collected between 1967 and 1976 by ACESNA.

Figure 6. Incoming direction of winds by month for the Central African towns of N'Délé and Birao. The figure is based on data collected from 1970 to 1976 by ACESNA.

N'Délé


N
NE
E
SE
S
SW
W
NW
1.5
1.0
0.5
Wind speed
(m/sec)
Nov.
Jan.
Dec.
Feb.
Oct.
Mar.
Sept.
July-Aug.
June
May
Apr.

Birao


N
NE
E
SE
S
SW
W
NW
1.5
1.0
0.5
Wind speed
(m/sec)
Dec.-Mar.
Nov.-
Feb.
Jan.
July
Sept.
Aug.
Oct.
June
May
Apr.

being slightly more scattered and less forceful when reaching Birao.

The winds marking the change of seasons are generally variable both in N'Délé and Birao although there is a certain dissimilarity between stations due to the different lengths of seasons.

II. 2 TOPOGRAPHY

The absence of relief is a conspicuous feature of the St. Floris region. Situated at about 400 meters above sea level, the difference between lowest and highest points in the park is less than 50 meters.

In the north, the land slopes gently to the west and the lowest elevation (400 meters) is situated at the Gounda-Bahr Kameur confluence. In addition, there is a general inclination from south to north. The highest point is near the Goro river on the southern boundary.

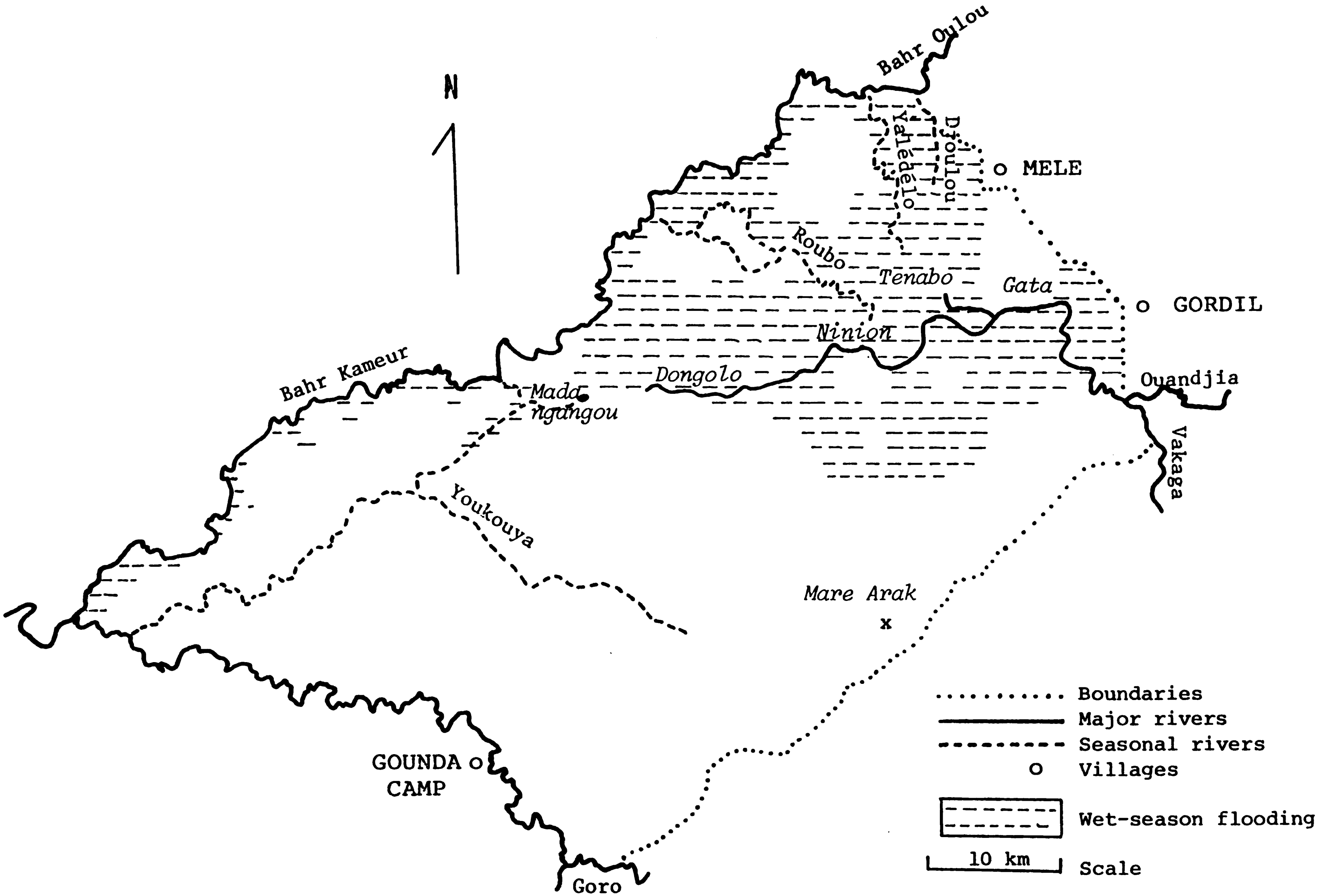
Erosion is localized and is only evident on the woodland-plains edge where relief is greatest. Drainage on the uplands is principally by seepage and/or evaporation as slopes are often insufficient for run-off. Large expanses on the plains are characterized by impeded drainage with numerous hog-wallow depressions (gilgai microrelief) characteristic of lightly or intermittently inundated areas.

II. 3 HYDROLOGY

St. Floris is located near the eastern perimeter of the Chari bassin. Unfortunately, there are no available hydrological data collected in or near the park and specifics await further studies.

The park is part of the southern tributary system of the Aouk which has two branches: the Bahr Kameur and Gounda rivers. The former drains the northern plains area in St. Floris as an intricate network of drainage canals and rivers most of which flow only seasonally (Figure 7).

Figure 7. Map of the St. Floris National Park, Central African Republic showing the major watercourses and the extent of seasonal flooding.


N
Bahr Oulou
Djoulou
Yalédélo
MELE
Roubo
Tenabo
Gata
GORDIL
Ninion
Dongolo
Ouandjia
Vakaga
Bahr Kameur
Madd
ngangou
Youkouya
Mare Arak
GOUNDA CAMP
Goro
Boundaries
Major rivers
Seasonal rivers
Villages
Wet-season flooding
10 km
Scale

The

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The most notable of these are the Ouandjia, Vakaga and Bahr Oulou rivers, all with sources in the Bongo mountains located southeast of the park. Flood waters covering vast expanses on the plains come, for the most part, from run-off carried by the Ouandjia and Vakaga rivers. Lowest water levels occur in March, April, and early May when these waterways occasionally dry up, leaving many stagnant pools. The network of drainage canals between the Vakaga-Ouandjia confluence and the Bahr Kameur is extremely complex and apparently there has been a recent change in course. The Bahr Kameur is defined as commencing either at the Djoulou or the Yalédélo, i.e. the most important point of entry from the Ouandjia-Vakaga, although the principal waterway during low water conditions is the Ninion-Dongolo circuit. The Roubo, Yalédélo, and Djoulou flow, perhaps with similar capacity, when the water level is higher in the Ouandjia and Vakaga. Water entering the park from the Vakaga and Ouandjia only arrives at the Bahr Kameur during the wettest months. This effluence comes from two large basins, one north of Dongolo and the other southeast of Mélé. These collect much of the initial flow at the beginning of the rainy season and present an extensive area for evaporation. Only when these basins overflow is water carried to the Bahr Kameur.

The southern sector of St. Floris is drained by the Gounda and its tributary, the Goro. Plains areas, characterized by seasonal inundations, are found in a narrow band along these two rivers and to a lesser extent along the Youkouya, a seasonal stream draining the center of the southern sector.

The Gounda was the only river observed to flow continuously during the driest period of the year. Flow in the Ouandjia, Vakaga, Bahr Kameur, and Goro was interrupted (within the confines of the park) in late April and early May in 1977 and all but the Goro stopped during the same period in 1978. This is probably a recent phenomenon resulting from the general decrease in annual rainfall.

II. 4 GEOLOGY

The geologic history of the St. Floris region is described by Delafosse (1960). During the Precambrian, marly and arenaceous sediments were deposited throughout the region. After metamorphism and some folding of these sediments, the region underwent a long period of erosion that formed a peneplain. During the Cretaceous, a covering of sandstone was deposited upon the peneplain. This formation is still visible on the plateau south of St. Floris. Tectonic movements during the Tertary produced numerous faults. These caused the collapse of the Chadian basin and began a new cycle of erosion characterized by the fluvio-lacustrine deposition of Quaternary sediments.

Two types of the Neo-Chadian alluvial coverings of the Precambrian and Cretaceous basement are present in St. Floris. The Matoumara depression, involving most of the northern plains region, and the river valleys of the major watercourses are of recent formation. Alluvium is deposited there on a continuous seasonal cycle. In contrast, the southern sector and upland sites of the north are characterized by older formations, although similar in origin.

II. 5 SOILS

The soils of the northeastern corner of the CAR are poorly studied because of their inherent poor agricultural quality and logistical difficulties posed to investigators. A rudimentary soil description is given by Quanton (1962), who analysed the gross horizon structure of

several test holes and described the pedological generalities of the region. Boulvert (1976) completed a soil map of the St. Floris quadrangle (1/200,000 scale) from aerial photos but type descriptions lack detailed field observations and data.

Soils in St. Floris vary along a physiographic gradient with the most evolved and less hydromorphic soils occurring on upper elevations. Woodland soils are essentially Luvisols (FAO/UNESCO 1973). Three subdivisions of this generalized soil unit can be distinguished. Most important are Ferric Luvisols which are widespread and uniform over much of the park. They are enriched in clay and hydroxides of iron and exhibit the lowest base saturation in upper horizons of any major soil type. An ironstone (indurated) layer does not occur throughout but if present, is found at depths of two meters or more. On slightly lower elevations, a dark red soil is found having an ironstone layer at less than one meter from the surface (Plinthic Luvisols). Gleyic Luvisols are encountered further downslope, although limited in extent. Low-lying soils exhibit great diversity based on the mode of drainage, degree of flooding, and deposition of alluvial material. All of these soils have hydromorphic properties within 50 centimeters of the surface. Eutric Fluvisols are found where alluvium is deposited on a seasonal cycle and where the extent of flooding is greatest. These soils exhibit no diagnostic horizons, a high clay content, and heavy iron mottling deeper than five centimeters from the surface. Eutric Gleysols, similar to the preceding soil unit, occur over much of the lightly flooded areas where the soil surface is flat. These occupy vast plains areas and are probably the most widespread of the low-lying soil units. Localized areas of Vertisols, characterized by extensive dry season cracking and the presence of hog-wallow depressions (gilgai microrelief), are found where drainage is impeded. Stone-sized calcium carbonate concretions are readily visible on the surface along the upraised perimeter of the hog-wallows.

II. 6 VEGETATION

II. 6. 1 Methods

Most species identifications (Appendix E) were undertaken in 1978. This inventory was incomplete, however, especially lacking wet season herbs and less common grasses and sedges. It was hoped that specimens could be prepared on herbarium sheets for use by future botanists. Due to serious constraints of time and materials, however, the project was unable to add specimens to the Eaux et Forêts herbarium at the Bureau Technique de Bois in Bangui.

A study to assess the frequency of occurrence of grasses was conducted in January 1978 on the plains and in the impeded-drainage tree savanna. Though not the ideal season, most grass species were nevertheless identifiable. Transects were selected randomly for the Gounda plains and the impeded-drainage tree savanna. The northern plains region is vast and highly variable and a rapid survey of sufficient coverage to yield acceptable results was infeasible. It was decided, therefore, to sample the area Gordil-Tenabo-Ninion-Vakaga ford, where four transects were selected commencing on the edge of the plains and extending perpendicular to a river. Unfortunately, only one of the four original transects was surveyed due to extensive burning on plains areas at the time of the study. Three additional transects were subjectively selected in areas considered representative of major plains vegetative sub-types.

The method utilized on all areas entailed dropping a metal rectangle 50 centimeters long by 20 centimeters wide (1/10 meter square) to the ground every 50 paces along the transect line. Species of grasses were recorded as present when a base or tuft appeared inside the rectangle.

In June 1978, the trees and shrubs of four vegetation types were studied. The relative density of trees, two or more meters in height, was assessed using the Point-Centered Quarter method (Cottam and Curtis 1956). Randomly-selected transects consisted of 25 points, 50 meters apart. No further transects were undertaken when the slope of the species-area curve leveled off. Shrubs, one-half to two meters in height, were counted on circular plots formed by revolving a five meter length of rope around every third point along the transect line.

A vegetation map of St. Floris (Appendix G) was drawn using aerial photos taken in December 1955 by the Institute Geographique Nationale (IGN) in Paris, France. The 1/200,000 scale topographic maps of the Haraze and St. Floris quadrangles, also produced by IGN, were also consulted. Information concerning location and extent of vegetation types was noted while walking transects and during general observation from the air and on the ground.

An attempt was made (Appendix F) to record the Goula and Banda names of plants indigenous to St. Floris. This list was compiled in hope of aiding future park biologists. Plant names offered by various individuals of these tribes tended to differ, however, and should be viewed with some caution. Other listings of indigenous plant names are given in Gillet (1964) [Goula] and Buchanan and Schacht (1979) [Banda].

II. 6. 2. Description of the vegetation

Some disagreement prevails concerning the vegetation zone within which St. Floris is situatied. Aubrèville (1950) placed the park in the Sudano-guinean zone; Sillans (1959) and Cabaille (1960) assign a Sudan designation; and Corfield and Hamilton (1970) locate it in the Sudano-sahelian zone. The vegetation in the northern sector contains species that are typical of the Sudan savanna. In the south, several species characteristic of the northern Guinean zone (Keay 1959) are encountered. It is probably acceptable to include St. Floris in the Sudan zone due to its general resemblance with this type.

The vegetation of St. Floris is organized in a zonal or mosaic manner. The effect of topography on water movement and hence on soil development seems evident as the dominant factor causing the orderly arrangement of soil and accompanying vegetation types. This relationship has been extensively studied by ecologists in the medium rainfall zone of Africa. Within a catena, there are three general aggregates of soil-vegetation units that are commonly referred to as complexes. Seven vegetation types are described within these complexes, denoted as eluvial, colluvial and illuvial by Morrison et al. (1948).

The soil-vegetation catena (Figure 8) is depicted in composite form in order to illustrate the general physiographic relationship between types. This necessitated generalization, especially on the illuvial complex, and any attempt to reconstruct the pictorial presentation in the field should bear this in mind. Plant species tended to vary from north to south due to differences in rainfall, soils, and topography, hence a catena is presented separately for the northern region (north of the Youkouya) and the Gounda-Goro area in the south.

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Eluvial complex

This complex is found on upper-level, well-drained sites where soils are characterized by erosion of surface particles and a downward movement of dissolved and suspended materials into soil horizons. These soils are coarse and exhibit low fertility due to extensive leaching. Soil depth is variable due to the variable presence of an ironstone layer which is formed most commonly on the eluvial-colluvial edge as a result of lateral downhill movement of iron in the water table. This layer is a principal feature of the *Combretum* scrub type and insufficient soil depth often inhibits woody vegetation, creating open "ironstone meadows." In the other two types (*Isoberlinia doka* wooded savanna and *Terminalia laxiflora* wooded savanna) in this complex, an ironstone layer may or may not be present. If present, it is usually situated at greater than one meter below the surface.

The vegetation on the eluvial complex, where soil depth permits, is a mixed savanna woodland rich in species. Though highly variable in detail, it is similar in fundamental character. Termitaria are a conspicuous part of this complex, although they are generally older and more degraded than termite mounds on colluvial or illuvial complexes. Eluvial termitaria support a thick vegetative cover of plant species indigenous to the dry forest. There, edaphic conditions (soil depth and humidity) coupled with protection from fire produce a flora strikingly similar to that found in the dry forest community.

Isoberlinia doka wooded savanna

It is present only in the southern part of the park in the vicinity of the Goro river. Generally situated on redistributed iron soils, it occupies the highest physiographic position in the catena. The soils in this community are the most evolved, albeit degraded, in the park and if an ironstone layer exists, it is situated at least one meter under the surface.

A well-developed canopy is dominated by 15 to 20 meter high leguminous species, notably *Isoberlinia doka* and to a lesser extent *Burkea africana* and *Prosopis africana*. The generally sparse understory includes *Piliostigma thonningii*, *Combretum ghasalense*, *C. hypopilinum*, *Lannea schimperi*, *Bridelia scleroneura*, *Hymenocardia acida*, *Ximenia americana*, and *Grewia mollis* plus scattered *Lonchocarpus laxiflorus*, *Terminalia laxiflora*, and *Indigofera* sp.. The herbaceous layer consists of the grasses *Andropogon gayanus*, *Hyparrhenia* spp., *Ctenium newtonii*, *Loudetia arundinacea*, *Pennisetum pedicellatum*, and *Beckeropis uniseta* and the sedges *Mariscus alternifolius* and *Cyperus* sp.. At the beginning of the wet season, the herbs *Asparagus flagellaris*, *Uriginea altissima*, *Commelina schweinfurthii*, and *Kaempferia aethiopica* are in flower.

Termitaria, generally of ochre color like the surface horizon, are normally small, well-spaced, and moderately degraded. They support a sparse vegetation due to shading from the upperstory. Trees common to these mounds include *Anogeissus leiocarpus*, *Ficus* sp., *Leptoderris brachyptera*, *Lonchocarpus laxiflorus*, *Diospyros mespiliformes*, and *Tamarindus indica*. The woody segment of the understory is dominated by *Clausena anisata*, *Feretia apodanthera*, *Boscia senegalensis*, *Capparis tomentosa*, and *Ziziphus* spp..

Terminalia laxiflora wooded savanna

In its various diverse forms, this type occupies the greatest surface area of any vegetative community in St. Floris. The soils, extensively leached ferric luvisols, exhibit a general uniformity throughout. The texture of the surface horizon varies from sandy-loam to loamy-sand.

The *Terminalia laxiflora* wooded savanna features the greatest species diversity in the park. The canopy, underlying shrubs, and herbal layers all are well developed. Variation between sites, often forming a mosiac, is generally due to soil depth and the incidence of fire. Relative densities of woody vegetation and average height of tree species were measured along random transects bordering the Gounda-Dongalo track (Table 1).

The dominant tree universally present throughout this type is *Terminalia laxiflora* which occurs in pure stands or is co-dominant with one or more of the following species: *Crossopteryx febrifuga*, *Butyrospermum paradoxum*, *Afrormosia laxiflora*, *Combretum glutinosum*, *Burkea africana*, or *Prosopis africana*. In the north, *Terminalia avicennioides* replaces *T. laxiflora* as the dominant species. *Parinari curatellifolia*, *Afzelia africana*, *Daniellia oliveri*, *Khaya senegalensis*, *Sclerocarya birrea*, and *Lonchocarpus laxiflorus* are occasionally observed in the canopy, though never forming pure stands or achieving co-dominant status.

The extent of the understory appears to be inversely proportional to the shading offered by canopy trees. In the more-open areas, too, grasses may fuel hot fires which have detrimental effects on the growth of small trees and shrubs. Common shrub species include *Piliostigma thonningii*, *Detarium microcarpum*, *Ximenia americana*, *Gardenia erubescens*,

Table 1. Relative density and average height of tree species and relative density of shrubs in the *Terminalia laxiflora* wooded savanna.

Species	Trees[1]		Shrubs[2]
	Rel. den. (%)	Height (m)	Rel. den. (%)
Terminalia laxiflora	38.0	6.5	26.9
Piliostigma thonningii	11.3	3.2	3.7
Detarium microcarpum	9.0	3.9	11.7
Crossopteryx febrifuga	7.7	7.3	4.0
Combretum glutinosum	3.7	6.3	0.9
Butyrospermum paradoxum	3.3	5.6	3.7
Ximenia americana	3.0	2.4	-
Afrormosia laxiflora	3.0	12.9	0.3
Anogeissus leiocarpus	2.6	4.7	0.3
Burkea africana	1.6	11.4	0.6
Gardenia erubescens	1.6	2.4	2.9
Xeromphis nilotica	1.3	2.8	0.6
Tamarindus indica	1.3	7.4	0.3
Hymenocardia acida	1.3	2.8	-
Combretum sp.	1.0	6.2	0.9
Combretum hypopilinum	1.0	4.1	4.6
Hexalobus monopetalus	1.0	4.3	0.6
Terminalia avicennioides	1.0	2.7	0.3
Khaya senegalensis	1.0	28.3	-
Ziziphus sp.	1.0	2.8	-
Combretum molle	0.7	2.8	-
Combretum ghasalense	0.7	8.5	-
Prosopis africana	0.7	4.0	0.9
Lonchocarpus laxiflorus	0.7	5.5	0.3
Strychnos spinosa	0.3	3.0	2.9
Maytenus senegalensis	0.3	2.3	2.6
Grewia mollis	-	-	10.6
Fadogia ledermannii	-	-	8.9
Parinari curatellifolia	-	-	2.0
Feretia apodanthera	-	-	1.4
Cissus cornifolia	-	-	1.1
Ziziphus mucronata	-	-	0.9
Fadogia pobeguinii	-	-	0.9
Unkonwn (Rubiaceae)	-	-	0.9
Other species	(5) 1.6		(7) 4.6
Totals/Mean	99.7	$\bar{x} = 5.8$	100.1
Total numbers	300		349
Absolute mean density (stems/ha)	23.1		185.0

[1] Trees consist of woody vegetation two or more meters in height.

[2] Shrubs are classified as woody and perennial herbs and vines between one-half and two meters in height.

Xeromphis nilotica, *Combretum hypopilinum*, *Hymenocardia acida*, *Strychnos spinosa*, *Grewia mollis*, *Maytenus senegalensis*, and *Bridelia scleroneura* along with saplings of many of the major tree species. Grasses common to this type include *Hyparrhenia barteri*, *H. filipendula*, *H. coriacea*, *Andropogon gayanus*, *A. schirensis*, *Cymbopogon giganteus*, *Ctenium newtonii*, *Loudetia annua*, *L. simplex*, *Beckeropis uniseta*, *Pennisetum pedicellatum*, *Eragrostis* sp., and *Elionurus argenteus* (flowering after burning). *Asparagus flagellaris*, *Urginea altissima*, *Kaempferia aethiopica*, *Cissus caesia*, *C. cornifolia*, *Indigofera* sp., *Fadogia ledermanii*, and *F. pobeguinii* are common where afforded sufficient protection from hot fires. *Cochlospermum tinctorium*, flowering after burning, is locally abundant in its vegetative form after the first rains. The grasses, several species of forbs and vines resume growth after the first rains.

Termitaria, often larger than those in the preceding vegetation type, form islands of dense cover. No termite activity was observed and degradation of mounds varied from moderate to heavy. Tree species, indigenous to these sites are often of considerable size and include *Anogeissus leiocarpus*, *Diospyros mespiliformes*, *Tamarindus indica*, *Khaya senegalensis*, *Hexalobus monopetalus*, and *Leptoderris brachyptera*. Larger termitaria support an almost inpenetrable understory of shrubs: *Ferentia apodanthera*, *Boscia senegalensis*, *Erythroxylum emarginatum*, *Ziziphus mucronata*, and *Capparis tomentosa*; vines: *Cissus quadrangularis*, *Ampelocissus miltistriata*, *Hippocratea africana*, *Melothria deltoidea*, and *M. maderaspatana*; and herbs: *Haemanthus multiflorus* and *Costus* sp..

Combretum scrub over ironstone

This type, generally situated on the outer edge of the eluvial complex, is characterized by shallow soils overlying an indurated ironstone layer, a light brown to dark red surface horizon often containing pebble-sized iron-stone concretions, and short scrub vegetation. "Ironstone meadows," formed where soil depth is insufficient to support woody species, are interspersed with thick vegetation on slightly deeper sites. Wet-season waterholes are frequently formed in depressions occurring on these open areas.

This type appears to have many diverse forms, though a general homogeneity is apparent when termitaria are purposely overlooked. In some areas, especially between Ninion and Dongolo, the ironstone layer extends onto the plains and plant species characteristic to the illuvial complex are sometimes encountered. Also in the area of Ninion, ironstone islands, completely surrounded by plains, containing the *Combretum* scrub type are present. The vegetation on one of these areas immediately south of Ninion was randomly sampled (Table 2). The mean tree height (3.5 meters) was the shortest among the four types sampled.

In the north, *Combretum nigricans* var. *elliotii* is the most abundant species, often forming considerable thickets along edges of ironstone meadows. Although present in the south, this species is sub-dominant to *C. ghasalense*. Other common species include *Stereospermum kunthianum*, *C. hypopilinum*, *Hymenocardia acida*, *Acacia polyacantha* subsp. *campylacantha*, *Detarium microcarpum*, *Dischrostachys glomerata*, and *Maytenus senegalensis*.

Few specific shrub species are present and 72.2 per cent of those sampled were saplings or stunted individuals belonging to the four most

Table 2. Relative density and average height of tree species and rela- density of shrubs in the *Combretum* scrub vegetation type.

Species	Trees[1] Rel. den. (%)	Trees[1] Height (m)	Shrubs[2] Rel. den. (%)
Combretum nigricans var. *elliottii*	43.1	3.0	51.8
Combretum ghasalense	15.6	3.8	3.7
Stereospermum kunthianum	12.5	2.5	10.2
Combretum hypopilinum	10.6	2.2	6.5
Anogeissus leiocarpus	8.8	6.3	0.9
Lonchocarpus laxiflorus	2.5	3.8	-
Crossopteryx febrifuga	2.5	3.7	-
Leptoderris brachyptera	1.3	9.3	-
Ferentia apodanthera	0.6	2.4	2.8
Mitragyna inermis	0.6	2.1	1.9
Ampelocissus multistriata	-	-	7.4
Grewia mollis	-	-	4.6
Cissus sp.	-	-	2.8
Other species	(3) 1.9		(8) 7.4
Totals/Mean	100.0	$\bar{x}$ = 3.5	100.0
Total numbers	160		108
Absolute mean density (stems/ha)	20.9		106.0

1 Two or more meters in height.

2 Between one-half and two meters in height.

abundant tree species. Among the other 27.8 per cent, only *Grewia mollis* is not characteristic to termitaria.

On shallow sites, the herb layer is dominated by the grasses *Loudetia annua*, *Sporobolus festivus*, *S. infirmus*, and *Microchloa indica*. *Hyparrhenia filipendula*, *H. coriacea*, *Andropogon schirensis*, and *Ctenium newtonii* are found on deeper sites. *Eragrostis* sp., *Oryza barthii*, *Sacciolepis ciliocincta*, and *Echinochloa obtusiflora* occupy humid sites in depressions. Sedges common to ironstone meadows include *Bulbostylis oritrephes*, *B. coleotricha*, and several species of *Cyperus*. Immediately following the onset of the rains, flowers of *Crinum* sp., *Chlorophytum bequaerta*, and *Costus* sp. give these openings a showy appearance.

Due to differences in soil depth and level of degradation, termitaria exhibit a wide variation in physiognomy and plant species composition. Larger mounds, generally on deeper soils, resemble those on *Terminalia laxiflora* woodland sites while small termitaria, often highly degraded, support a heterogeneous flora. In addition to species listed in the previous vegetation type, plants indigenous to termite mounds in the *Combretum* scrub type include *Cassia sieberiana*, *Rhus* sp., *Commiphora pedunculata*, *Securidaca longepedunculata*, *Grewia villosa*, *G. flavescens*, *Cissus crotalarioides*, *C. palmatifida*, *C. rufescens*, and *Paullina pinnata*.

Colluvial complex

The colluvial complex is a sorting ground for eroded material coming from the physiographically higher eluvial complex. In addition, soils are generally deeper, richer, and finer textured than those in the eluvial complex. In St. Floris, the colluvial complex is often reduced to a strip several meters wide or may, in some cases, be absent.

The dry forest is the only extensive vegetation type which occurs on this complex. Where altered by fire, colluvial vegetation shows considerable variability. These variants often bear little physiognomic resemblance to the classic type though they are rarely of sufficient area or homogeneity to be classified as a separate vegetation type.

Dry forest

This community occurs along plains edges and in small islands on upland sites in areas where fire is absent and favorable soil conditions exist. Plants indigenous to the dry forest are fire-intolerant and degradation from burning progressively eliminates the most susceptible species. In its most unmodified state, the compact upperstory is dominated by *Anogeissus leiocarpus*, *Khaya senegalensis*, *Tamarindus indica*, *Pterocarpus lucens*, *Cassia sieberiana*, and *Diospyros mespiliformes* all normally attaining considerable size. The woody segment of the understory is well developed with *Erythroxylum emarginatum*, *Feretia apodanthera*, *Teclea oubanguiensis*, *Clausena anisata*, *Boscia senegalensis*, *Allophyllus africanus*, *Hexalobus monopetalus*, *Combretum lecardii*, *Ziziphus* spp., *Acacia ataxacantha*, and *Capparis tomentosa*. The herb layer, poorly developed due to excessive shading, is composed of shade-loving forbs and vines. Grasses are conspicuously absent. Termite mounds are not a general feature and when present, species common to the unmodified community are found.

The most common fire-modified form consists of a thick pure stand of *Anogeissus leiocarpus* sometimes accompanied by *Lonchocarpus laxiflorus*, or *Prosopis africana* in the upperstory and the shrubs *Teclea oubanguiensis*, *Feretia apodanthera*, *Erythroxylum emarginatum*. In this degraded form, the remaining tree and shrub species cited for the classic

community are often present though confined to termitaria. The grasses *Pennisetum pedicellatum* and *Beckeropsis uniseta* are present where the canopy is sparse allowing some light to penetrate to the herb layer.

Illuvial complex

The illuvial complex consists of periodically flooded alluvial soils situated at the lowest physiographic position in the catena. The recurrent deposition of fine-particulate matter results from seasonal flooding of major rivers. The extent of flooding depends on yearly rainfall, distance from rivers, and microrelief. Drainage on this complex varies from fair (once flood waters withdraw) to non-existant. Two different soil classes are found. Impeded soils (Vertisols), generally containing the higher clay content, are readily recognized by the presence of hog-wallow depressions. Drainage is generally poor and these areas drain by means of evaporation. Drained Gleysols, which occupy the majority of this complex, lack hog-wallows and drainage takes place over an imperceptible slope.

Plants best adapted to the humid conditions of this complex are perennial grasses. Woody vegetation is usually confined to raised sites such as termitaria though several species of trees survive seasonal or intermittent flooding. In addition, grass fires, extremely hot due to the abundance of fuel, also tend to inhibit all but the most fire-tolerant plants. The illuvial complex displays three vegetation types: two sparse tree savanna types and the plains. Although similar in appearance, the tree savanna types were separated because of differences in plant species and soil characteristics.

Termitaria are present on all three types, although on the plains they form only on specific areas. Generally of recent formation, these mounds often support little vegetative cover during or immediately following termite activity.

Combretum glutinosum tree savanna

This community occupys a small area in the southern sector of the park. Soils, flooded only intermittently, exhibit fair to poor drainage, a flat soil surface, and a general absence of hog-wallow depressions. The hard and compact surface horizon is of a light brown or gray color. No calcium carbonate concretions were observed.

Of the several species of trees that do not exist on termitaria *Combretum glutinosum* is the most abundant. Other species include *Piliostigma thonningii*, *Nauclea latifolia*, *Mitragyna inermis*, and *Gardinea ternifolia*. Trees and shrubs were sampled along the Gounda-Dongolo track (Table 3). There are no common shrub species in this type.

A tall perennial grass cover is a major feature of the *Combretum glutinosum* tree savanna dominated by *Hyparrhenia rufa*, *H. barteri*, *Andropogon gayanus*, *A. schirensis*, *Ctenium newtonii*, and *Loudetia simplex*. *Vetiveria nigritana*, *Echinochloa obtusiflora*, and *Oryza barthii* dominate on humid sites in small basins and hog-wallows.

The abundant termitaria exhibit a wide range of sizes depending on age and the level of degradation. Like eluvial and colluvial mounds, species characteristic of the dry forest are most prevalent. Common trees not endemic to the dry forest include *Ficus platyphylla* and *F.* sp..

Impeded drainage tree savanna

This vegetation type, especially prevalent in the northern sector, is found adjacent to the plains where the topography is flattest and flooding is most extensive. Like the *Combretum glutinosum* tree savanna,

Table 3. Relative density and average height of tree species and relative density of shrubs in the *Combretum glutinosum* tree savanna.

Species	Trees[1] Rel. den. (%)	Trees[1] Height (m)	Shrubs[2] Rel. den. (%)
Combretum glutinosum	71.5	8.3	100.0
Anogeissus leiocarpus	5.5	10.7	-
Mitragyna inermis	5.5	4.8	-
Piliostigma thonningii	4.5	4.7	-
Nauclea latifolia	2.5	5.7	-
Tamarindus indica	2.0	4.5	-
Diospyros mespiliformes	2.0	12.3	-
Crossopteryx febrifuga	1.0	9.5	-
Terminalia laxiflora	1.0	14.0	-
Xeromphis nilotica	1.0	2.7	-
Other species	(7) 3.5		-
Totals/Mean	100.0	$\bar{x}$ = 7.6	100.0
Total numbers	200		26
Absolute mean density (stems/ha)	3.6		21.0

[1] Two or more meters in height.

[2] Between one-half and two meters in height.

this type exhibits a sparse wooded cover dominated by several tree species capable of surviving the harsh fire and flooding conditions. Drainage is conspicuously impeded and many hog-wallow depressions are found throughout.

Woody vegetation was sampled in the southeastern corner of the park near the Vakaga ford. Six tree species not endemic to termitaria dominated 95 per cent of the sample (Table 4). *Terminalia macroptera* and *Pseudocedrela kotschyi* often 10 to 15 meters in height, are found in pure or mixed stands on higher physiographical areas giving the appearance of a well-spaced orchard-like savanna. Plains invader species *Piliostigma reticulata*, *Combretum glutinosum*, *Mitragyna inermis*, and *Acacia seyel* are found most commonly on low-lying areas near the edge of the plains though they sometimes occur in conjunction with the two aforementioned species. Scattered *A. sieberiana*, *Gardinea ternifolia*, and *Combretum hypopilinum* are found throughout. In the south, the two *Acacia* species are replaced by *Detarium microcarpum*, *Nauclea latifolia*, and *Lophira lanceolata*. Large *Daniellia oliveri* occasionally occur on upper edges of this type where drainage is better.

The tall and dense herbal layer was sampled in the same area as the woody vegetation (Table 5). *Hyparrhenia* spp. (mostly *H. rufa*) dominate along with *Andropogon gayanus*, *Loudetia simplex*, *Eragrostis gangetica*, and *Setaria pallidefusca*. Other less abundant species include *Brachiaria jubata*, *Sporobolus sangenius*, *Cloris pilosa*, *Panicum anabaptism*, and *Schoendfeldia gracilis*. Hog-wallow depressions are the preferred habitat of *Oryza barthii*, *O. longistiminata*, *Echinochloa obtusiflora*, and *E. pyramidalis*. During the early rainy season, the flowers of monocotyledenous forbs give the open areas a showy appearance. *Pancratium*

Table 4. Relative density and average height of tree species and relative density of shrubs in the impeded-drainage tree savanna type.

Species	Trees[1] Rel. den. (%)	Trees[1] Height (m)	Shrubs[2] Rel. den. (%)
Terminalia macroptera	26.4	5.6	6.8
Piliostigma reticulata	24.1	4.5	2.7
Combretum glutinosum	17.9	7.4	1.4
Mitragyna inermis	12.3	5.4	-
Pseudocedrela kotschyi	5.2	3.9	48.6
Acacia seyel	3.3	2.5	4.0
Balanites aegyptiaca	2.4	7.3	-
Anogeissus leiocarpus	1.9	14.9	-
Gardenia ternifolia	1.9	2.9	2.7
Tamarindus indica	1.4	8.1	-
Combretum hypopilinum	1.4	4.1	-
Acacia sieberiana	0.9	5.2	2.7
Capparis tomentosa	-	-	20.3
Securidaca longepedunculata	-	-	5.4
Maerua oblongifolia	-	-	4.0
Other species	(2) 0.9		(1) 1.4
Totals/Mean	100.0	$\bar{x}$ = 5.6	100.0
Total numbers	212		74
Absolute mean density (stems/ha)	4.7		55

[1] Two or more meters in height

[2] Between one-half and two meters in height.

Table 5. Frequency of occurrence of grass species in the impeded-drainage tree savanna type.

Species	Frequency of occurrence
Hyparrhenia (mostly *H. rufa*)	39.0
Andropogon gayanus	14.9
Loudetia simplex	8.5
Eragrostis gangetica	8.5
Setaria pallidefusca	5.7
Echinochloa obtusiflora	5.0
Oryza longistiminata	5.0
Brachiaria jubata	3.5
Vetiveria nigritana	2.1
Rottboellia exaltata	1.4
Sporobolus sangenius	1.4
Chloris pilosa	1.4
Other species	(3) 2.1
Total	100.0

trianthum, opening at night after the first heavy rain, is frequently floriferous on open areas with white ground-level flowers. *Crinium distichum*, *Anthericum* sp., and *Albuca* sp. flower at the beginning of the rainy season and are often present in considerable numbers.

Termitaria are a conspicuous feature in this type showing a great variability in size, physiognomy, and floral content. Large mounds, generally moderately degraded, resemble eluvial and colluvial termitaria. Those of recent formation support a characteristic vegetative cover. Plant speciation differs along a north-south gradient. Common trees found throughout, often 15 or more meters in height, include *Acacia sieberiana*, *Diospyros mespiliformes*, *Tamarindus indica*, *Anogeissus leiocarpus*, *Kigelia africana*, *Cassia sieberiana*, *Crataeva religiosa*, *Ficus ingens*, and *Khaya senegalensis*. In the north, *Ficus gnaphalocarpa*, *F. dekdekena*, *Balanites aegyptica*, *Vitex doniana*, *V. madiensis*, and *Lannea schimperi* are also present sometimes achieving local dominance. Numerous species are present in the woody understory. Plants endemic to this strata vary greatly between sites. Species, many of which are characteristic to this type, include *Ziziphus abyssinica*, *Z. mucronata*, *Z. spina-christi*, *Antidesma venosum*, *Combretum lecardii*, *Nauclea latifolia*, *Hoslundia opposita*, *Feretia apodanthera*, *Boscia senegalensis*, *Grewia villosa*, *Acacia ataxacantha*, *Capparis tomentosa*, *Maerua oblongifolia*, and *Securidaca longepedunculata*.

The extent of the herbal layer depends upon shading. Where extensive, this strata is restricted to several species of forbs *Sansevieria liberica*, *Haemanthus multiflorus*, and *Costus* sp. all flowering after the rains. A thick cover of the grass *Rottboellia exaltata* is present where shading from woody vegetation is minimal.

Flooded plains

The plains occur on extensive areas in St. Floris where seasonal flooding is extensive. Soils are among the least evolved in the catena due to the continuous seasonal deposit of alluvium and the lack of horizon development. The most heavily flooded areas on the plains are intersected by numerous drainage canals. These canals, along with several large depressions and ox-bow lakes, remain flooded throughout much of, if not the entire, dry season. Vertisols, with hog-wallow depressions, occur on upper physiographical areas where flooding is light or intermittent.

Site variation on the plains is considerable, differing in mode of drainage and the extent of flooding. The flora is arranged in a zonal manner. Perennial grasses, sedges, and annual forbs are best adapted to the conditions of flooding and harsh annual fires. Trees and shrubs are confined to termitaria, locally abundant on impeded hog-wallowed soils on higher, less humid, sites. Three plains regions, varying topoedaphically and in floristic composition, were differentiated during the survey.

Gounda-Bahr Kameur sub-type

This vegetative community is found on the flooded plains forming a narrow ribbon along the river valleys of the Gounda, Bahr Kameur, Vakaga and Goro. Relief is greatest and drainage most complete of any plains area except in the numerous ox-bow lakes that are found throughout. Vegetative zonation, based on degree and duration of flooding, is a visible feature in these areas. The frequency of occurrence of grasses in this sub-type were surveyed along the Gounda river near the tourist camp (Table 6).

Table 6. Frequency of occurrence of plains grasses in the Gounda-Bahr Kameur and Gordil-Ninion sub-types.

Species	Gounda-Bahr Kameur sub-type	Gordil-Ninion sub-type[1]				
		1	2	3	4	Total
Jardinea congolensis	32.0	1.4	-	-	-	0.4
Panicum anabaptism	15.0	7.0	0.8	1.8	-	2.5
Paspalum orbiculare	14.4	25.3	24.8	1.8	-	17.5
Vetiveria nigritana	11.8	5.6	0.8	-	15.2	3.6
Eragrostis gangetica	7.8	1.4	0.8	-	-	0.7
Hyparrhenia spp.	7.1	28.2	14.9	63.6	54.5	32.5
Loudetia simplex	3.9	-	-	-	12.1	1.4
Setaria anceps	2.0	1.4	-	18.2	12.1	5.4
Andropogon gayanus	2.0	-	-	-	-	0.0
Sporobolus sp.	1.3	-	-	-	-	0.0
Brachiaria jubata	0.7	-	-	-	-	0.0
Digitaria sp.	0.7	-	5.8	-	-	2.5
Echinochloa stagnina	0.7	11.3	-	-	-	2.9
Unknown species	0.7	-	-	-	-	0.0
Echinochloa pyramidalis	-	4.2	43.8	-	-	20.0
Vossia cuspidata	-	12.7	6.6	-	-	6.1
Panicum sp.	-	-	0.8	14.5	-	3.2
Loudetia togolensis	-	-	-	-	6.1	0.7
Sporobolus pyramidalis	-	1.4	-	-	-	0.4
Setaria pallidefusca	-	-	0.8	-	-	0.4
Totals	100.1	100.1	99.9	99.9	100.0	100.2

[1] Results are given for each transect. Only transect 1 was randomly selected. Transects 1 and 2 were situated along the road from Gordil to the Vakaga ford, and 3 and 4 were located in the general area of Ninion.

The sandy river banks support a sparse vegetative cover consisting of the sedges *Fimbristylis cioniana*, *Cyperus imbricatus*, *C. digitatus*, subsp. *auricomis* var. *bruntii*, *C.* sp.; forbs *Jussiaea errecta*, *J.* sp., *Polygonum lanigerum* var. *africum*, *P. libatum*, *Stachytarpheta angustifolia*; and grasses *Phragmites karka*, *Digitaria debilis*, and *Panicum fluvicola*. *Vossia cuspidata* and *Echinochloa stagnina* form floating mats in conjunction with *Jussiaea repens* var. *diffusa*. An occasional woody thicket of *Irvingia smithii*, *Syzygium guineense*, combined with scattered *Morelia senegalensis* and *Trichilia retusa* form around the perimeter of ox-bow lakes and other low-lying areas along waterways. In the shade of this often dense cover, the sedge *Mariscus luridus* forms a sparse, but visible, herbal layer. Vegetative cover endemic to ox-bow lakes depends upon the duration of the aquatic environment. Where water remains year-around, *Nymphaea lotus*, *Vossia cuspidata*, and *Echinochloa stagnina* are present. Depressions dry for two or three months support a thick cover of *Stachytarpheta angustifolia* at the bottom with *Jardinea congolensis*, *Paspalum orbiculare*, and *Cyperus digitatus* subsp. *aruicomis* var. *bruntii* found on less humid sites around the perimeter. On lightly flooded areas, *Setaria anceps*, *Vetiveria nigritana*, *Sporobolus* sp., *Eragrostis gangetica*, and *Panicum anabaptism* form a mixed herbaceous cover. Near the woodland edge, species common to the impeded-drainage tree savanna are found: *Hyparrhenia* spp. (especially *H. rufa*), *Andropogon gayanus*, *Brachiaria jubata*, and *Loudetia simplex*.

Gordil-Ninion sub-type

This area is characterized by imperceptible slopes and vast inundated plains interspersed by drainage canals on heavily flooded areas.

On lightly-flooded terrain there are many localized areas of impeded drainage. Termitaria, often active without a vegetative cover, are found most commonly on the embankment formed along the extension of the Ouandjia/Vakaga rivers. On this embankment, tree species *Acacia sieberiana*, *A. seyel*, and *Mitragyna inermis* are interspersed with numerous termitaria supporting species found in the northern portion of the impeded-drainage tree savanna type.

On flooded areas of long duration, extensive floating mats of *Vossia cuspidata* and *Echinochloa stagnina* are found along with *Polygonum senegalensis* and *P. libatum*. On lightly-inundated areas, *Echinochloa pyramidalis* occurs singly or in conjunction with *Paspalum orbiculare*, *Oryza longistiminata*, and *O. barthii*. *Sesbania dalzieli* forms conspicuous two to three meter high stands in flooded areas used heavily by ungulates. Small thickets of *Mimosa pigra* are locally common on moderately-flooded areas. *Vetiveria nigritana*, *Setaria anceps*, *Hyparrhenia rufa*, *Loudetia simplex*, *Eragrostis gangetica*, *Panicum anabaptism*, and *Digitaria* sp. occupy the lightly-inundated zone. *Vetiveria nigritana*, *Oryza longistiminata*, and *Cyperus exaltatus* are common species in hog-wallow depressions on upper physiographic sites. *Pancratium trianthum* and *Crinum distichum*, flowering at the beginning of the rainy season, are often abundant near the woodland edge.

<u>Dongolo-Mada ngangou sub-type</u>

This sub-type is physiognomically similar to the preceding except that water courses are reduced to shallow canals flowing into and out of a vast stagnant marsh. This area is flooded for eight months of the year. Most of the vegetation is aquatic including *Neptunia oleracea*, *Jussiaea repens* var. *diffusa*, *Polygonum libatum*, *P. senegalensis*, *Vossia cuspidata*, and *Oryza longistiminata*. Lightly or intermittently flooded areas support the grasses *Brachiaria jubata*, *Setaria aurea*, *Hyparrhenia rufa*, *H*. sp., *Panicum anabaptism* and sedges *Bulbostylus oritrephes*, *Cyperus exaltatus*, and *C. spacelatus*. Sedges found in stream beds include *Cyperus digitatus* subsp. *auricomis* var. *bruntii*, *C*. sp., and *Scirpus* sp. A. Large termitaria are locally abundant on specialized areas and their dense vegetative cover is often a conspicuous feature of the landscape. These mounds often support sizable trees including *Khaya senegalensis*, *Lannea schrimperi*, *Kigelia africana*, *Anogeissus leiocarpus*, *Ficus gnaphalocarpa*, *F*. sp., and *Tamarindus indica*. The understory on large moderately degraded mounds is similar to other illuvial termitaria.

Another basin is found between Tenabo and Mêlê which appears to bear a phytognomic likeness to this sub-type.

II. 8 SUCCESSION

The three most important factors influencing the vegetation in the St. Floris area are fire, flooding, and soil depth. Burning has a tremendous effect on the vegetation by selectively inhibiting fire-intolerand species. A community can be held in "fire climax," which is significantly different, both physiognomically and in species composition, from its protected counterpart. On the eluvial and colluvial complexes, where soil depth is sufficient, the dry forest represents the natural climax community. Continued burning destroys characteristic tree species causing an evolution to a mixed savanna woodland. In contrast to deeper sites, shallow soils have a different climax form which may or may not be altered by burning.

The decrease in the depth of wet-season flooding has allowed the invasion of trees and shrubs on plains areas. Fire-tolerant invader species *Combretum glutinosum*, *Mitragyna inermis*, *Piliostigma reticulata*, *Acacia seyel*, and *A. sieberiana* sometimes form even-age stands. If drier conditions continue, these species are followed by *Terminalia macroptera* and *Pseudocedrela kotschyi* which become, in turn, the dominant woody species. As drainage is enhanced, this evolution can continue toward the formation of the *Terminalia laxiflora* savanna woodland or the dry forest under similar conditions in the absence of fire. A parallel evolution is apparent in the formation of termitaria. The majority of active mounds are found on the illuvial complex, often occurring on raised sites on the plains. In contrast, most degraded termitaria exist on drier sites. In this manner, mounds act as a substrate for trees and shrubs. This represents the primary source of woody invasion on the plains.

It is impossible to accurately reconstruct the vegetative changes the park has undergone during the last several centuries. Plains areas were probably more extensive when wetter conditions prevailed in the past.

II. 9 FIRE

St. Floris has no specific burning policy. The majority of fires are set haphazardly, most often at the beginning of the dry season as soon as the grasses dry. The extent of annual burning relates to the degree of human activity by fishermen, honey gatherers, and cattle herders. A high percentage of the park is burned annually, especially the northern plains sector. During periods of management, an early burn policy was favored by park personnel.

The general burning situation on surrounding areas is similar to that in St. Floris. Cattle herders, arriving from Sudan and Chad, burn pastures several weeks ahead of their herds to ensure an adequate food supply during their seasonal movements.

THE FAUNA

St. Floris has, since its inception, been noted as one of the richest wildlife areas in the CAR. Yet, no adequate studies have been carried out to provide a basis for the implementation of an intelligent wildlife management program. A major goal of this study was to furnish species lists of vertebrates, determine the status of important species, and outline significant trends and problem areas demanding attention.

III. 1 MAMMALS

Due to the importance of large mammals in the economic value and tourist appeal of St. Floris, special efforts were made for their study. A species list of mammals identified in St. Floris was prepared (Appendix A). This was based on the actual observation of 59 species with an additional 3 based on tracks or presence on adjacent areas.

An important objective was an inventory of ungulates, elephant, large carnivores, and primates indigenous to St. Floris. These data were intended to compute baseline population estimates of large mammals. Population estimates of ungulates and elephant were to be used to compare the standing crop of St. Floris to that computed for other West and Central African national parks and reserves.

A means was needed to monitor future population changes of large mammals in the park. This "index" required the establishment of a system of roadways and the standardization of a methodology for periodic counting.

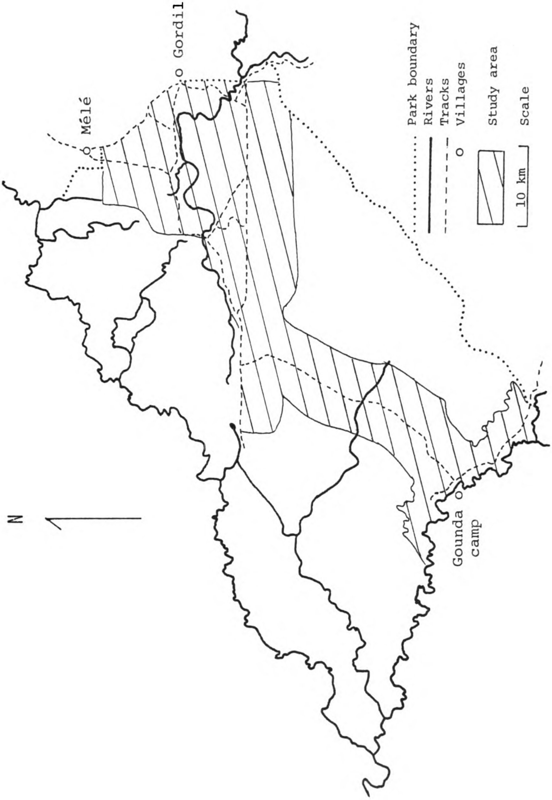
Specific objectives were 1) to cover an area of the park sufficient to detect population changes and 2) for this methodology to be repeatable by park personnel or wildlife specialists.

No previous ground inventories of large mammals had been conducted in the northern sector of the CAR. A comparative appraisal of the various methods utilized during the course of this study (line transects, road-strip counts, and an aerial census) would, therefore, assist in the selection of optimal methodology for future large mammal inventories.

III. 1. 1 Methods

In 1977, a walking census using line transects was established to compute population estimates of ungulates and collect data on herd structure, population age and sex composition, habitat selection, and behavioral data. A study area comprising about 30 per cent of the park (853 km^2) was located in the vicinity of roadways (Figure 9). Within this area, 39 line transects were selected at random. A transect consisted of two parallel lines one kilometer apart beginning on a road. Transect length (distance along the first leg) was set at a maximum of five kilometers except in the center of the study area. There, the transects ran north and south between the Vakaga ford to Dongolo road and the Gordil-Ninion route (based on routes 5/6 and 9/11 in Figure 10). Observations were recorded only on the parallel lines and not along the one kilometer separating the first and second leg. Transects were walked between 0800 and 1300 hours by a team of two men. The first used a compass to proceed on a heading, generally in a cardinal direction, while the second was responsible for recording data and counting paces with a hand counter. Both members served as observers. All large mammals were recorded on field sheets by species, location (number of paces along the line), vegetation

Figure 9. Map of the St. Floris National Park showing the 1977 study area.


N
o Gordil
o Mélé
Gounda o
camp
Park boundary
Rivers
Tracks
Villages
Study area
Scale
10 km

type, herd size, relative age, and sex where possible. On plains areas, where visibility was often in excess of a kilometer in any direction, the census area consisted of a 400 meter strip (200 meters either side of the transect line). A herd was counted if more than half of its members were within the strip. Animals crossing the strip in front of the observers were not counted until they were within 500 meters of the census team. Perpendicular distances between the transect line and the animal (or center of a herd) were recorded in the woodland. A total of 341.5 kilometers of line transects was logged by two teams of observers over a three-month period from February 22 to May 26, 1977.

Strip widths were determined separately for the woodland and the plains. In the woodland, categories of ungulates with similar herd sizes and visibility distances were recognized (Table 7). The estimator $4\bar{y}$ (4 times the mean sighting distance) proposed by Hemingway (1975) was used to compute strip widths as it appears to best represent the true sampling area of ungulates in Miombo woodland (Rogers 1975). In 1977, grass burning on plains areas was extensive and visibility was excellent along all transects surveyed. The census area equaled the strip width multiplied by the total length of plains transects.

The study area contained the greatest number and diverstiy of ungulates in the park. This was due primarily to its proximity to villages housing game guards and to a well-developed network of roads that discouraged poaching. The census was intended only to reflect densities on the study area and not over the entire park area. The study area can be viewed, however, as a region of more-natural large mammal density to which condition the entire park might possibly be restored.

Table 7. Mean sighting distances, strip widths and sampling percentages of four visibility classes of ungulates for woodland and plains areas. Line transects surveyed February-May 1977, St. Floris National Park, Central African Republic.

Species	Mean sighting distance (meters)	Strip width[a] (meters)	Sampling[b] percentage
WOODLAND			
Grimm's duiker	31.1	124	5.0
Oribi and reedbuck	42.9	172	6.9
Wart hog	43.6	174	7.0
Kob, topi, hartebeest, waterbuck, and roan	53.5	214	8.6
Mean	41.5	166	6.7
PLAINS			
All species	—	400	16.0

[a] See text.

[b] Given as the percentage of total woodland (550 km^2) or total plains (303 km^2) area in the study area.

During both years of the study, road-strip counts were conducted along most park roads (Figure 10). Counts were made between 0700 and 1200 hours by an observer perched on top of a Toyota land-cruiser travelling at 30 kilometers per hour. A series of counts entailed one count on each of the 14 tracks. On plains areas, large mammals (kob-size and larger) and ostrich were counted within a strip 500 meters on either side of the road. In open areas, smaller mammals (Grimm's duiker, wart hog, oribi, reedbuck, and primates) were counted up to 200 meters from the road. Data were collected on both plains and woodland areas by species, herd size, age and sex structure, vegetation type, and distance in kilometers along the track. In 1977, a single series was completed while two series of counts were conducted in 1978.

In an attempt to assess the feasibility of using road-strip data to compute ungulate population densities, 13 counts (Table 10) were undertaken between February and June 1978 along the wooded portions of the Gounda-Dongolo track (route 14 in Figure 10). A range finder was used to determine the perpendicular distance at first sighting and the distance at which the animal or herd first disappeared from sight. Often it was necessary to scare the animal to record the disappearing distance. The visibility class (sparse, moderate, and dense) of each observation was also recorded. These classes were based subjectively on vegetation density. Visibility classes were noted every 0.3 kilometer on either side of the track. Using disappearing distances, a composite strip width for large ungulates was calculated by pooling the data for roan, hartebeest, topi, waterbuck, and giraffe. The weighted disappearing distances (Table 8) were calculated using the formula WDD = $\bar{d}_i p_i$, where d_i was the average disappearing distance in each of i visibility classes and p was

Figure 10. Map of the St. Floris National Park showing tracks used in road-strip counts.

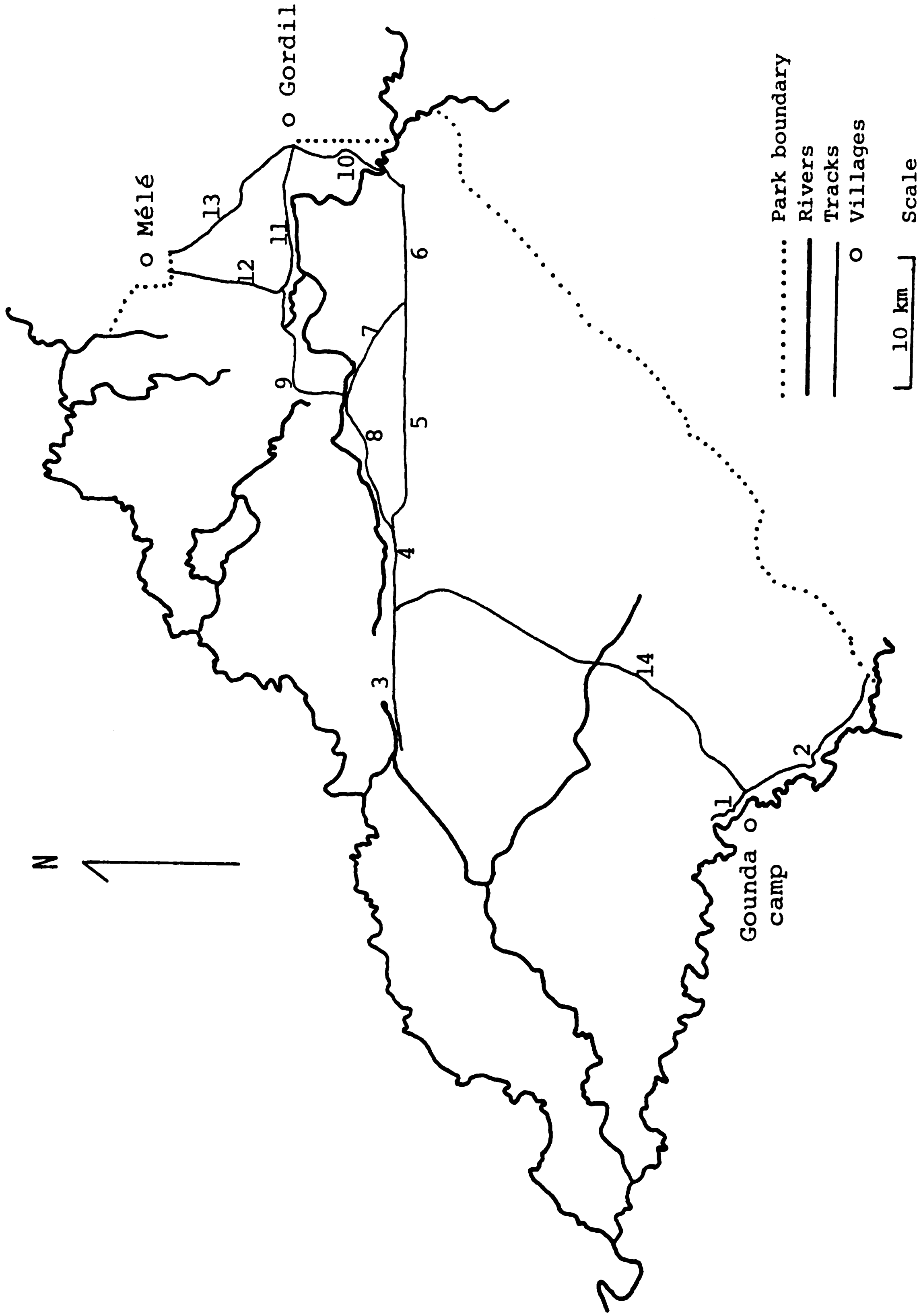

N
o Gordil
o Mélé
Gounda camp
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Park boundary
Rivers
Tracks
o Villages
10 km
Scale

Table 8. Mean disappearing distances of 8 ungulate species in 3 visibility classes and composite weighted disappearing distances expressed in meters. Figures are based on 13 road-strip counts conducted March-June 1978 along the Gounda-Dongolo track in the St. Floris National Park, Central African Republic.

Species	Visibility class[a] 1	2	3	Weighted[b] disappearing distances
Grimm's duiker	73.1	61.7	41.2	62.0
Oribi	114.6	92.8	60.6	94.6
Wart hog	131.0	87.9	81.0	102.2
Hartebeest	180.0	119.1	80.0	—
Topi	185.5	162.5	—	—
Waterbuck	—	125.0	97.7	—
Roan	170.9	112.5	75.0	—
Giraffe	186.7	100.0	85.0	—
Large ungulates[c]	179.2	120.9	88.8	136.0

[a] Arranged in increasing order of vegetation density: 1) sparse, 2) moderate, and 3) dense.

[b] Calculated by multiplying the mean disappearing distance in each class by the fraction of that class along track.

[c] Due to limited data and apparent similarities in disappearing distances, strip widths for large ungulates were computed by pooling data for hartebeest, topi, waterbuck, roan, and giraffe.

the percentage of that class along the track. The 13 counts on the Gounda-Dongolo track were treated separately in computing confidence limits. Twenty-five walking census transects located in the southern wooded sector of St. Floris were analyzed to compare ungulate densities with these road counts.

An aerial census planned for March-April 1978 was canceled due to a lack of aviation fuel in the CAR. This inventory was intended to provide population estimates of larger ungulates and elephant.

In addition to specific surveys, sightings of infrequently-encountered animals, unusual concentrations, and interesting behavior were recorded on field sheets.

As no enumeration method conducted in the park to date could realistically yield population estimates of large mammals for the entire park area, subjective estimates were employed. The means of estimating and levels of subjectivity differed between species. The Grimm's duiker population was estimated by multiplying the woodland density computed from line transects to the approximate area of woodland (1800 km^2) in the park. A similar approach was followed for oribi. Because they also occur on the plains, the total density (plains and woodland) from line transects was multiplied by the surface area of the park. Study area population estimates from line transects (Table 9) of wart hog, reedbuck, waterbuck, kob, roan, hartebeest, and topi were subjectively augmented by the number of animals felt to occur outside the study area. For the most part, these estimates were determined from general observation from the air and on the ground. The hippopotamus population was estimated from total counts of concentration areas. Black and white photographs of the major hippo pools were taken from the air on January 3, 1978 and later analyzed from print enlargements. Similar counts were periodically conducted during both years on the ground using multiple observers. Populations of other animals were estimated from general observation. The presence of tracks of the larger species (rhinoceros, giraffe, elephant, and buffalo) were also used in the formation of estimates.

III. 1. 2 Results

The total length of line transects was greater in the woodland (64.5%) than on the plains (35.5%). The surface area of both types was computed by multiplying these percentages by the total surface area of the study zone calculated from a topographic map. In the woodland, strip widths of ungulates increased with animal size (Table 7) and the sampling percentage varied among the four ungulate size classes. The plains were sampled more intensively (16.0%) than the woodland ($\bar{x}$ = 6.7%).

Population estimates and 95 per cent confidence limits of nine ungulate species were computed from line transect data (Table 9). The hippopotamus population was estimated using total counts of major concentration areas. Sightings of buffalo, giraffe, giant eland, and bushbuck were insufficient for the computation of density. No elephant were counted on line transects. Subjective estimates of these five species are included to calculate the ungulate and elephant biomass of the study area (3,532 kg/km^2).

The accuracy of the biomass figure depends on the accuracy of both the population estimates and unit weights used for each species. No study has been conducted in the St. Floris area to calculate mean weights for large mammalian species. The literature shows a tremendous variability in unit weights in Africa and a variation of up to 100 per cent is not uncommon (Coe et al. 1976). Differences in age-class composition would

Table 9. Ungulate and elephant densities, population estimates, and biomass within a study area comprising 853 square kilometers of the St. Floris National Park, Central African Republic.

	Density/km^2			Population[a]	Weight[b]	Biomass[c]
Species	plains	woodland	total	estimate	(kg)	(kg)
Elephant[e]	—	—	—	50	1500	75,000
Wart hog[d]	1.59	0.94	1.17	999 ± 630	60	59,880
Hippopotamus[f]	—	—	—	1100	1000	1,100,000
Giraffe[e]	—	—	—	35	700	24,500
Buffalo[e]	—	—	—	700	510	357,000
Bushbuck[e]	—	—	—	150	40	6,000
Giant eland[e]	—	—	—	100	365	36,500
Grimm's duiker[d]	0.04	1.82	1.18	1018 ± 388	10	10,130
Reedbuck[d]	2.35	0.26	1.07	912 ± 399	40	36,440
Waterbuck[d]	3.20	0.04	1.17	996 ± 285	175	174,125
Kob[d]	32.27	0.04	11.48	9737 ± 4814	70	685,510
Roan[d]	0.33	0.32	0.32	275 ± 355	250	68,750
Hartebeest[d]	3.19	1.12	1.86	1583 ± 1194	165	161.030
Topi[d]	1.96	0.06	0.74	629 ± 482	165	103,620
Oribi[d]	0.47	1.53	1.15	983 ± 459	15	14,760
Total	49.1	6.1	20.1			3,012,635

Biomass = 3,012,635/853 + 3,532 kg/km^2

[a] 95 per cent confidence limits were computed using the method of Jolly (1969).

[b] Weights from Child (1974) and Coe et al. (1976).

[c] Biomass was computed by multiplying the population estimate by the unit weight.

[d] Population estimates and 95 per cent confidence limits were based on line transects.

[e] Population estimates were subjectively estimated from road-strip counts and general observation.

[f] The population estimate was based on total counts.

result in a certain amount of variation between areas. Unit weight variation could also be rationalized if well-planned studies aimed at accurate determinations were conducted. To a great degree, however, these figures represent little more than educated guesses in West and Central Africa. Weights used in this survey are those of Child (1974) and Coe et al. (1976).

Results of each series of road-strip counts are presented (Table 10). Kob were the most abundant ungulates counted on all three series (Table 11). Topi, hartebeest, wart hog, and waterbuck were similar in relative abundance between series. An assessment of trend cannot be made over this two-year period.

The data collected on road-strip counts are inappropriate for the computation of average ungulate densities because these counts were made in prime areas of high density of large mammals. Therefore, if these results were projected to the entire park area, they would tend to overestimate ungulate populations. Stratification was not possible due to a lack of roadways in the north, along the Bahr Kameur, where mammal densities are lowest. This is not to say that road-strip counts cannot be utilized to calculate population estimates for the entire park area, but special care must be given to insure an unbiased methodology.

Although several similar road-strip counts were undertaken by Stangenec in 1968-1969 and Spinage in 1976 (both reported in Spinage 1976) along some of the same routes, those counts were too limited to compare with the present data. The data from this survey are presented only as a possible basis for future counts.

Average density and population estimates of 11 ungulate species were computed from road-strip counts on the Gounda-Dongolo track (Table 12).

Table 10. Totals of 3 series of dry-season road-strip counts on 14 tracks in 1977 and 1978 in the St. Floris National Park, Central African Republic.

Track[a]	Distance (km)	Date of count	Kob	Hartebeest	Topi	Waterbuck	Wart hog	Reedbuck	Buffalo	Oribi	Roan	Giraffe	Giant eland	Grimm's duiker	Bushbuck	Red-fronted gazelle	Lion	Baboon[b]	Tantalus monkey[b]	Patas monkey[b]	Ostrich
		4/29/77	48	26	0	12	26	0	0	4	0	0	0	0	0	0	0	1	1	0	0
1	5.0	5/14/78	41	14	0	19	21	0	0	5	0	0	0	0	0	0	0	1	0	0	0
		5/23/78	45	14	0	27	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0
		4/25/77	148	103	1	33	17	3	0	0	0	0	1	0	1	0	0	4	0	1	0
2	20.0	4/11/78	104	18	0	34	22	0	9	1	0	0	0	0	2	0	1	0	1	0	0
		5/16/78	142	0	0	47	1	0	5	0	0	0	0	1	6	0	0	1	0	0	0
		5/15/77	0	4	7	40	5	13	0	0	0	0	0	0	0	0	0	0	0	1	0
3	12.3	4/12/78	0	163	111	6	29	3	0	2	2	0	0	0	0	0	0	3	0	0	0
		4/18/78	0	54	66	1	33	1	0	0	2	0	0	0	0	0	0	0	0	0	3
		4/11/77	321	6	0	10	5	0	0	0	0	0	0	0	0	0	0	5	0	0	0
4	4.8	4/10/78	27	16	25	58	9	0	0	0	1	0	0	0	0	0	0	2	0	0	2
		5/05/78	145	0	0	23	2	0	0	0	1	0	0	0	0	0	0	1	0	0	0

[a] See Figure 10 for location of tracks.
[b] Only troops were counted for primate species.

Table 10 (*continued*).

Track	Distance (km)	Date of count	Kob	Hartebeest	Topi	Waterbuck	Wart hog	Reedbuck	Buffalo	Oribi	Roan	Giraffe	Giant eland	Grimm's duiker	Bushbuck	Red-fronted gazelle	Lion	Baboon	Tantalus monkey	Patas monkey	Ostrich
5	20.6	5/15/77	0	5	44	0	2	13	0	4	3	0	0	2	0	0	0	0	0	0	3
		4/10/78	0	29	53	0	1	9	0	0	0	0	0	0	0	0	0	2	0	1	0
		5/05/78	0	3	310	3	5	11	0	6	1	0	0	0	0	0	0	0	0	0	0
6	11.1	4/01/77	0	7	8	0	6	0	0	0	0	0	0	0	0	0	0	1	0	0	0
		5/03/78	0	2	1	2	10	2	0	5	2	0	0	0	0	0	0	0	0	0	0
		5/05/78	0	2	2	0	6	0	0	2	0	3	0	0	0	0	0	2	0	0	0
7	8.0	4/01/77	101	45	51	19	7	0	0	0	0	0	0	0	0	0	0	0	0	0	29
		5/03/78	63	1	0	1	1	26	0	0	0	0	0	0	0	0	0	0	0	0	0
		5/24/78	514	1	63	11	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0
8	12.7	4/11/77	491	77	101	106	5	15	0	3	6	0	0	0	0	0	0	3	0	1	0
		5/03/78	77	3	3	46	1	37	0	0	0	0	0	0	0	0	1	1	0	0	0
		5/16/78	147	2	3	40	4	33	0	1	0	0	0	0	0	2	3	0	0	0	0

Table 10 (*continued*).

Track	Distance (km)	Date of count	Kob	Hartebeest	Topi	Waterbuck	Wart hog	Reedbuck	Buffalo	Oribi	Roan	Giraffe	Giant eland	Grimm's duiker	Bushbuck	Red-fronted gazelle	Lion	Baboon	Tantalus monkey	Patas monkey	Ostrich
		4/01/77	997	0	8	4	11	0	38	0	0	0	0	0	0	0	0	0	0	0	0
9	9.0	5/09/78	966	0	0	23	12	3	0	0	0	0	0	0	0	0	3	0	0	0	0
		5/16/78	709	0	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4/01/77	178	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
10	7.5	5/10/78	107	5	1	1	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
		5/17/78	94	0	0	1	3	3	0	1	0	0	0	1	0	0	0	0	0	0	0
		4/01/77	32	119	116	64	90	8	0	0	0	0	0	0	0	0	0	2	0	0	10
11	13.0	5/02/78	85	78	29	72	30	0	0	0	1	0	0	0	0	0	0	0	0	0	0
		5/09/78	138	48	46	76	22	4	0	2	7	0	0	0	0	0	2	0	0	0	2
		4/13/77	0	11	15	2	25	0	28	0	0	0	0	0	0	0	0	1	0	0	0
12	11.5	5/02/78	1	18	4	20	5	7	0	0	3	10	0	0	0	0	0	0	1	0	0
		5/04/78	0	11	4	32	10	5	0	0	8	0	0	0	0	0	0	1	0	0	0

Table 10 (*continued*).

Track	Distance (km)	Date of count	Kob	Hartebeest	Topi	Waterbuck	Wart hog	Reedbuck	Buffalo	Oribi	Roan	Giraffe	Giant eland	Grimm's duiker	Bushbuck	Red-fronted gazelle	Lion	Baboon	Tantalus monkey	Patas monkey	Ostrich
		4/05/77	0	0	0	0	4	0	0	3	0	0	0	0	0	0	0	1	1	0	0
13	15.3	5/04/78	0	0	0	0	3	0	0	3	0	0	0	0	0	0	0	1	1	0	0
		5/10/78	0	0	0	1	7	0	0	6	0	0	0	0	0	0	0	0	0	0	0
		5/30/77	0	0	2	0	12	0	50	8	0	3	0	0	0	0	0	1	0	0	0
		2/03/78	0	1	0	0	5	0	0	15	4	0	0	6	0	0	1	0	0	0	0
		3/05/78	0	19	0	0	1	0	0	18	0	3	0	3	0	0	0	2	0	0	0
		4/10/78	0	12	0	0	6	0	0	20	0	1	24	1	0	0	0	1	0	0	0
		4/12/78	0	3	1	0	3	0	100	16	9	6	0	3	0	0	0	2	1	0	0
		4/18/78	0	2	3	0	2	0	0	26	2	0	2	4	0	0	0	2	0	0	0
14	38.0	5/06/78	0	31	2	0	0	0	0	3	4	0	0	2	0	0	0	1	0	0	0
		5/16/78	0	35	10	13	2	0	0	21	2	0	0	6	0	0	0	0	0	0	0
		6/06/78	0	16	7	1	8	0	0	16	7	0	0	3	0	0	0	2	0	0	0
		6/08/78	0	12	11	2	5	0	0	19	8	0	0	1	0	0	0	0	0	0	0
		6/10/78	0	11	1	0	10	0	0	17	4	2	0	3	0	0	0	0	0	0	0
		6/14/78	0	14	0	0	9	0	0	14	5	3	0	2	0	0	0	2	0	1	0
		6/17/78	0	38	5	7	9	0	0	16	1	1	0	7	2	0	0	1	1	0	0
		6/19/78	0	0	0	0	1	0	0	8	1	0	0	2	0	0	0	2	2	0	2

Table 11. Total number of large mammals, presented as total individuals and groups, sighted on three series of road-strip counts in the St. Floris National Park, Central African Republic.

	1977[a]		1978[b] 1		1978[b] 2	
Species	Individuals	Groups	Individuals	Groups	Individuals	Groups
Kob	2316	202	1471	118	1934	120
Hartebeest	403	59	351	56	153	45
Topi	353	50	227	31	502	40
Waterbuck	290	52	282	60	269	56
Wart hog	215	62	145	54	98	50
Reedbuck	54	25	91	40	71	33
Buffalo	116	3	34	2	5	1
Oribi	22	12	33	15	34	17
Roan	9	2	15	8	23	7
Giraffe	3	2	12	2	4	2
Giant eland	1	1	5	1	0	0
Grimm's duiker	2	1	4	4	5	5
Bushbuck	1	1	2	2	8	6
Red-fronted gazelle	0	0	0	0	2	1
Lion	0	0	5	3	5	2
Baboon[c]		19		11		7
Tantalus monkey[c]		2		4		1
Patas monkey[c]		3		1		0
Total	3785	496	2677	412	3113	393

[a] The 1977 series consisted of one count on each of 14 tracks during the dry season (see Figure 10).

[b] Means of the first five 1978 counts on the Gounda-Dongolo track (route 14 in Table 10) were added to the first series. Means of the last eight counts were added to the second 1978 series. All values for individuals and groups were rounded to the nearest whole number.

[c] Only troops were counted for primates.

Table 12. Average density and population estimates of 11 ungulate species comparing road-strip counts and line transects in the southern woodland sector of the St. Floris National Park, Central African Republic.

Species	1977 line transects: Average density	1977 line transects: Population est. ± 95% CL[a]	1978 road-strips: Average density	1978 road-strips: Population est. ± 95% CL[a]
Wart hog	0.709	1180 ± 777	0.604	1006 ± 435
Giraffe	0.025	41[b]	0.119	198 ± 171
Buffalo	1.590	2647 ± 4431	0.744	1239
Bushbuck	0.085	142	0.033	54
Giant eland	0.025	41	0.193	322 ± 619
Grimm's duiker	1.750	2915 ± 454	0.702	1169 ± 404
Waterbuck	0.025	41	0.171	285 ± 364
Roan	0.348	579 ± 759	0.350	582 ± 279
Hartebeest	1.217	2026 ± 1867	1.440	2403 ± 1196
Topi	0.000	—	0.298	496 ± 368
Oribi	1.476	2458 ± 988	2.230	3721 ± 776

[a] Average density multiplied by the surface area of the southern wooded area (1665 km^2).

[b] Confidence limits could not be calculated because of limited observations.

A comparison was made between these data and 25 of the line transects surveyed in the 1977 walking census. In both cases, average densities were expanded to yield population estimates for the southern wooded sector of the park. Population estimates were comparable between both censuses for wart hog, roan, and hartebeest. Oribi and Grimm's duiker showed a wider variation though relative abundance values were similar. The elevated density for oribi on road counts can possibly be attributed to the high percentage of this species observed in the *Combretum glutinosum* tree savanna type which is found along 20 per cent of the track. This vegetation type was not encountered on walking transects. The probability that Grimm's duiker flee more readily when approached by persons on foot than by the passing of a vehicle and the high percentage of open country along the Gounda-Dongolo track also may explain the lower density of this species on road counts. The strip width for Grimm's duiker was identical (124 meters) in both surveys. Strip widths were greater for oribi, wart hog, and large ungulates on road counts. It is not known, however, whether this reflects real visibility differences between areas or the effect of using different methods for computing strip widths. Relative abundance values of giraffe, bushbuck, buffalo, giant eland, and waterbuck were similar.

Subjective dry-season population estimates of ungulates, carnivores, elephant, and primates are presented (Table 13). Each estimate was expressed as an interval. The wide range of the intervals reflects the effects of seasonal movements and the imprecision inherent in subjective estimates. Kob were estimated to be the most abundant large mammals in the park. Nine other ungulates have mean population estimates between 1000 and 3250. The most common primate was the baboon. No population estimates

Table 13. Dry-season population estimates of large mammals in the St. Floris National Park, Central African Republic.

Species	Population estimate[a]
Baboon	1500 - 4000
Patas monkey	200 - 400
Tantalus monkey	250 - 500
Colobus monkey	20 - 50
Hunting dog[b]	0 - 40
Cheetah[b]	0 - 5
Lion	50 - 100
Leopard	10 - 40
Elephant	50 - 400
Black rhinoceros[b]	0 - 5
Wart hog	800 - 1800
Hippopotamus	1200 - 1300
Giraffe	75 - 150
Buffalo	500 - 1500
Bushbuck	200 - 400
Giant eland	100 - 300
Grimm's duiker	2000 - 4000
Red-flanked duiker	5 - 50
Reedbuck	700 - 1500
Waterbuck	700 - 1500
Kob	6000 - 10000
Roan	350 - 800
Hartebeest	1500 - 3000
Topi	1500 - 3000
Oribi	2500 - 4000
Red-fronted gazelle[b]	0 - 10

[a] Population estimates were subjectively determined using results of line transects, road-strip counts, total counts, and aerial and ground observation.

[b] Zeros are given as the lower limit in rare species that are not known to occur in the park throughout the dry season.

are included for the smaller nocturnal species (small carnivores and lesser galago) due to a lack of observations and data.

The ungulate and elephant biomass of St. Floris (Table 14) was computed from the means of the population estimates. Hippopotami (30.5%) and kob (13.7%) accounted for a total of 44.1 per cent of the total (1551 kg/km^2). No other ungulate species contributed greater than 10 per cent to this figure.

III. 1. 3 Discussion

On line transects, the most probable sources of error included the inability to see animals within the strip and difficulties in estimating sighting distances. In the woodland, the accuracy of distance measurements could be improved by recording the actual sighting distance in lieu of the perpendicular distance. The use of a rangefinder would also improve the accuracy of these measurements. The excellent visibility on plains areas following burning allows for an increase in the strip width. For large mammals (kob-size and larger) the width of the strip should be increased to 600 meters (300 meters on either side of the line). This augmentation should significantly increase the sampling area without detracting from the precision of the inventory. The strip width for smaller mammals should remain at 400 meters.

Animal movements during the three-months census period could also have biased the results. Although most species appeared to be sedentary during this period, local movements caused by the influx of cattle frequently occurred.

Some form of stratification is needed in future line transect inventories. Total average density for the nine ungulate species (Table 9) was 45.4 animals/km^2 on the plains and 6.1 animals/km^2 in the woodland. The

Table 14. Calculation of ungulate and elephant biomass for the St. Floris National Park, Central African Republic.

Species	Population estimate[a]	Weight (kg)[b]	Biomass (kg)
Elephant	225	1,500	37,500
Wart hog	1,300	60	78,000
Hippopotamus	1,250	1,000	1,250,000
Giraffe	112	700	78,400
Buffalo	1,000	510	510,000
Bushbuck	300	40	12,000
Giant eland	200	365	73,000
Grimm's duiker	3,000	10	30,000
Reedbuck	1,100	40	44,000
Waterbuck	1,100	175	192,500
Kob	8,000	70	560,000
Roan	575	250	143,750
Hartebeest	2,250	165	371,250
Topi	2,250	165	371,250
Oribi	3,250	15	48,750
		Total	4,100,400

Biomass = 4,100,400/2,643 = 1551 kg/km^2

[a] See Table 13.
[b] Weights from Child (1974) and Coe et al. (1976).

sampling percentage on the plains was 2.4 times greater than that in the woodland (Table 7). The variance of animals censused per unit area was 463 times greater on the plains than in the woodland. Stratification based on the ratio of the variances (Cochran 1963) seems unrealistic in this case and another method should be used.

Buchanan and Schacht (1979) repeated the road-strip counts in St. Floris in 1979. They reduced the strip width on the plains, however, to 400 meters (200 meters on either side of the road) for large ungulates. Moreover, the strip width for smaller ungulates, primates, and carnivores was reduced to 200 meters and counts were conducted in May instead of the normal March-April period. Buchanan and Schacht used the same methodology as this study in the woodland. While total animals counted were reduced by more than 50 per cent, there appeared to be an acceptable number of observation of most species. The determination of whether an animal was within the strip would also be simplified using this modified methodology. If additional tracks were added to the census, the reduced strip-width would prove useful in reducing the time spent counting animals while increasing the geographical coverage. Future road-strip counts should, therefore, follow the methodology of the 1979 counts. The most time-consuming activity during road-strip counts is the collection of herd structure data. These are not essential for population index purposes. In general, counts along the tracks specified in this survey noting species and herd size would be sufficient.

The road-strip counts on the Gounda-Dongolo track provided acceptable estimates of the relative abundance of 10 species of ungulates. This conclusion is based on comparisons with the data of the 1977 walking census (Table 12). Ideally, a comparison of this nature should be based on concurrent surveys to minimize seasonal and yearly variations in animal numbers. Although both surveys were conducted during the same general season, it is impossible to assess the reliability of the estimators in light of the confounding variable presented by yearly differences in average ungulate density. Nevertheless, assuming that ungulate densities were similar between years, the results indicate that road-strip counts yielded estimates of average ungulate density that were acceptable from a management point of view. The methodology could be improved if additional roads were added to the survey and replications were increased. The disappearing distance method for determining strip-width should be utilized.

An aerial census was conducted in St. Floris in January 1978 by FAO project CAF/72/010 (reported in Loevinsohn et al. 1978). Population estimates and average densities of six ungulate species and elephant were computed. Estimates of the populations of kob, waterbuck, and topi were significantly below those presented in this study (Table 13). The population estimates of hartebeest, giraffe, and roan were roughly comparable, although in all cases those derived from aerial counts were situated on the low end of the interval in Table 13. The estimate for elephant was dramatically higher. No giant eland or buffalo were recorded during the census. Comparing these results with those of this study suggest that this aerial census poorly estimated ungulate populations in St. Floris. Future aerial inventories should utilize a high-wing aircraft with a slower flight speed and attain a greater sampling proportion.

Due to the dramatic increase in the surface area of St. Floris since the study, the analysis of large mammal populations has become greatly complicated. Much of the new area is devoid of roadways. An aerial census is presently the method of preference for a survey of the entire park area. With the construction of roads in much of the new area, a system of tranks could be periodically counted. Aerial census and road-strip data should be sufficient from a management point of view.

A biomass standing crop comparison of ungulates and elephant in West and Central African national parks and reserves was tabulated. In this comparison, weights were standardized and biomass figures were reclaculated for several areas. St. Floris is only intermediate when compared to the other areas (Table 15). This is primarily due to the extremely low numbers of ungulates in the north and northwest and to the low densities of larger species, such as elephant and buffalo, throughout the park. The ungulate and elephant biomass of the 1977 study area (Table 9), however, was greater than that of any other West African park or reserve (Table 15). This area supported the greatest standing crop of ungulates in St. Floris. The difference in biomass between this area and that of the entire park seemed to be influenced more by the extent of protection than by habitat differences. The greater biomass in the study area indicates the likely potential for the park as a whole, if protection measures were strengthened.

It must be remembered in connection with biomass comparisons, of course, that while differences in the sizes of ungulates tend to be equated in this procedure, the greater metabolic rates of the smaller species could cause differences between standing crop biomasses even beyond those caused by habitat variations. Although biomass has been a popular measure in Africa and elsewhere, a more precise measure of the total biological impact of an animal population on the environment is its expenditure of metabolic energy (Lamprey 1964). This method or the measurement of energy exchange, assesses more directly the animal impact by employing energetic measures rather than summing ungulate body weights.

Table 15. Comparison of ungulate and elephant biomass figures for West and Central African national parks and reserves.

Locality	Biomass (kg/km^2)[a]
St. Floris National Park, CAR (1977 study area)[b]	3,532
Bouba Ndjida National Park, Cameroon[c]	2,548
Arly National Park, Upper Volta[d]	2,386
Waza National Park, Cameroon[e]	1,785
Pô National Park, Upper Volta[f]	1,562
St. Floris National Park, CAR (total park area)[g]	1,551
Deux balé National Park, Upper Volta[h]	1,130
Borgu Game Reserve, Nigeria[i]	710
Comoé National Park, Ivory Coast[j]	290

[a] Calculated using unit weights from Table 9.
[b] This study, see Table 9.
[c] Calculated from means of population estimates given in van Lavieren and Bosch (1976), Table 11, page 27.
[d] Green (1977), calculated from author's population estimates on page 68.
[e] Esser and van Lavieren (1979), Table 4, page 14.
[f] Heisterburg (1975), calculated from author's population estimates in text.
[g] This study, see Table 14.
[h] Sihvonen (1977), Table 14, page 37.
[i] Child (1974), Table 9, page 22.
[j] Geerling and Bokdam (1973), calculated from population estimates appearing in the text.

Although this is the method of choice, its computation would be difficult to express accurately with the data available.

III. 1. 4 Notes on individual species

Much of the information presented in this section was based on general observation during the two-year study period. Herd sturcture results were included where sufficient data were collected and comparisons of herd structure and age and sex ratios were made with similar studies in other West and Central African parks and reserves. In addition, adult sex ratios of several ungulate species were compared to other national parks (Table 16). The 1977 age and sex results were compiled using both the road-strip and walking census data, while the 1978 results were based solely on road counts. Herd sizes were computed by pooling data from both years. The existence of previous reports allowed for a discussion of trends and future prospects of several important species.

Aardvark

Although no actual observation of this species was recorded inside the park during the study, their excavations were often encountered in areas of deep soils in the woodland and along the edge of the plains. This nocturnal animal is probably not uncommon in areas where soil depth is sufficient for burrowing and their principal food sources, termites and ants, are plentiful.

Elephant

There is a long history of elephant exploitation in St. Floris. Félix (1949) reported finding a map with the park area marked "Arab elephant hunting grounds," dating to the period of heavy depredations

Table 16. Comparison of adult sex ratios in four West and Central African national parks and reserves stated as males/100 females.

Species	St. Floris[a] CAR n	M/100 F	Bouba Ndjida[b] Cameroon n	M/100 F	Pô[c] Upper Volta n	M/100 F	Borgu[d] Nigeria n	M/100 F
Wart hog	(225)	92			(15)	114		
Reedbuck	(205)	103	(185)	67	(83)	48		
Waterbuck	(387)	42	(116)	46	(99)	9	(106)	60
Hartebeest	(548)	57	(134)	46			(313)	74
Oribi	(184)	70	(395)	82	(104)	108	(223)	103

[a] This study.
[b] Bosch (1976).
[c] Heisterburg (1975).
[d] Child (1974).

during the late 19th and early 20th centuries which supported a flourishing ivory and slave trade in the region. More recently, elephant numbers have fluctuated depending on the amount of protection they have been afforded, with frequent sightings during the years of protection and virtually no elephants seen during gaps in surveillance. The incursions of Chadian and Sudanese horsemen with the cattle herds tend to drive the elephants south of the park, though this does not always provide sanctuary, as the frequently-encountered elephant remains bear witness. From the 1977 walking census data, an estimated 200+ elephants were poached in the park during the period 1972 to 1977. This was based on the assumption that elephant skulls decompose in five years.

During two field seasons in the park, elephants were observed on 19 occasions, singly and in groups of up to 200. Numbers tended to fluctuate due to seasonal movements. Very few elephants inhabited the park during the height of the dry season. With the onset of the rains in May, elephants move north and as many as 500 may be intermittently present during the rainy season (Thal 1972). These seasonal movements need to be studied in greater detail and an effort made to determine to what degree migrations are influenced by seasonal habitat preferences as opposed to human harassment.

The elephants that remain in the park during the dry season are occasionally observed coming onto the plains at dusk to water. Always extremely wary, they spend the daylight hours in the woodland. Besides poachers, lions are responsible for killing young elephants and several kills were found in the park and along the western bank of the Gounda.

Elephants feed on a great variety of plants and are often destructive in areas where they congregate. These mammals were observed to feed on the leaves and stems of the grasses *Phragmites karka* and *Jardinea congolensis*, and branches and leaves of *Mimosa pigra*, *Acacia seyel*, *A. sieberiana*, *Hymenocardia acida*, *Terminalia laxiflora*, and *Combretum hypopilinum*. Bark was stripped from *Pseudocedrela kotschyi*, *Butyrospermum paradoxum*, and *Prosopis africana*. A more complete description of elephant food habits in the St. Floris area is presented in Buchanan and Schacht (1979).

The park should support more elephants than are now present and if a serious effort were made to control poaching, the population should begin to increase in a few years.

Black rhinoceros

No rhinoceros were seen in the park during this study, although their tracks were observed on three occasions in 1977 and once in 1978. All were noted in the southern part of the park in the vicinity of the Gounda and Goro rivers. Buchanan and Schacht (1979) report seeing tracks on two occasions in 1979 near Mare Arak. It is probable that one or more rhinos exist in the park, but there may be too few to reproduce successfully.

Wart hog

Herd size	1	2	3	4	5	6	7	8	9	10	$\bar{x} = 2.7$
No. of obsv.	76	43	51	28	16	6	3	2	2	2	

Wart hogs are common throughout the park wherever water is available. The dry months of March and April find these animals concentrated along the plains edges in the vicinity of permanent water. For watering and mud wallowing, they prefer shallow muddy basins to the predominantly sandy river banks.

Wart hogs feed on the roots of perennial grasses and are especially fond of the grasses *Vetiveria nigritana*, *Oryza longistiminata*, and *Echinochloa obtusiflora*, various sedges, and the tubers of other monocotyledonous herbs. Their diggings are often extensive and damage park roads in areas of impeded drainage where their preferred foods abound.

The birth period is between December and March. Family groups consist of one or more females, subadults, and young. Males are normally solitary or in small all-male groups. Age data were recorded for 450 animals: 53 per cent adults and 47 per cent combined subadult and young. The ratio of young per female having young varied between the two years of the study: 2.0 young per female in 1977 and 1.6 young per female in 1978. One wart hog carcass, killed by a lion, was observed in 1978.

Hippopotamus

This species has been of special interest since the park was created for its protection after the hippopotamus population had drastically declined at the beginning of the 20th century. During the last 40 years, hippos have increased in number in the Tenabo-Gata area although this is probably due as much to immigration from the northern areas of the park as from reproductive buildup. They are more concentrated than formerly and more than half of the estimated 1200 to 1300 hippos (Table 14) in the park can be found in one pool near Tenabo during the dry season. Other concentration areas with up to 200 individuals are located at Gata, Dongolo-Mada ngangou, and several points between the Vakaga ford and Gata. Numbers in these concentration areas varied from year to year as well as during the course of the dry season. Movements from one concentration area to another were noted during both seasons of the study. The reasons for these displacements were not always apparent although they appears to be related to changing water levels, the ability to find adequate forage, and the amount of harassment they received from poachers and fishermen. For the first time in several years, a small group of hippos remained at Dongolo during the 1978 dry season.

Spinage (1976) reported the death of approximately 30 hippos at Gata in March of 1976 and attributed it to a lack of food rather than to disease or poaching. In 1977, about 25 hippos were observed at Tenabo between the end of March and the beginning of May. Deaths were less numerous in 1978. This period corresponds with the height of the dry season when forage was scarcest and hippos were most concentrated. Hippos graze primarily on plains areas during the height of the dry season as there is no green forage elsewhere. Following the rains, however, hippos feed in woodland areas when grass regrowth becomes available. The most striking areas of overgrazing were situated on the plains immediately adjacent to pools where hippos concentrated. The animals were rarely, if ever, found in large numbers except on extensive plains areas in the northeastern part of the CAR.

Unless hippos are allowed, through increased protection, to move back into the rivers bordering the park, it is doubtful that the population can increase further. The small area near Gordil, where hippos are in highest concentration, is at or near carrying capacity.

Giraffe

Giraffes are observed fairly frequently but cannot be categorized as common. They are generally found singly or in small groups of up to five. A herd of 10-12 was seen on several occasions between Tenabo and Mélé in May-June 1978, however, and a sighting of 25-30 was recorded three kilometers east of Dongolo on June 12, 1978. It is possible that giraffes gather at the end of the dry season in preparation for a seasonal migration to the north.

These animals are extremely shy and are generally seen at a great distance. This wariness is attributable to poaching pressure from Arab horsemen. Giraffes are prized for their tail hair in adjacent Islamic societies. This is often woven into a necklace for use as a bride-price. Moreover, the meat is often smoked and the hide has various uses but especially in making beds and sandals. It is believed that these animals react to heavy poaching in much the same manner as elephants by retreating to the south during the dry season, only to return north at the time of the departure of cattle herds and the accompanying poachers. Giraffes were seen more often in 1978 than during the previous two years which possibly reflects the increased protection the park received then. Overall, this species and the elephant are considered to have suffered the most from poaching in recent years.

The preferred habitat of giraffes is the open impeded-drainage tree savanna. These long-necked browsers were observed feeding on *Terminalia macroptera*, *Combretum glutinosum*, *Acacia sieberiana*, *A. seyel*, and *Piliostigma reticulata*.

A few years of adequate protection could do much to enhance the population status of this beautiful animal. But a few more years without protection could see its disappearance from the CAR.

Buffalo

Herd size	1	3	5	8	9	26	28	38	50	100	150	$\bar{x} = 28.5$
No. of obsv.	1	2	1	1	1	1	1	1	2	1	1	

Buffaloes are found throughout the park in groups ranging from one to 250. Herds were seen on several occasions in the same general locations suggesting that they may be rather sedentary in the St. Floris area during the dry season. There were some indications of buffalo movements during the rainy season, but the extent and orientation are unknown.

Buffaloes have been observed to feed on a variety of grasses and woody vegetation including *Hyparrhenia* spp., *Vetiveria nigritana, Vossia cuspidata, Echinochloa pyramidalis, Paspalum orbiculare, Crataeva religiosa,* and *Antidesma venosum.* This species seeks water in the morning or evening and generally stays in the shade of the woodland during the day.

There have been at least two recorded die-offs of buffalo during the past 25 years. The most recent was in 1969-1970 when an estimated 5 to 10 per cent of the buffalo population in the north was destroyed. There also was a more serious epidemic in 1956 (Thal 1972). Thal attributes the latter to rinderpest and Malbrant (1952) cites this disease as responsible for periodic die-offs during the first half of the 20th century. It is believed that by preventing cattle from coming into the immediate area of the park, rinderpest could be controlled thereby reducing the risk to buffalo, wart hog, and giant eland, the most susceptible species.

Buffaloes are difficult to census effectively because they mostly occur in large widely-dispersed herds. Comparing this survey to the 1970 aerial census (Loevinsohn 1978) indicates that buffaloes are less numerous than before, although no specific factor has been uncovered to explain the decrease. Some evidence of poaching was noted in camps of cattle herders (Betibangui personal communication).

Bushbuck

Bushbucks are found along rivers bordered by wooded savanna. They were frequently observed along portions of the Vakaga, Gounda, and Goro rivers and at Dongolo. These handsome antelope are wary by nature and are often seen standing atop a termite mound where they rest during the day. Bushbucks are found singly or sometimes in groups up to five. The young are generally concealed and a specific calving period was not noted.

Giant eland

Elands were observed infrequently during the study. Sightings in the Gata-Tenabo area in 1976, 1977, and 1978 indicated that a group of 40-50 inhabited the Matoumara woods during the height of the dry season. Other observations revealed that an even greater number frequented the wooded southern sector. One group of 25-30 was seen there on three occasions in April and a group of 40 in January 1978. A herd of 65-70 was sighted near the eastern boundary of St. Floris in 1977.

These huge antelopes are extremely wary and always keep to wooded areas. Naturally gregarious, elands form large herds usually composed of a bull, females, subadults and young. Males not part of a large herd are generally seen singly or in small groups. Malbrant (1952) reports that elands make short seasonal migrations in response to water needs.

Malbrant (1952) suggests that elands are very susceptible to poachers on horseback due to their slow speed and ease in tracking. They are also reported to be very sensitive to rinderpest (Thal 1972).

Red-flanked duiker

This species was not observed in the park during this study but Buchanan and Schacht (1979) report seeing one near Dongolo in 1979. St. Floris represents the northern limit for this species in the CAR and they will probably never be numerous.

Grimm's duiker

Herd size	1	2	$\bar{x} = 1.1$
No. of obsv.	73	13	

This tiny antelope was common in the wooded savanna where it is occasionally seen darting out from thick cover. Grimm's duikers were especially fond of the dense vegetation associated with termite mounds. Essentially nocturnal, they remain hidden during the day and allow a person to approach quite closely before fleeing. The young of this species were almost never seen.

Reedbuck

Reedbucks were commonly found on the plains during the dry season in association with unburned patches of tall perennial grasses, but were rarely seen elsewhere. The plains surrounding Ninion were especially attractive to this species. 2.3 redbucks per linear kilometer were counted there on May 3, 1978. Counts were made on tracks 7 and 8 in Figure 10. This species is well adapted to hiding in the tall grass due to their protective coloration and relatively small size. Age class composition of reedbucks was computed (Table 17).

Table 17. Age class composition of reedbucks calculated from road-strip counts in the St. Floris National Park, Central African Republic. Values are expressed as subadults and young per 100 adults and as percentages.

Year	Totals	Adults	(%)	Subadults	(%)	Young	(%)
1977	51	100	(59)	47	(27)	23	(14)
1978	151	100	(59)	53	(31)	17	(10)

The adult ratio of males to females was markedly higher in St. Floris than in Bouba Ndjida and Pô National Parks (Table 16) but the cause is not apparent.

Waterbuck

Herd size	1	2	3	4	5	6	7	8	9	10	11-15	16-20	21+	$\bar{x} = 5.2$
No. of obsv.	60	33	17	15	10	11	6	10	5	5	13	8	5	

This species was most commonly found near permanent water during the dry season and was especially common at Dongolo, in the vicinity of Gata, and along the Gounda and Goro rivers. Waterbucks were rather sedentary especially during the dry season. Adult males defended territories while subadult non-territorial males formed small groups. Groups of up to 25 were most often composed of adult and subadult females and young. Young were observed from December to June.

Waterbucks are essentially grazers. The ecological separation between this species and kob is difficult to define as they appear to have much the same preferences for perennial grass species especially during the driest months. They are more frequently encountered in wooded areas than kob, however, and have been seen as far as ten kilometers from permanent water after the first rains of the wet season. In the study area, dry season average densities computed from line transects varied considerably between woodland (0.04 animals/km^2) and plains (3.2 animals/km^2) (Table 9).

This species is not commonly harassed by poachers. It is generally the least timid of the ungulates in the park.

Kob

Herd size	1	2	3	4	5	6	7	8	9	10	11-20	21-30	31-50	50+
No. of obsv.	278	47	20	22	16	20	16	17	10	8	59	32	29	38

The kob is the most numerous ungulate in St. Floris. It is truly at home on the large expanses of low-lying plains which border the extension of the Vakaga/Ounadjia rivers along the Ninion-Dongolo branch. Herds of several hundred were observed on the plains at Ninion and in the area between Ninion and Tenabo. They often attained a density of 100 per square kilometer at the height of the dry season. Average density on the plains segment of the study area was calculated as 32.27 per square kilometer (Table 9). The species also was common along the Gounda river.

Kob were always found near permanent water, generally on plains areas, during the dry season. Those grass species grazed most heavily by kob during the dry season were *Echinochloa pyramidalis*, *E. stagnina*, *Vossia cuspidata*, *Paspalum orbiculare*, *Hyparrhenia* spp., and *Jardinea congolensis*. Kob along the Gounda and Goro rivers appeared to move into the woodland to graze on perennial grasses that began to sprout at the onset of the first rains.

Large herds generally consist of adult and subadult females with young or groups of subadult or adult males. Most adult males, however, occupy a small area of ground which they defend against intrusions by other males. Territorial males appear to be quite sedentary on a defended area during the dry season. Territories are probably relocated on higher ground during the rainy season as dry season sites become flooded. Two territorial grounds, evidently clusters of individual territories, were located at Ninion and at a point along the extension of the Ouandjia/ Vakaga two kilometers northwest of the Vakaga ford. There were numerous scattered single territories in suitable hatitat along watercourses. The territorial grounds appeared to be located in areas of maximum density.

Neonates were observed throughout the study period indicating a year-around calving period. The adult sex ratio was computed as 50 males per 100 females (n = 695).

Kob were preyed upon most heavily by lions. Lion prides were observed on numerous occasions near kob concentrations. Poachers also took kob. Kob skins were found in several camps of transient cattle-herders and fishermen.

Roan antelope

Herd size	1	2	3	4	6	7	8	9	10	26	$\bar{x} = 3.0$
No. of obsv.	26	6	3	4	2	1	2	1	1	1	

Roan are fairly common in St. Floris. They are more timid than most other ungulate species and are, therefore, generally seen at a distance. Roan antelopes divide their time between the wooded savanna and the plains where they can occasionally be observed going to and from water. In the study area, dry season average densities computed from line transects were similar for the plains (0.33 animals/km^2) and the woodland (0.32 animals/km^2) (Table 9). Herds consist of single adult males, small groups of subadult and/or adult males, or larger groups of females, subadults, and young which are often accompanied by a dominant male. The largest herds occur in the northern sector where groups of 20 to 30 are not rare.

Roan were difficult to sex and age due to their timidity, rarely standing still long enough for adequate observation. Moreover, the sample was biased by the over-representation of small groups, and for this reason no analysis of herd structure was conducted.

Roan are characteristically grazers over much of their range and it appeared that they obtain much of their food from herbaceous species in St. Floris. Observations suggest that food habits vary on a seasonal basis and a diversity of browse and herb forage is consumed. Roan were especially fond of perennial grass regrowth in the woodland after fires.

Although little evidence was uncovered concerning the extent of poaching on roan, it appears that their numbers have declined in recent years (Cabaille personal communication).

Hartebeest

Herd size	1	2	3	4	5	6	7	8	9	10	11-15	16-20	21+	$\bar{x} = 5.3$
No. of obsv.	80	24	22	20	15	15	14	11	6	3	11	16	5	

Hartebeest were found throughout the park utilizing all vegetation types except the dry forest. During the driest months, this species was most commonly observed along the Gounda and Goro rivers and in the environs of Gata and Mada ngangou. In the northern sector, herds of hartebeest frequently associated with topi.

During the height of the dry season, hartebeest feed on plains grasses and often seek shade on the woodland edge or on termite mounds during the hottest hours. A comparison of average densities between plains and woodland in the study area (Table 9) shows that hartebeest were approximately three times more dense on the plains during the driest months. With the first rains of the wet season, this species moved into the woodland to graze on the new flush of perennial grasses. Along the Gounda, hartebeest were conspicuously absent on the plains after the first rains but reappeared there two to three weeks later.

A typical herd of this species consists of an adult male with females, subadults and young. Male herds were also observed, composed of adults and subadults not part of a family group. In areas of preferred habitat or during migration, hartebeest sometimes formed herds exceeding 500 individuals of mixed ages and sexes. The age composition of hartebeest was computed for both years of the study (Table 18).

Table 18. Age class composition of hartebeest calculated from road-strip counts in the St. Floris National Park, Central African Republic. Values are expressed as subadults and young per 100 adults and as percentages.

Year	Totals	Adults	(%)	Subadults	(%)	Young	(%)
1977	358	100	(62)	27	(17)	34	(21)
1978	565	100	(60)	28	(17)	38	(23)

Bosch (1976) reports that male hartebeest (a different sub-species) actively defends territories in the Bouba Ndjida National Park in Cameroon. This phenomenon was not observed in St. Floris. At best, it must be an ephemeral practice since seasonal migrations occurring yearly represent considerable displacements to the north or east (Malbrant 1952). A peak calving period seemed to occur in November and December, though several neonates were noted periodically through June. The approximately 8 month gestation period (Dekeyser 1955) would indicate a peak of mating activity during the period March to May. This corresponded with the height of the dry season when hartebeest were most concentrated. No such peak calving period was noted in the Borgu Game Reserve in Nigeria (Child 1974) although, here again, there is a different sub-species in this reserve.

An unknown portion of the total hartebeest population in St. Floris is thought to migrate north with topi into the Aouk-Aoukalé Reserve and east to Goz Sassoulko and Birao. This movement follows the retreat north of cattle herds at the onset of the rainy season (Malbrant 1952 and Félix 1953).

Topi

Herd size	1	2	3	4	5	6	7	8	10	11-15	16-20	21+	$\bar{x} = 8.0$
No. of obsv.	62	22	17	8	12	5	4	4	3	6	5	18	

Topi are common on the northern plains during the dry season and they were often observed there in considerable numbers. The greatest concentrations were observed near Mélé, Mada ngangou, and between Dongolo and Ninion where herds in excess of 350 were noted. To a lesser degree, these ungulates were found at Gata, Tenabo, near the Vakaga ford, and in the more open areas of the southern sector although rarely, if ever, seen along the Gounda or Goro rivers.

Herd structure is similar to that of hartebeest although topi are generally found in larger groups. This species freely associates with hartebeest and age and sex patterns in large concentrations become difficult to assess. Age class composition of topi computed from road-strip counts in 1977 and 1978 is presented (Table 19). The calving period varied between years. Birth of young was concentrated during a two or three week period occurring between February and April. Back calculating an 8 month gestation period (Dekeyser 1955) indicates a breeding season during the period June to August. This corresponds with the height of the rainy season when few topi are present in St. Floris.

Topi are a true plains ungulate and are exclusively grazers, utilizing many perennial grass species found in open areas including *Hyparrhenia* spp., *Vetiveria nigritana*, and *Echinochloa pyramidalis*. Félix (1953) reported a seasonal movement of topi in response to the rains. It appears that as the plains become flooded producing a thick growth of tall grass, this species moves north to drier habitat where grasses are probably in an earlier stage of development. It is unknown what percentage of the population left the park for the northeastern migration, although some topi probably spend all or part of the wet season in the southern sector.

Table 19. Age class composition of topi calculated from road-strip counts in the St. Floris National Park, Central African Republic. Values are expressed as subadults and young per 100 adults and as percentages.

Year	Totals	Adults	(%)	Subadults	(%)	Young	(%)
1977	313	100	(71)	21	(15)	20	(14)
1978	631	100	(63)	30	(19)	27	(17)

Oribi

Herd size	1	2	3	4	5	$\bar{x} = 1.9$
No. of obsv.	44	50	29	6	2	

This antelope was most commonly observed in the more-open portions of the woodland. It was found singly, in pairs, or in small groups of up to five. A total of 269 individuals were aged and sexed giving an age ratio of 80 per cent adults and 20 per cent subadults and young. This compares with Child's (1974) findings of 87 and 13 per cent respectively for the Borgu Game Reserve in Nigeria. The low percentage of non-adults probably could be explained by the habit of this species to hide it's young. A peak calving period appeared to occur between December and February. Oribi remained sedentary throughout the dry season. They were observed to feed on woodland perennial grasses.

Red-fronted gazelle

Malbrant (1952) states that this small gazelle is rarely found south of 10° N latitude and cites the tse-tse fly (*Glossina* sp.) as an important factor. The presence of this species in the park is based on observations of a pair, probably the same two, seen on six occasions at Ninion near the end of the 1978 dry season. In 1979, Buchanan and Schacht (1979) report the sighting of four gazelles in the same location. While the sex structure of these animals is not known, it is possible that a reproducing population may become established.

Hunting dog

Hunting dogs are rarely seen in St. Floris; a total of nine sightings were recorded during the two seasons of study. Packs of up to a dozen were observed, with the most frequent sightings occurring in the Vakaga-Gordil-Gata area. Groups were also seen in both 1977 and 1978 near the Gounda river across from the tourist camp.

These animals are very mobile and cover large areas in search of prey. It is possible that this species reproduces in the St. Floris area although no young were observed. The low numbers of hunting dogs perhaps is related to their efficiency as a predator. They are curious and not at all shy, often approaching vehicles, and it has been customary for park personnel and sport hunters to shoot them on sight. Fortunately, this attitude is changing and the harassment is relaxing throughout the northern sector of the CAR.

Jackal

Of the two species observed in St. Floris, the side-striped jackal was observed more frequently than the common jackal. These small scavengers were seen occasionally as they came onto the plains at dusk. Several sightings were made at Dongolo in 1978.

Spotted hyena

Although hyenas were distributed throughout the park, they were most commonly encountered in the northern plains sector during the dry season. Generally occurring singly, they were rarely seen due to their nocturnal nature.

Cheetah

In 1978, cheetahs were seen on two occasions in the sector of the Manovo-Gounda Reserve adjacent to the park although they were never observed inside the park itself. Also in 1978, a group of four was observed twice at a point 40 kilometers south of the Gounda tourist camp. It is quite probable that these unique large cats inhabit the park from time to time but their numbers are low.

Cheetahs shun human beings and the presence of cattle herders and fishermen in the northern sector of the park must surely inhibit them from utilizing this otherwise ideal habitat.

Lion

Lions occupy fairly large territories in loose family groups. All 46 recorded sightings during the study occurred in areas of high prey density.

Lions rest in the shade during the day, often at an edge of the plains. They generally hunt in the evening. Observed kills included kob (the most common), buffalo, waterbuck, topi, elephant, and wart hog. Lions did not appear to be overly harassed by poachers (although they are occasionally trapped in leopard snares). They should continue to thrive in St. Floris, given sufficient prey.

Leopard

Leopards must be categorized as uncommon in St. Floris. Because of their nocturnal habits, however, they may be somewhat more common than is apparent. This species was seen on six occasions, with as many as three seen together. Two sightings were made west of Dongolo, one at Ninion, one east of Ninion on the road from the Vakaga ford, and two between Dongolo and the Gounda river.

Leopards prey on small antelopes, baboons, and a variety of other small animals. The only leopard kill found during the study was an oribi cached seven meters up in a large *Tamarindus indica* near the Vakaga radier.

That these predators are heavily poached was evidenced by a recently constructed snare trap found at Dongolo in January 1978. Cable snares also were taken from several fishermen and poacher camps. A serious conservation effort is needed to protect these beautiful felines if they are not to disappear from the park and surrounding areas.

Serval

Servals were seen infrequently during the study as their nocturnal habits make observation during the day difficult. Tracks indicated that this species is common in the park.

Baboon

Baboons were found throughout the park, usually occurring in troops averaging about 40 individuals although troops of 60 or more have been recorded. They were often seen on the plains during the hottest daylight hours going to and from water. Baboons feed on fruit especially those of *Ficus* spp., *Butyrospermum paradoxum*, *Diospyros mespiliformes*, and *Tamarindus indica*. They also eat insects and roots and tubers of various monocots.

The rich well-watered plains and bordering wooded savanna provide ideal habitat for this primate. The scarcity of the baboon's natural enemy, the leopard, may also play a part in their well being.

Patas monkey

These terrestrial monkeys were generally observed on the plains at the height of the dry season. Patas are common only on the northern-most plains areas (Buchanan and Schacht 1979), the region of greatest poaching and livestock herding. Patas are extremely timid and difficult to approach. Troops of up to 20 individuals were often encountered.

Tantalus monkey

This species is not abundant except in the dry forest where troops of 20 individuals have been observed. Tantalus are probably the third most common primate after baboon and lesser galago.

Colobus monkey

This beautiful monkey was rarely seen in the park and only two observation were recorded during the study. They are largely arboreal and are found only in the dry forest.

Colobus skins are sought by poachers and a skin of an adult was taken from a poacher camp on the Bahr Kameur in 1978. The status of this species must be considered as threatened.

III. 1. 4 Herbivore distribution

A thorough understanding of the complex patterns of species distribution is paramount in the future planning of St. Floris. It is especially important in the determination of park boundaries, the protection of large mammals, and habitat management.

From the information available, large-herbivore distribution is governed by three principal factors: water availability, the quality and availability of forage, and illegal human activity. These factors affect many species in a particular manner and cause an array of distribution patterns. Territoriality is a secondary influence having an effect on the spatial arrangement of individuals or groups of some species. The site for the establishment of territories is related in some degree, however, to these three factors.

Water availability is probably of basic significance. During the driest months, species which must drink on a frequent and regular basis are restricted to areas adjacent to major rivers. It would appear that the distribution of topi, hartebeest, elephant, giraffe, buffalo, kob, waterbuck, bushbuck, reedbuck, roan, and wart hog is affected, at least partially, by water availability. Oribi and Grimm's duiker are generally the only large mammalian herbivores observed distant from water during the driest months, thereby indicating that they can exist without water for extended periods of time. Individual waterholes dry or fill in a particular manner and many species move into or out of an area in response to water availability.

Forage quality and availability is also a function of the habitat. Like water availability, forage types and abundance are closely related to climate, especially rainfall. Response to this factor is complex and varied, both by season and by species. No in-depth food habits studies could be conducted under this project. Several studies of food habits of various hervivore species have been undertaken in the St. Floris area (Gillet 1964, 1970 Thal 1972) but all were brief.

The nutritive value of herbs is variable over the course of a year. The abundant tall perennial grasses relocate food reserves from the leaves to the roots at the beginning of the dry season and are of little value as forage when dry. While annuals may cure better than tall perennial grasses, their forage value is also greatly reduced when dry. Basically, the highest nutritive value occurs at an early phenological stage in grasses. As the plant matures, crude protein, the most readily digestible carbohydrates, and some minerals decrease, and fiber, lignin, and cellulose increase (Stoddart et al. 1975). There is variation in the growth phenology of various forages which allow grazers to find high quality forage on a year-around basis. Following a fire, early growth is both tender and nutritious and grazing herbivores are attracted to graze on newly burned areas.

Although there are some seasonal variations in forage quality of woody species, their value remains more constant than herbs. Unlike grazers, browsing herbivores are rarely drawn to burned areas as fire destroys seedlings and removes leaves from shrubs and trees. The foliage is replaced in time but burning may inflict some hardship on most browsers for up to two months during the dry season. The giraffe, however, generally feeds above the level of vegetation destroyed by fire.

The availability of forage also varies on a seasonal basis and is especially marked in grasses and forbs. On upland areas, growth of perennial herbs ceases during the dry season when soil humidity becomes inadequate to support growth. The perennial grass flush appearing soon after early fires generally wilts later in the dry season. During the height of the dry season, therefore, herb forage is extremely restricted on upland sites. The biomass of available forage is greatest near the end of the wet season but they seem to be less-readily consumed perhaps due to a reduced forage quality. Doubtless, it is necessary to assess both availability and quality when examining herbivore feeding strategies related to distribution.

In East Africa, migratory herbivores either satisfy their nutritional needs by moving over large distances and utilizing a few plant species (Talbot and Talbot 1963) or by choosing a specific growth stage or stratum of the vegetation (Vesey-Fitzgerald 1960 and Gwynne and Bell 1968) which are of best quality at a given time of the year. In contrast, non-migratory herbivores are less specific in their demands and feed on a variety of species and vegetative components over the course of the year (Kutilek 1979). Kutilek found that four East African ungulates including waterbuck and reedbuck practice a seasonal grazing rotation among the six vegetation types in a relatively-small area in the Lake Nakuru National Park, Kenya. He found, too, that non-migratory herbivores exhibit a diverse feeding regime in the confines of a small home range.

The orientation and duration of seasonal movements of hartebeest and topi in the St. Floris area seem to be related to the growth patterns of preferred plant species. Further study is needed, however, to clarify whether the displacements are a function of illegal activity or food habits.

The home ranges of kob, waterbuck, reedbuck and oribi appeared cover a small area, possibly indicating the mixed feeding regime of non-migratory herbivores. Few observations were made of the feeding habits of reedbuck and oribi. Kob and waterbuck, however, appear to have very similar feeding strategies. In December and January, their grazing was restricted to recently-burned area in woodlands near rivers and in the stands of grasses *Jardinea congolensis*, *Vossia cuspidata*, *Paspalum orbiculare*, and *Echinochloa stagnina* found on most humid sites. These perennials remain green long after grasses on drier sites have dried and kob and waterbuck graze the green portions of these species. As the dry season progresses, small areas on the plains are burned and, about one week following a fire, kob and waterbuck undertake local movements to graze on the perennial grass regrowth. Both species continue to graze on the plains with preference given to newly-burned areas, until the first rains of the wet season. Kob then move to higher ground (plains edges in the northern sector and the woodland along the Vakaga, Gounda, and Goro rivers) where they feed on new shoots of various grasses of the tribe Andropogoneae (Genera *Hyparrhenia* and *Andropogon*). Waterbucks are found more distant from the plains during this period although they appear to feed on similar grass species. Little information is available on the feeding habits of these two species during the height of the wet season, but they do not appear to wander far from the major rivers (Cabaille personal communication).

Illegal human activity exerts an important influence on large-mammal abundance. Densities are highest in areas adjacent to major villages housing Eaux et Forêts personnel and where roads facilitate surveillance. They are lowest where protection is not afforded. While poachers prefer species whose hide, hair, or tusks have a high market value, no species appears immune from poaching.

III. 2 BIRDS

Although no systematic bird studies were attempted, an effort was made to compile as complete a species list for the park as possible. Over 200 species were identified and constituted a majority of the species occurring in the area (Appendix B).

Water birds

The topography of the park provides wet lowlands especially attractive to many species of water birds such as ducks, geese, storks, ibis, pelicans, herons and many less obvious shorebirds. The plains, which are totally inundated during the rainy season, drain slowly and trap many fishes in numerous small basins. At these pools, in addition to the rivers, it is not uncommon to see spectacular concentrations of pelicans, storks, and ibis fishing or resting during the height of the dry season. Abdim's and woolly-necked storks are seen at the end of the dry season, often in considerable numbers, as they migrate north. The rare whale-headed stork (*Balaeniceps rex* Gould) was observed once in 1978 several kilometers east of Gordil and some individuals are probably found in the park from time to time.

Ostrich

Ostriches were frequently seen on the plains during the dry season. They lay their eggs in December and January in woodland areas to the northeast and in the southern sector of the park. They move onto the plains after the young hatch. A single pair may be seen with as many as 20 young. Two or more families of young were observed together on two occasions. Subadults (one to two years of age) form flocks of up to 10 individuals.

This species has become threatened throughout much of its West African range. One rarely drives the length of St. Floris, however, without seeing several ostriches. The park is fortunate to have a healthy breeding population.

Other birds

Carmine bee-eaters arrive in number in late March/early April to nest in large colonies in the sandy river banks. They, along with several other species of bee-eaters and a variety of kingfishers, present a colorful background to the mammalian wildlife concentrated along the rivers during the dry season.

Other important avifaunal residents include several species of eagles, of which the African fish-eagle and the bataleur are the most notable. There are numerous other birds of prey, along with several species of bustards, hornbills, rollers and sunbirds.

The richness of birdlife is a great asset to St. Floris from the standpoint of tourism. It also shows the importance of the park as a sanctuary for the numerous European migrants that pass through or winter there.

III. 3 REPTILES

The compilation of a species list was undertaken (Appendix C) but it represents only a small fraction of the species in the park.

Nile crocodile

Caballle (1960) reports this reptile to have been previously very numerous, with hundreds often seen at Gata. He attributes their subsequent depopulation to poaching, with a large percentage having disappeared between 1956 and 1959. Today, crocodiles are found only along the Gounda and Goro rivers. Their existence in the northern plains region has not been substantiated for some time.

The disappearance of this predator throughout much of the park has led to a fish population boom especially in the northern plains region. Sufficient prey would be available for the crocodile if reintroduced, although this practice is unwarranted unless a serious protection program is implemented concurrently.

Monitor lizard

Although heavily poached, this large lizard is still commonly found along the Gounda and parts of the Vakaga rivers where it was observed robbing nests of carmine bee-eaters. Monitor lizards spend much of the day in branches of trees overhanging the water and their holes were often found in termite mounds.

Turtles

The large terrestrial African spurred tortoise was often seen along the Gounda-Dongolo track. The aquatic Nile soft-shell turtle was frequently found in fishermen's catches.

African python

This species was observed on two occasions. Their skins were frequently found in fishermen's camps.

III. 4 AMPHIBIANS

Several species of toads and frogs were observed. No amphibians were identified, however, due to a lack of taxonomic keys.

III. 5 FISH

A total of 25 species was identified during the study (Appendix D), representing a small fraction of those actually present. The Gounda is characterized by a diverse fish population. Pools on the northern plains harbor mostly catfish (*Clarias lazarius*) and *Polypterus endlicheri endlicheri*. The Nile perch (*Lates niloticus*) and tiger-fish (*Hydrocyon* spp.) are especially common along the Gounda.

Local fishermen employ gill-nets and lines of hooks stretched transversly along the bottom of the river. These fixed lines, are especially selective of catfish which make up the majority of the catch.

MANAGEMENT RECOMMENDATIONS

IV. 1 OBJECTIVES

As for any area, the first step in the intelligent management of a national park is a clear statement of land-use objectives. The CAR statute covering the rationale for the establishment of national parks, law 60/140 of August 19, 1960, states that the parks are "to be preserved and devoted to the propagation and protection of wildlife and indigenous vegetation and the conservation of objects of esthetic, geologic, historic, or scientific value for their future benefit and public recreation" (translation). Unfortunately, no legal documents specify objectives for a national park/reserve system as a whole nor the role of individual protected areas as a part of that system. One might then ask: why is St. Floris assigned the status of a national park, what specifically is to be preserved and/or exploited, and under what premises were the boundaries fixed?

Ideally a national park/reserve system should be established to include units representing several basic biotic zones of the country so that animal and plant species endemic to these zones are contained within this system (Petrides 1965). There are presently natural areas not enjoying protected *de jure* status in important biotic zones that could presumably be included in a system of protected natural areas. While the discussion of these new areas is beyond the scope of this study, it it important to point out that St. Floris also plays a fundamental role in the preservation of the sudan savanna/flood plains region of the CAR.

Originally, St. Floris was established for the purposes of biotic preservation: protection of a region rich in wildlife with special consideration given to the hippopotamus. The northeastern region of the CAR is one of the last extensive areas in Africa remaining in a rather pristine natural state. Although animal numbers have declined due to the influence of man, only one large mammalian species, the white rhinoceros (*Ceratotherium simum* Burchell), has been completely exterminated in the region in modern times. The incidence of fire has also had a marked influence on the vegetation. Nevertheless, the ecosystem is still in a healthy natural state and this condition should continue, given adequate protection.

St. Floris will play an even more important role in the protection of endemic flora and fauna when a greater human population in the region causes an expansion of the land area utilized for agricultural or pastoral pursuits. A decline in wildlife numbers can be expected due to hunting and loss of habitat. Moreover, the existence of many species of migratory birds common to St. Floris (herons, storks, ducks, geese, etc.) depends upon the protection of all their seasonal ranges. Due to the relatively high density of wildlife species and the fact that the soils in St. Floris are inherently of poor agricultural value (Quanton 1962), a national park is the most appropriate resource use of the area. Livestock husbandry is not a viable enterprise as cattle can only exploit a fraction of the park area. Because of the presence of the tse-tse fly in woodland areas, the plains can only be grazed during the dry season.

St. Floris is relatively free from direct competition with the interest of local Central African citizens. The future human needs of the region can easily be developed outside the confines of the protected area without infringing on the welfare of local inhabitants. The park may also play an important role in the environmental health of the sub-saharan region north of the 10° N meridian. One of the greatest problems in this region has been the desertification of the Sahel. Through overutilization of the range by livestock, the cutting of trees for firewood, and a decline in annual rainfall, the desert is advancing southward at an alarming rate. Protected natural areas, in the CAR and elsewhere, may become important buffers against overexploitation by man, thus slowing down the advance of the desert. Even though St. Floris is situated well south of the problem area, one should not overlook this role of natural areas in the long-term environmental health of Central Africa.

Secondly, a national park has a cultural value insofar as it is essentially a "living museum" valuable esthetically, scientifically, and educationally. While these cultural values are presently perceived as minor, one should not overlook their importance in public education and economic development. In many developed countries and in an increasing number of developing nations, the preservation of cultural values is regarded as a major objective in national park management.

While it is not explicitly stated in Central African legal codes, the economic importance of national parks in Africa has been one of the driving forces behind their establishment and development. Economic development is generally perceived as the highest national priority on this continent. Tourism, especially as in the case of Kenya, can be a major means of obtaining foreign exchange. Besides tourism, national parks can sometimes benefit local residents in providing bushmeat. As game numbers increase within the confines of the parks, animals will disperse into external areas where they can be harvested without depleting park populations.

The management of national parks with regard to the objectives of preservation of natural areas and human non-consumptive use are not without conflicts. While human visitation, primarily in the form of tourism, is basic to the conception of national parks (IUCN 1975), this objective and the preservaton of natural conditions are sometimes incompatible. Natural succession is altered by burning intended to enhance game viewing, and mass tourism may have an adverse effect on those species (cheetah, giant eland, and black rhinoceros) that are intolerant of human interference. There is much controversy regarding the policy of shooting sick or wounded animals that could potentially be dangerous to visitors. Human intervention might be considered, for example, if the elephant or hippopotamus population increased to a point where it destroyed the habitat for other species or caused severe overgrazing and soil erosion. While these discussions are presently of secondary importance in St. Floris, as there are currently more serious threats to the park's existance, future statutes concerning management objectives should attempt to clarify these conflicts.

The CAR government has set aside a high proportion of land area devoted to national parks and reserves. However, due to the recent exacerbation of poaching, it is apparent that the country's present park/reserve system can not be adequately protected in its entirety with the means presently employed. Therefore, several target areas must be defined to be given highest priority in future development and protection initiatives. In setting priorities one should review such factors as logistics, present and future patterns of human use, numbers and diversity of indigenous wildlife, the role of the area in the overall environmental protection scheme of the CAR, present infrastructure, and tourism possibilities.

IV. 2 LEGAL STATUS AND BOUNDARIES

St. Floris was included on the first United Nations list of national parks and equivalent reserves (Harroy 1971). In a more recent listing (IUCN 1975), however, all parks and reserves in the CAR were omitted except for Bamingui-Bangoran (national park—provisional status) and Vassako-Bolo (strict nature reserve—normal status). In an attempt to understand the rationale behind the omission of St. Floris, one must examine the three criteria used by IUCN (International Union for the Conservation of Nature) for the recognition of national parks: 1) status of general *de jure* protection, 2) size in excess of a certain minimum, and 3) protected status adequately maintained. While the exact reason is not known by the author, the lack of a *de facto* protection appears to be the most plausable factor influencing the change of status. The fact that only two of the CAR's protected natural areas remain on the IUCN list probably reflects the feeling that the CAR is not making a serious effort to protect its national parks and reserves.

An in-depth discussion of the legal status and boundaries of St. Floris is unnecessary due to the existence of a recent work on this topic (de Saussay 1978). Those concerned with the statutes governing the park area and restrictions on human use should consult this source and Spinage (1976).

During the past 20 years, there has been much discussion regarding the enlargement of St. Floris. It was evident that the original park area did not represent a self-contained ecological unit as many species, e.g. buffalo, giant eland, topi, giraffe, and hartebeest, migrated seasonally beyond the confines of the park. With the nationalization of the adjacent Safarafric hunting concession, a proposal was submitted to the CAR Government (Temporal 1978) to increase the surface area of the park. In March of 1979, this proposal was accepted and the surface area of the new park, tentatively named Manovo-Gounda-St. Floris, increased to approximately 17,000 square kilometers. This park contains the most developed infrastructure (guard houses, roads, and airstrips) of any protected public area in the country. Manovo-Gounda-St. Floris also harbors diverse and healthy populations of wildlife in addition to geologic formations and human historical sites that have potential tourist interest.

The surface area of St. Floris has changed five times since 1933. One would hope, however, that the enlargement would not necessarily be regarded as the final boundaries as the most important detail in the delineation of an ecological unit, the study of the seasonal ranges of large mammals, has never been conducted. It is doubtful that future distribution studies will reveal a clear-cut ecological boundary, and park borders should, to the extent possible, include the seasonal ranges of the most important mammalian species. The present problems in the Waza National Park in Cameroon dramatically illustrate the importance of determining park boundaries on an ecological rather than a geographical basis.

The enlargement of St. Floris followed the completion of this study. The following discussion of management and development recommendations covers primarily the pre-1979 surface area. Many of the stated problems/ priorities, however, are also applicable to the new enlarged area.

IV. 3 PROTECTION

The lack of protection is having a profound influence on the park's flora and fauna. Herds of livestock, carcasses of elephant and giraffe, and poachers and fishermen are frequently observed throughout the park. Under present conditions, the development of tourism is futile because of the unfavorable impression created by the rampant illegal human activity in the park and the continuous decline in wildlife numbers. Basically there are three categories of illegal human activity in the St. Floris region: 1) professional poaching, 2) fishing, and 3) livestock (cattle and sheep) husbandry.

Professional poachers are both Central African citizens and foreigners (principally Chadian). These poachers generally bear firearms, and their purpose or occupation is the procurement of marketable animal products and, to a lesser extent, bushmeat. [The term poacher is used here to define those 1) hunting in a protected area, and 2) harvesting animals protected by law.] Evidence suggests that professional poachers travel in small groups in search of those species with marketable products, such as elephant and giraffe, and to a lesser degree leopard, python, colobus monkey, and crocodile. There appears to be a well-organized system of distribution of animal products. Ivory, giraffe tail-hair, and skins of various other animals are, for the most part, marketed outside the CAR via Chad. In the northeast sector of the CAR, the majority of Central African professional poachers come from the immediate vicinity of N'Délé. There, human population density is greater and fish supplies (for food) are lower than in the Vakaga prefecture. The aforementioned target species are abundant in the Manovo-Gounda Reserve and it is generally unnecessary for N'Délé-based poachers to travel to St. Floris to hunt. Most professional poachers operating in St. Floris are Chadians; especially residents of villages situated in the Aouk-Aoukalé Reserve which are within easy access to the park. It is probable that this activity takes place on a year-around basis.

Fishermen can be divided into two groups differing in nationality and area of operation. In the northeast, Central African citizens from the villages of Mélé, Gordil, Manou, and Sikikédé fish primarily at Gata, Tenabo, Ninion, and Dongolo. Although fishing is their principal activity, observation suggests that they are also opportunistic poachers as skins of kob, Grimm's duiker, python, and monitor lizard have been found in fishing camps along with crocodile harpoons. The second group, operating along the Bahr Kameur, Gounda, and Goro rivers, are generally of Chadian nationality. They are apparently most active along the Gounda and Goro rivers during the rainy season when surveillance is hampered by flood conditions. To what degree this group is related to the villages in the southwest sector of the Aouk-Aoukalé Reserve is not known. Poaching appears to be an important, though secondary, activity of these Chadian fishermen and skins of crocodile, colobus monkey, python, monitor lizard, and kob are commonly found in fishing camps. Moreover, this group may have an important detrimental effect on the leopard as snares are commonly taken from fishing camps and snare traps are often observed in the vicinity of these camps.

Cattle herders are rarely, if ever, of Central African citizenship. The majority of livestock (mostly cattle) entering the park originate from the Nyala region of Sudan, and to a lesser extent, the Haraze sub-prefecture in Chad. In general, livestock enter the park in late December and early January and depart in late May using the park as a dry season range. Sudanese livestock follow the Bahr Nzili, Bahr Oulou, and Aoukalê rivers to St. Floris. The majority of Chadian livestock move directly south to the plains of the Bahr Kameur and Massaberta in the Manovo-Gounda Reserve (see Thal 1972).

In 1977, cattle were observed throughout much of the park. Except for several control operations undertaken in March of that year, little was done to combat cattle herding. During the 1978 dry season, more numerous operations were conducted and cattle were visibly less numerous though nevertheless present. A total of 76,700 cattle (both Chadian and Sudanese) were estimated to pasture in the area comprising St. Floris, Aouk-Aoukalê, and hunting sectors 16 and 21 (Loevinsohn personal communication). While as of January 5, 1978, there were an estimated 9000 cattle in St. Floris (Loevinsohn _et al_. 1978), this number undoubtably increased later in the dry season.

There are three principal reasons for the presence of livestock in St. Floris: 1) Due to the combined effects of climatic change and overgrazing, the amount of good pasture land in Chad and Sudan has been reduced and herdsmen are forced to move south to pasture their livestock; 2) The open plains of St. Floris provide ideal dry season habitat for cattle; and 3) The presence of cattle has generally gone uncontested. The effects of livestock on the vegetation and wildlife of the northern region of the CAR aptly stated by Thal (1972) are still applicable (trans.):

"The presence of domestic cattle push game off their habitual range and lower the productivity of plains grasses through trampling and overgrazing.

"Risks of an epidemic (rinderpest) are great as many cattle illegally entering the park have not received the necessary vaccinations stipulated by law.

"The herders are ardent poachers, using bow and poison arrows, or spears from horseback to hunt antelope and especially giraffe and elephant."

The illegal influences of man in St. Floris can be significantly curtailed by eliminating the foreign presence from the park and adjacent protected areas. The majority of illegal activity by foreigners occurs in the north either by residents of Chadian villages in the Aouk-Aoukalê Reserve or by Chadian and Sudanese livestock herders who pass through this reserve on their way to St. Floris. Numerous Chadian villages are located in the southwest sector of Aouk-Aoukalê and the total human population is estimated to be 500 to 1500. The reserve has no passable roads and it is doubtful if Eaux et Forêts personnel have visited its interior in the last 10 to 15 years. How long these villages, once located to the north of the Aouk river (Chad-CAR boundary), have existed in the reserve is not known, however, from ruins of the former villages seen from the air, one would surmise a residency of 3 to 7 years. The 1978 aerial census undertaken by FAO project CAF/72/010 showed that endemic large mammals were all but absent in the vicinity of these villages and adjacent areas of St. Floris and the Manovo-Gounda Reserve. Doubtless, human numbers will progressively increase and/or continue to move southward unless the CAR Government makes some attempt to relocate these people back into Chad. From personal observations of the behavior of Chadian nationals in Aouk-Aoukalê, they appear to believe that the land on which they reside is part of the Republic of Chad, and the longer their presence remains uncontested, the more difficult the relocation process will become.

In the 1950's, the French colonial government benevolently donated a grazing area north of Birao to herders to keep livestock out of St. Floris and Aouk-Aoukalé. Due to climatic changes and the effects of livestock overgrazing, however, the designated area can no longer provide sufficient forage for the increasing number of livestock. The recognition of this trend is important. Not only are livestock utilizing an increasing large area of the CAR, but also their use is having a detrimental effect on the vegetation. While the benefits to the Kreich of Sudan and the Helmat Arabs of Chad are obvious, one must analyze the economic benefit of this activity to the Central African people. Are the adverse ecological effects of livestock husbandry offset by real political and economic benefits to the CAR? In answering this important question, one should analyze the number of foreign cattle and sheep using the northern region that are sold and consumed in the CAR, the amount of trade (not including livestock) generated by the presence of the herders, and the political implications relating to the stability of the region. Preliminary indications suggest that foreign livestock husbandry has an overall negative effect on this region in particular and to the CAR in general.

On a world-wide basis, the productivity of rangelands has been greatly reduced as the result of rampant overutilization by domestic livestock. In most cases, controls were instituted after the range resource had been severely, and perhaps irreversably, damaged. Unless the northern grazing region of the CAR is to suffer the same fate, some regulatory measures must be instituted that will limit the number of cattle entering the country to a level commensurate with the grazing capacity of the range area. The Ministry of Agriculture and Husbandry should regulate livestock use in this sector to 1) protect range areas from overuse, 2) provide northern towns and villages with a more stable supply of meat, and 3) provide better veterinary control of livestock entering the CAR. A successful government grazing control program would scale down the problem of surveillance in St. Floris and adjoining protected areas.

While government regulation is a necessary step in the control of the livestock problem, surveillance measures will be the most important deterrent to illegal grazing in national parks and reserves in the near future. The effectiveness of this surveillance will, in turn, reinforce government grazing regulations. However, at present the problem is acute due to the great number of cattle involved, the refusal of herders to recognize the laws governing grazing in protected areas, and the logistics problem involved in surveillance. Livestock was successfully controlled in St. Floris during the 1950's when manpower and materials (vehicles, arms, and ammunition) were in greater supply. Obviously, an increase in the number of adequately supplied game guards and the construction of a well-distributed network of roads, are essential to an effective control program. Another major protection problem pertains to dealing with livestock when encountered in protected areas. Four proposals previously presented to the CAR government are reviewed in Barber et al. (1977). While the most universally used policy in the past has been the shooting of livestock (in accordance with present statutes: law 62/333 of December 7, 1962), the possibility of confiscating entire herds should be given consideration.

While livestock control and the relocation of villages would require a strong well-armed mobile unit, protection measures aimed at controlling fishermen and professional poachers could best be accomplished using foot patrols. Teams of two or three game guards, given the necessary arms and ammunition, should be assigned an itinerary for a systematic ground surveillance program. These teams should be especially active along rivers where human activity is greatest.

IV. 4 STAFF, TRANSPORT, AND EQUIPMENT

The present levels of staff, transport, and equipment are insufficient to adequately protect and manage St. Floris. While the transport and equipment problems can be ameliorated by allocation or purchase, the problem of staff living and working conditions is more complex. The FAC St. Floris project has completed construction of four guard houses in Gordil and three in Mélé thereby increasing the lodging facilities to accomodate eight families in Gordil and five in Mélé. Under present conditions, a force of 12 game guards would appear sufficient for the eastern sector of the park. Although the lodging problem has been somewhat resolved, poor living and working conditions create an unhealthy working environment in both villages. This problem is basically twofold:

1) Local villagers will no longer sell food to game guards. This is due to the resentment against recent more-diligent enforcement of regulations prohibiting fishing in the park. This lack of cooperation by local residents has made it impossible to maintain a security force during the wet season.

2) Game guards are paid less frequently than their counterparts in Bangui and they also perceive that due to their remoteness from

the capital, opportunities for advancement are relatively poor. These game guards feel that their work is not considered of great importance by the CAR government as is manifest by the lack of a budget for the management of St. Floris and particularly the insufficient supply of arms and ammunition. Even the most dedicated and enthusiastic team of game guards becomes apathetic when they realize that they are not being adequately supported.

At times in the 1950's, stocks of food were delivered to park personnel during the wet season and vehicles, guns, and ammunition were in greater supply. Presently, food and materials are insufficient and park staff moral is extremely low. Most anti-poaching operations are launched with the intent of procuring food for the park staff.

The following recommendations are given regarding staff, transport, and equipment for the protection and management of St. Floris:

1) A Conservator/Chef de Cantonnement should be appointed to the park headquarters and be responsible for the management and protection of Manovo-Gounda-St. Floris.

2) The number of game guards assigned to the St. Floris sector should be commensurate with the ability of the CAR government to furnish supplies to them especially during the wet season.

3) Game guards should be supplied with sufficient arms and ammunition to effectively perform their patrol duties.

4) A guard camp should be located on the Gounda river north of the Goro and three to four guards should be assigned to patrol the western sector of St. Floris.

5) At least one 4-wheel drive vehicle should be provided to the Conservator on a permanent basis along with sufficient fuel, oil,

and parts.

6) The maintenance of park roads requires a minimum of one road grader in good condition. In order to lay down laterite and perform other miscellaneous tasks, one dump truck and a front loader would also be necessary. Sufficient fuel, oil, parts, drivers, and mechanics must be provided to keep this equipment operating.

The above recommendations represent the minimum requirements necessary to manage St. Floris on a short term basis. If development programs are successful, the number of staff, vehicles, and equipment should be increased proportionally.

The surveillance of such a large protected area would be enhanced by the use of an aircraft. Aerial observation would aid in the location of cattle herds and villages, and in the study of seasonal movements of large mammals. The utilization of an airboat during the wet season would have a deterrent effect on illegal fishing which is most prevalent during high water conditions. Airboats provide a high degree of mobility in shallow water while inflicting minimal damage to aquatic vegetation.

IV. 5 HABITAT MANAGEMENT, FIRE POLICY

Fire is the principal habitat management tool available to the park manager. Burning has a direct modifying effect on the vegetation. Succession is maintained at a specific seral stage in areas subject to periodic fires. The effects tend to vary depending on the season of the burn and the vegetative community involved. Generally hot (late season) fires are detrimental to woody vegetation and early burns have a debilitating influence on perennial grasses which have not completely relocated food reserves from the leaves to the roots. Fire, therefore, should be managed with utmost care and respect.

The establishment of a burning plan for St. Floris is greatly complicated by the fact that most fires are set by those illegally using the park. Thus, without control of where and when fires are set, a comprehensive fire management program is impossible to implement. With the impetus of successful protection measures, however, a more sophisticated program could be undertaken based on the following considerations (adapted from Koster 1978):

1) Burning should be conducted only to perform a specific task. Frequent and uncontrolled fires are not in the best interest of the vegetation and wildlife that depend on plant communities.

2) Each vegetation community should be given special consideration and a specific burning policy.

3) Since much of the park burns uncontrollably, efforts should be made, where possible, to limit the extent of burns.

4) Unburnt areas should be left throughout the park in all vegetation types.

5) Early burning is necessary for game viewing and should be undertaken in the vicinity of roadways when favorable conditions permit. A certain rotation is necessary because, while certain herbivores are benefited by burning, it destroys the food resources of others.

6) No burning should be conducted in areas subject to erosion or overgrazing.

The vegetation of St. Floris is sparse and there is no need to institute late burns to open dense areas. Burning should take place immediately after grasses dry with the objective of forming a mosaic. This would provide a more stable food supply for herbivores as well as control an extensive burn later in the dry season. All fires should be set by park personnel. The area of burning could be reduced by setting fires late in the afternoon when winds are lightest and humidity is greatest.

Burning either early or late has a detrimental effect on the dry forest vegetation type and a conscious effort should be made to protect these areas from fire. It should be borne in mind that the dry forest, in addition to being esthetically pleasing to humans, is the preferred habitat for several primates (especially tantalus and colobus monkeys). Continued burning would reduce the habitat for these primates and other animals and plants common to this community.

IV. 6 TOURISM

IV. 6. 1 Generalities

The development of tourism in St. Floris is justified both by the number and diversity of indigenous wildlife and the general open aspect of the vegetation which facilitates game viewing and photography. Most tourists visiting the park in 1977 and 1978 were favorably impressed by what they observed and several returned on subsequent occasions to the Gounda and St. Floris. There are, however, three important constraints to the development of mass tourism which must be kept in mind.

The first pertains to the length of the tourist season. Seasonal flooding and high grass prevents game viewing during the period July to January. Plains areas only become convenient for tourism beginning in mid-February following the burning of the high grass which impedes animal observation. With the enlargement of the park to include more southern areas, viewing at the Koumbala, Goumba, and Sakala could become the focal point of tourism in late December and January. St. Floris would supplement these areas later in the dry season. The tourist season could also be prolonged if roads were correctly constructed.

The second constraint to mass tourism is the lack of infrastructure and organization needed to transport and accomodate tourists. Here it is important to separate the international from the local tourist. International tourists generally have no previous experience in the CAR and they are not cognizant of the realities of life in the country. For this reason, they depend heavily on a well-organized program enhanced by the courteous assistance of tourist guides. For a better insight into this situation, one should observe how the sport hunting firms in the CAR receive and assist hunters throughout their stay. In Kenya there are special training centers to train tourist guides how best to cater to the international tourist. For this reason, and the fact that Kenya possesses a rich and well-managed national park system, the tourist industry is flourishing. There, tourists are received and conducted during their stay with utmost efficiency and ease. Most visitors to the national parks of the CAR in recent years are local tourists who live and work in the country. They are accustomed to life in the CAR and the infrastructure needed for this group is much less extensive than for the international tourist. The number of local tourists is small and one should not expect the establishment of a lucrative tourist industry based solely on this group. The development of a viable tourist industry, therefore, is dependent upon attracting the international tourist.

The third constraint to the development of tourism is logistics. St. Floris is 850 kilometers by road from the international airport in Bangui and the present poor state of access roads to the park precludes the development of mass international class tourism based on ground transportation. Even if roads were vastly improved, the distance involved and the lack of facilities (hotels and restaurants) and scenic interests along the route would do little to improve the situation. Under present conditions, one should consider flying tourists to and from the park which would necessitate well-organized and dependable flights of international standards.

Tourism in the CAR has never been a major industry and St. Floris has undoubtedly recieved less than 1000 tourists in its 47 year history. For this reason, the reception services for tourists are poorly developed in the north. Relations between tourists and local officials (Gendarmes and Eaux et Forêts personnel) were the most common complaints from those visiting St. Floris during the past two years. There were several incidents in 1977, where tourists were forbidden from taking photographs by local officials. In 1978 there were also several problems involving registration of tourists at the Gordil Gendarmarie and the necessity to possess a permit to visit the park. The intention here is not to blame those involved but to show how the lack of a clear policy regarding visitor use of the park may ultimately negate any attempts toward the development of tourism. Registration cards should be filled out when entering the park and a brochure with a map of park roads and regulatiions covering vehicle speed in the park, camping, off-road driving, photography, leaving the vehicle, etc. should be clearly stated. Tourists should be treated as guests and park personnel must be briefed on the best ways to fulfill their important duties, while at the same time creating a congenial atmosphere between themselves and visitors.

IV. 6. 2 Facilities

The present tourist facilities at Gordil and the Gounda are insufficient to accomodate an increased number of tourists. Additional tourist camps or hotels need to be constructed. There has been much discussion on the hotel site in St. Floris and five areas have been proposed: 1) Gata/Matoumara, 2) Gordil—near the Eaux et Forêts camp, 3) Vakaga radier, 4) Dongolo—on the site of the former camp, 5) Gounda—across the river from the present camp. Each of these sites has specific advantages and disadvantages and a decision should be based on the following criteria: 1) ease of year-around access, 2) incidence of flooding, 3) location in relation to existing facilities (air strips, roads, and tourist camps), 4) scenic nature of the site, 5) availability of a clean water supply, and 6) the detrimental effects that such a facility might have on the wildlife.

In general, tourist camps are best operated by private firms due to their access to investment capital and their greater efficiency. The CAR government should, therefore, encourage private capital investment toward the construction of hotels. These firms would become more encouraged if protection measures were improved and some clarification were given to management and development objectives. The CAR government should allow foreign firms to earn modest profits from their investments provided that the services rendered are of high quality and compatible with government regulations.

Many of the tourists recently visiting the Gounda and St. Floris were restricted in their movements because of a fuel shortage. If fuel were available either at the Gounda or the Koumbala camps, more tourists would be encouraged to visit the park.

IV. 6. 3 Improvement of game viewing

The present road system in Manovo-Gounda-St. Floris is insufficient to accomodate many tourists. There are few circuits and visitors are obliged to retrace their route in order to return to their point of departure. Several circuits are needed especially between St. Floris and the Gounda camp. One could follow the Bahr Kameur from Mada ngangou to the Gounda river, thence south to the Gounda ford along the eastern bank of the Gounda. A second possibility would be a track from the Vakaga river to Mare Arak and along the Youkouya to its intersection with the Dongolo-Gounda track. This track would provide good viewing during the early dry season and at the beginning of the wet season while being only marginal at the height of the dry season. A track should be constructed along the Bahr Kameur from Mada ngangou to Mêlê serving primarily for protective surveillance over the short term with the potential of becoming an important tourist track as protection measures succeed in guarding this region from poaching and livestock grazing.

Road construction in the park has generally been accomplished by dropping the blade of a road grader or bulldozer and driving forward forming a shallow trench. While this is the fastest and most economical means of creating a track, it is unusable by vehicles after a heavy rain. Game viewing in late May and June is inhibited more by the condition of the tracks than by any other reason. Water collects in the roadways and vehicular travel is brought to a standstill until they dry. The solution to this problem would be the construction of crowned roads on high ground. This is accomplished by using three passes of the grader instead of two. The grader blade should be inclined in order that the first and second passes move soil from the edge into the middle of the track and the third levels the center. This method was used, to some extent, in 1978 by the FAC St. Floris project and it should be continued. On the plains and in areas of impeded drainage, laterite has been used to cover roadways. Although it has been shown to be successful in permitting vehicle use when wet and inhibiting tracking of roads by hippopotami, buffaloes, and elephants in the wet season, it is expensive and time comsuming. For this reason, tracks on plains areas should be kept to a minimum: only in essential access areas or those of high tourist value. Initially the road should be constructed so that the crest is higher than the adjacent ground to permit drainage. The subsequent deposit of laterite would tend to lower the cost of yearly renovation in addition to extending vehicle use during May and June.

Presently there are few road signs in St. Floris and tourist needs would be better served by additional signs. Signs should be as inobtrusive as possible while providing the essential information (road name, distance, etc.). Road signs would complement a park map and each track should be named either after an animal that is commonly seen along it or after a geographical site to which it leads.

In order to diversify game viewing in Manovo-Gounda-St. Floris, the construction of miradors (observation huts or tree houses) should be considered near selected waterholes and salt licks. Placement should be made in areas that would not endanger normal use by wildlife and where visitor protection is ensured.

IV. 7 WILDLIFE MANAGEMENT IN SURROUNDING AREAS

St. Floris is, for the most part, bordered by protected areas. The establishment of an efficacious protection program and the development of infrastructure (roads and guard houses) in contiguous reserves would do much to enhance the status of wildlife in St. Floris. As there are few Central Africans living in these areas and conflicts with other human activities are minimal, the continuation of the protected status appears to be the most appropriate land-use policy.

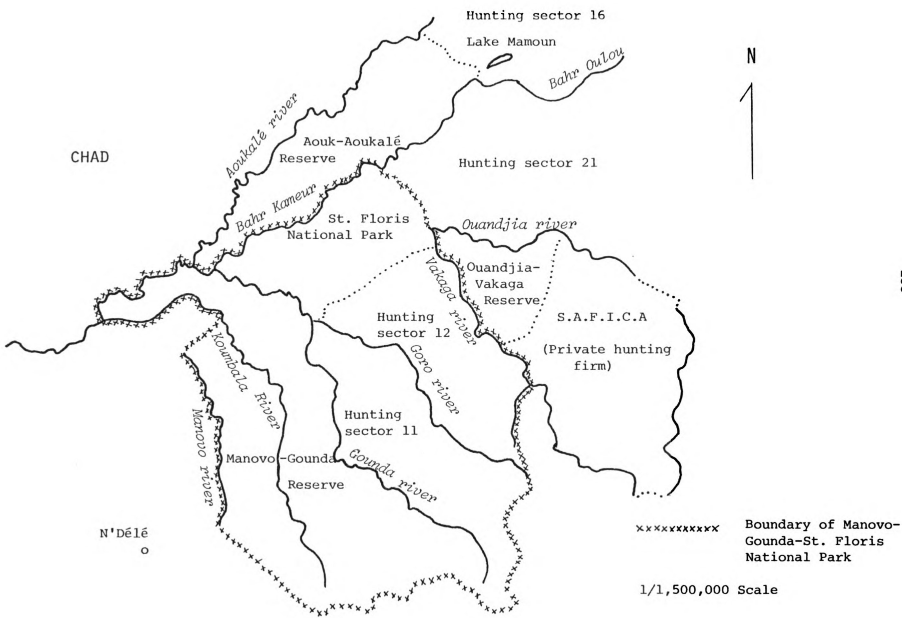
Spinage (1976) recommended the annexation of a part of Sector 21 (Figure 11), a large hunting sector east of Gordil and Mélé, to the present area of the park. Although, the rationale for protecting the wooded area directly east of Gata is sound, the extent of Sector 21 to be contained in St. Floris should be governed primarily by present patterns of human use, the ability to clearly delimit the boundaries, and the richness and diversity of wildlife using the area. It is doubtful whether a major portion of this sector should be annexed after consideration of the above criteria.

Very little sport hunting takes place in adjacent hunting sectors and its effect on the numbers and behavior of large mammals is minimal. One would hope that the policy of encircling national parks by reserves to form buffer zones will be continued. In addition to protecting the seasonal ranges of the more mobile large mammal species, visitors are able to view wildlife that are not made timid through the effects of sport hunting.

IV. 8 FURTHER STUDIES

While significant funds have been spent in recent years on scientific research projects in St. Floris and elsewhere, animal numbers in the CAR have continued to decline. As a result, wildlife research projects and foreign ecologists do not enjoy the support of those interested in the protection of natural areas and the development of tourism as little

Figure 11. Map of the Manovo-Gounda-St. Floris National Park showing adjacent areas important to the wildlife management of the region.


Hunting sector 16
Lake Mamoun
Bahr Oulou
N
Aoukalé river
Aouk-Aoukalé Reserve
CHAD
Hunting sector 21
Bahr Kameur
St. Floris National Park
Ouandjia river
Vakaga river
Ouandjia-Vakaga Reserve
S.A.F.I.C.A
(Private hunting firm)
Hunting sector 12
Goro river
Koumbala River
Hunting sector 11
Manovo river
Manovo-Gounda Reserve
Gounda river
N'Délé
xxxxxxxxxxx Boundary of Manovo-Gounda-St. Floris National Park
1/1,500,000 Scale

has been accomplished to counteract the illegal exploitation of national parks and reserves. Research, in itself, can not and will not directly reverse this trend. However, put into its proper perspective, scientific research does play an integral role in the development and management of national parks. Initiatives based on the findings of well-implemented research projects have a greater possibility of successfully fulfilling the desired goals. Not only is such knowledge necessary for planning purposes, but also it is generally required in some form by funding and supervisory agencies. Research is an especially crucial requirement where considerable sums of money are involved.

This work is intended to provide much of the basic ecological information for the management and development of St. Floris. While an assessment of several of the important physical and biotic factors are included herein, the ecology of St. Floris remains poorly understood. It is unnecessary, however, to postpone development and management initiatives, especially at this critical stage, until a more complete understanding of the park's ecology is attained. There are, however, two important studies that should be undertaken because of their far-reaching implications to the park's ecosystem. The first entails the mapping of the distribution patterns of the important large mammals in the St. Floris region in order to protect, to the extent possible, the seasonal ranges of these species. The use of an aircraft and some form of animal marking or radio telemetry will probably prove necessary. In addition to the great expense involved in a project of this nature, the complex technology will necessitate the use of a foreign ecologist to direct the research. The second study consists of an analysis of the livestock problem in the northeast. An assessment of present range conditions, the number of cattle and sheep that enter or exit the country, inspection and immunization of the herds, and the economic benefits of livestock husbandry to the CAR should be included in this analysis. A Central African in the Direction of Husbandry with the assistance of an international range manager could conduct this study. The total cost of this project would probably not be excessive.

While the two above studies have important and far-reaching implications to the future of St. Floris, several other studies of lower priority should be conducted:

1) Road-strip counts should be continued in order to monitor population changes in response to protection measures.

2) The vigor and trend of perennial grasses throughout the park should be examined with special emphasis given to those on areas adjacent to high hippopotamus concentrations.

3) A system for long-term evaluation of the vegetation should be set up. This could be done by establishing permanent transects or quadrats located in areas representative of the major vegetation types.

4) A study aimed at assessing the influence of fire on the vegetation of St. Floris should be conducted. This study should evaluate the effects of fire in as many vegetation communities as possible.

5) The species lists of plants and animals should be completed.

6) Climatological data should be gathered on a regular basis at one or more sites in the park.

IV. 9 CONCLUSION

The protection and development of the Manovo-Gounda-St. Floris National Park is justified based on its unique nature and the positive potential for the development of tourism. The park is situated in a region of Africa that has exhibited a precipitous decline in faunal diversity and abundance, and many species now face imminent local extermination. The wildlife in Manovo-Gounda-St. Floris is, however, both rich and diverse and animal and plant species indigenous to the Guinea or Sudan savanna zones are well-represented. Given adequate protection in the future, these populations should continue to thrive. The tourism potential is further enhanced by the park's relative large size; the open aspect of the vegetation which facilitates game viewing; and the presence of two picturesque waterfalls, numerous unique rock formations, and several yet undated cave paintings. Moreover, this park has an established infrastructure of guard houses, roads, airstrips and tourist camps that exceeds any other public natural area in the nation. For these reasons, the park has significant potential and importance to merit a serious and concerted effort to concerve and develop. The Central African government should, therefore, award this park top priority in the northern sector of the CAR.

It is obvious that the development and protection of Manovo-Gounda-St. Floris faces some rather monumental problems. In addition to specific difficulties unique to the park, such as logistics, a poorly developed infrastructure, and large size, the problem is further coumpounded by the country's poor economic state and the lack of a public realization of the merits of protecting natural ecosystems. If present trends continue, not only will several species of large mammals become exterminated, but also wildlife numbers will decline dramatically in the CAR in the near future. The magnitude of the loss may not be immediately realized, but the destruction of the natuve fauna as a result of a policy of benign neglect has been shown to have important future economic and social repercussions. One must view the merits of protecting natural ecosystems with a long term perspective as the value of these areas generally increases as development proceeds. Today's measures will be appreciated most by future generations of Central Africans who will be able to take advantage of the economic, cultural, and recreational values inherent to national parks.

The possibility of success in this endeavor remains in spite of numerous difficulties, and the foresight and generosity of the French government in financially supporting the development and protection of national parks and reserves is both significant and commendable. Moreover, there is a realization of the importance of national parks in the Ministry of Eaux et Forêts, and given the necessary funds and organization, an efficacious program of protection and development could eventially be successful. It will take, however, the most diligent and coordinated efforts of all those agencies, both public and private, and personnel involved in order to realize the goal of maintaining and developing one of the most significant national parks in Central Africa.

APPENDICES

APPENDIX A

List of mammals identified in the St. Floris National Park.[1]

CHIROPTERA

Micropteropus pusillus (Peters, 1867)	Dwarf epauletted fruit-bat
Nycteris huspida (Schreber, 1775)	Hairy slit-faced bat
Lavia frons (E. Geoffroy, 1810)	Yellow-winged bat
Hipposideros commersoni (de Tarragon) *gigas* (Wagner, 1845)	Commerson's leaf-nosed bat
Eptesicus sp.	Serotine bat

PRIMATES

Papio anubis J. B. Fischer, 1829	Olive or doguera baboon
Cercopithecus patas (Schreber, 1774)	Patas monkey
C. tantalus Ogliby, 1841	Tantalus monkey
Colobus guereza Rüpell, 1835	Colobus monkey
Galago senegalensis E. Geoffroy, 1796	Lesser galago

PHOLIDOTA

Manis gigatea Illiger, 1815	Giant ground pangolin

LAGOMORPHA

Poelagus sp. or *Lepus* sp.	Hare

RODENTIA

Thryonomys swinderianus (Temminck, 1827)	Cane rat
Hystrix cristata Linnaeus, 1758	Crested porcupine
Arvicanthis niloticus (Demarest, 1822)	Nile rat
Dasymps sp.	Shaggy rat
Lemniscomys sp.	Spotted grass mouse
Praomys daltoni (Thomas, 1892)	"Dalton's mouse"
Praomys sp.	Multimammate rat
Heliosciurus gambianus (Ogilby, 1822)	Gambian sun squirrel
Xerus erythrops E. Geoffroy, 1803	Geoffroy's ground squirrel
Tatera robusta (Cretzschmar, 1826)	Fringe-tailed gerbil

CARNIVORA

Lycaon pictus (Temminck, 1820)	Hunting dog
Canis adustus Sundevall, 1846	Side-striped jackal
C. aureus Linnaeus, 1758	Asiatic jackal
Mellivora capensis (Schreber, 1776)	Ratel
Vivera civetta (Schreber, 1778)	African civet

[1] Nomenclature follows Meester and Setzer (1971)

Genetta sp.	Genet
Herpestes ichneumon (Linnaeus, 1758)	Egyptian mongoose
H. sanguineus (Rüppell, 1835)	Slender mongoose
Ichneumia albicauda (G. Cuvier, 1829)	White-tailed mongoose
Mungos mungo (Gmelin, 1788)	Banded mongoose
Crocuta crocuta (Erxleben, 1777)	Spotted hyaena
Acinonyx jubatus[2] (Schreber, 1776)	Cheetah
Panthera leo (Linnaeus, 1758)	Lion
P. pardus (Linnaeus, 1758)	Leopard
Felis libyca Forster, 1780	Wild cat
F. serval Schreber, 1776	Serval

TUBULIDENTATA

Orycteropus afer[3] (Pallas, 1766)	Aardvark

PROBOSCIDAE

Loxodonta africana (Blumenback, 1797)	African elephant

PERISSODACTYLA

Diceros bicornis[3] (Linnaeus, 1758)	Black rhinoceros

ARTIODACTYLA

Phacochoerus aethiopicus (Pallas, 1766)	Wart hog
Hippopotamus amphibius Linnaeus, 1758)	Hippopotamus
Giraffa camelopardalis (Linnaeus, 1758)	Giraffe
Syncerus caffer (Sparrman, 1779)	African buffalo
Tragelaphus scriptus Pallas, 1766	Bushbuck
Taurotragus derbianus (Gray, 1847)	Giant eland
Cephalopus rufilatus Gray, 1846	Red-flanked duiker
Sylvicapra grimmia (Linnaeus, 1758)	Grimm's duiker
Redunca redunca (Pallas, 1777)	Bohor reedbuck
Kobus ellipsiprymnus (Ogilby, 1833)	Waterbuck
K. kob (Erxleben, 1777)	Kob
Hippotragus equinus (Demarest, 1804)	Roan antelope
Alcelaphus buselaphus (Pallas, 1766)	Hartebeest
Damaliscus lunatus (Burchell, 1823)	Korrigum, Topi
Ourebia ourebi (Zimmerman, 1783)	Oribi
Gazella rufifrons Gray, 1846	Red-fronted gazelle

[2] Species was not seen inside park but was observed on an adjacent area.
[3] Presence based on tracks.

APPENDIX B

List of birds identified in the St. Floris National Park.[1]

STRUTHIANIDAE	
Struthio camelus Linnaeus	Ostrich
PHALACROCORACIDAE	
Phalacrocoras africanus (Gmelin)	Long-tailed cormorant
Anhinga rufa (Lacēpède & Daudin)	Darter
PELICANIDAE	
Pelecanus onocrotalus Linnaeus	White pelican
P. rufescens Gmelin	Pink-backed pelican
ARDEIDAE	
Ardea cinera Linnaeus	Grey heron
A. melanocephala Vogous & Children	Black-headed heron
A. goliath Cretzschmar	Goliath heron
Pyrrherodia purpurea (Linnaeus)	Purple heron
Casmerodius albus (Linnaeus)	Great white egret
Egretta garzetta (Linnaeus)	Little egret
Bubuleus ibis (Linnaeus)	Cattle egret
Ardeola ralloides (Scopoli)	Squacco heron
Nycticorax nycticorax (Linnaeus)	Night heron
Ixobrychus minutus (Linnaeus)	Little bittern
Ardeirallus sturmii (Wagler)	Dwarf bittern
SCOPIDAE	
Scopus umbretta Gmelin	Hammerkop
CICONIIDAE	
Ciconia ciconia (Linnaeus)	White stork
Disoura episcopus (Boddaert)	Woolly-necked stork
Sphenorynchus abdimii (Lichtenstein)	Abdims stork
Anostomus lamelligerus Temminck	Open-bill
Ephippiorhynchus senegalensis (Shaw)	Saddle-bill stork
Leptoptilus crumeniferus (Lesson)	Marabou
Ibis ibis (Linnaeus)	Wood ibis

[1] Nomenclature follows Mackworth-Praed and Grant (1970, 1973).

PLATALEIDAE

Threskiornis aethiopicus (Latham)	Sacred ibis
Hagedashia hagedash (Latham)	Hadada
Plegodis falcinellus (Linnaeus)	Glossy ibis
Platalea alba Scopoli	African spoonbill

ANATIDAE

Anas crecca Linnaeus	Teal
Dendrocygna viduata (Linnaeus)	White-faced tree duck
Nettapus avritus (Boddaert)	Pigmy goose
Sarkidiornis melanotos (Pennant)	Knob-billed goose
Alopochen aegyptiacus (Linnaeus)	Egyptian goose
Plectropterus gambensis (Linnaeus)	Spur-winged goose

SAGITTARIIDAE

Sagittarius serpentarius (Miller)	Secretary bird

FALCONIDAE

Gyps rupellii (Brehm)	Rüppel's griffon
Pseudogyps africanus (Salvadori)	White-backed vulture
Torgos tracheliotus (Forster)	Lappet-faced vulture
Trigonoceps occipitalis (Burchell)	White-headed vulture
Necrosyrtes monachus (Temminck)	Hooded vulture
Falco biarmicus Temminck	Lanner falcon
Milvus migrans (Boddaert)	Black kite
Elanus caeruleus (Desfontaines)	Black-shouldered kite
Hieraaetus spilogaster (Bonaparte)	African hawk-eagle
Polemaetus bellicousus (Daudin)	Martial eagle
Lophoeatus occipitalis (Daudin)	Long-crested hawk-eagle
Circaetus cinereus Vieillot	Brown harrier-eagle
C. pectoralis Smith	Black-chested harrier-eagle
C. cinerascens Müller	Banded harrier-eagle
Butastur rufipennis (Sundevall)	Grasshopper buzzard
Terathopius ecaudatus (Daudin)	Bateleur
Cumcuma vocifer (Daudin)	Fish eagle
Buteo auguralis Salvadori	Red-necked buzzard
Micronisus gabar (Daudin)	Gabar goshawk
Melierax metabates Heuglin	Dark chanting goskawk
Circus pygargus (Linnaeus)	Montagu's harrier
C. macrourus (Gmelin)	Pale harrier
C. aeruginosus (Linnaeus)	Marsh harrier
Polyboroides radiatus (Scopoli)	Harrier-hawk

PHASIANIDAE

Francolinus clappertoni Children	Clapperton's francolin
Ptilopachus petrosus (Gmelin)	Stone-partridge
Numida meleagris (Linnaeus)	Guinea-fowl

RALLIDAE

Limnocorax flavirostra (Swainson)	Black crake

BALEARICIDAE

Balearica pavonian (Linnaeus)	Crowned crane

OTIDIDAE

Neotis denhami (Children)	Denham's bustard
Lissotis melanogaster (Rüppell)	Black-bellied bustard

BURHINIDAE

Burhinus senegalensis (Swainson)	Senegal thicknee
B. capensis (Lichtenstein)	Spotted thicknee
B. vermiculata (Cabanis)	Water thicknee

JACANIDAE

Actophilornis africanus (Gmelin)	Lily trotter

CHARADRIIDAE

Charadrius dubius Scopoli	Little ringed plover
Hoplopterus spinosus (Linnaeus)	Spur-winged plover
Hiphidiopterus albiceps (Gould)	White-headed plover
Afribyx senegallus (Linnaeus)	Wattled plover
Himantopus himantopus (Linnaeus)	Black-winged stilt

ROSTRATULIDAE

Rostratula benghalensis (Linnaeus)	Painted snipe

SCHOLOPACIDAE

Tringa hypoleucos Linnaeus	Common sandpiper
T. nebularia (Gunnerus)	Greenshank

GLAREOLIDAE

Cursorius temminckii Swainson	Temminck's courser
Glareola prantincola (Linnaeus)	Pratincole

PLUVIANIDAE

Pluvianus aegyptius (Linnaeus)	Egyptian plover

LARIDAE

Chlidonias leucoptera (Temminck)	White-winged black tern
Rhynchops flavirostris Vieillot	African skimmer

PTEROCLIDIDAE

Pterocles exustus Temminck & Langier	Chestnut-bellied sandgrouse
Eremialector guadricinctus (Temminck)	Four-banded sandgrouse

COLUMBIDAE

Columba guinea Linnaeus	Speckled pidgeon
Streptopelia semitorquata (Rüppell)	Red-eyed dove
S. vinacea (Gmelin)	Vinaceous dove
Oena capensis (Linnaeus)	Namaqua dove
Turtur abyssinicus (Sharpe)	Black-billed blue-spotted wood dove
Teron waalia (Meyer)	Bruce's green pidgeon

CUCULIDAE

Cuculus canorus Linnaeus	Cuckoo
Clamator glandarius (Linnaeus)	Great spotted cuckoo
C. jacobinus (Boddaert)	Black and white cuckoo
Chrysococcyx caprius (Boddaert)	Didric cuckoo
Centropus senegalensis (Linnaeus)	Senegal coucal

MUSOPHAGIDAE

Musophaga violacea Isert	Violet turaco
Crinifer piscator (Boddaert)	Grey plantain-eater

PSITTACIDAE

Poicephalus meyeri (Cretzschmar)	Brown parrot
Psittacula krameri (Scopoli)	Rose-ringed parakeet
Agapornis pullaria (Linnaeus)	Red-headed lovebird

CORACIIDAE

Coracias abyssinica Hermann	Abyssinian roller
Eurystomus glaucurus (Müller)	Broad-billed roller

ALCEDINIDAE

Ceryle rudis (Linnaeus)	Pied kingfisher
Megaceryle maxima (Pallas)	Giant kingfisher
Corythornis cristata (Pallas)	Malachite kingfisher
Ispidina picta (Boddaert)	Pigmy kingfisher
Halcyon malimbicus (Shaw)	Blue-brested kingfisher
H. leuvovephalus (Müller)	Grey-headed kingfisher
H. chelicuti (Stanley)	Striped kingfisher

MEROPIDAE

Merops superciliosus Linaeus *pericus* Pallas	Blue-cheeked bee eater
M. orientalis Latham	Little green bee eater
M. nubicus Gmelin	Carmine bee eater
Melittophagus pusillus (Müller)	Little bee eater
M. bulocki (Vieillot)	Red-throated bee eater
Bombylonax breweri (Cassin)	Black-headed bee eater

BUCEROTIDAE

Tockus nasutus (Linnaeus)	Grey hornbill
T. erythrorhynchus (Temminck)	Red-billed hornbill
Bucorvis abyssinicus (Boddaert)	Abyssinian ground hornbill

UPUPIDAE

Upupa erops Linnaeus	Hoopoe

PHOENICULIDAE

Phoeniculus purpureus (Müller)	Green wood-hoopoe
Scoptelus aterrimus (Stephens)	Black wood-hoopoe

STRIGIDAE

Tyto alba (Scopoli)	Barn owl
Otus scops (Linnaeus)	Scops owl
O. leucotis (Temminck)	White-faced scops owl
Glaucidium perlatum (Vieillot)	Pearl-spotted owlet
Bubo africanus (Temminck)	Spotted eagle-owl

CAPRIMULGIDAE

Macrodipteryx longipennis (Shaw)	Standard-winged nightjar
Semeiophorus vexillarius Gould	Pennant-winged nightjar
Scotornis climacurus (Vieillot)	Long-tailed nightjar

TROGONIDAE

Apaloderma narina (Stephens)	Narina's trogon

CAPITONIDAE

Lybius rolleti (Defilippi)	Black-breasted barbet
L. leucocephalus (Defilippi)	White-headed barbet
L. vieilloti (Leach)	Vieillot's barbet

INDICATORIDAE

Indicator indicator (Sparrman)	Black-throated honey guide

PICIDAE

Campethera punctuligera (Wagler)	Fine-spotted woodpecker
Mesopicos goertae (Müller)	Grey woodpecker

ALAUDIDAE

Mirafra cantillans Blyth	Singing bush lark
Pinarocorys erythropygia (Strickland)	Red-tailed bush lark

MONTICILLIDAE

Budythes sp.	Yellow wagtail
Montacilla caspica Gmelin	Grey wagtail
M. alba Linnaeus	White wagtail
Anthus novaeseelandiae Gmelin	Richard's pipit

TIMALIIDAE

Turdoides pledeja (Cretzschmar)	Brown babbler

PYCNONOTIDAE

Pycnonotus tricolor (Hartlaub)	Dark-capped bulbul

MUSCICAPIDAE

Alseonax aquaticus (Heuglin)	Swamp flycatcher
Melaenornis edolioides (Swainson)	Black flycatcher
Batis orientalis (Heuglin)	Grey-headed puff-backed flycatcher
Platysteira cyanea (Müller)	Wattle-eye
Tchitrea viridis (Müller)	Paradise flycatcher

TURDIDAE

Oenathe heuglini (Finsch & Hartlaub)	Heuglin's red-breasted wheatear
Cossypha heuglini Hartlaub	White-browed robin-chat
C. cyanocampter (Bonaparte)	Blue-shouldered robin-chat
C. niveicapilla (Lafresnaye)	Snowy-crowned robin-chat
Phoenicurus phoenicurus (Linnaeus)	Redstart

SYLVIIDAE

Sylvietta brachyura Lafresnaye	Crombec
Camaroptera brevicaudata (Cretzschmar)	Grey-backed cameroptera
Prinia subflava (Gmelin)	Tawny-flanked prinia

HIRUNDINIDAE

Hirundo aethiopica Blandord	Ethiopian swallow
H. smithii Leach	Wire-tailed swallow
Riparia paludicola (Vieillot)	African sand martin

CAMPEPHAGIDAE

Campephaga phoenicea (Latham) — Red-shouldered cuckoo-shrike

Coracina pectoralis (Jardine & Selby) — White-breasted cuckoo-shrike

DIDRURIDAE

Dicrurus adsimilis (Bechstein) — Drongo

PRIONOPIDAE

Prionops cristata Rüppell — Curly-crested helmet shrike

LANIIDAE

Nilaus afer (Latham) — Northern brubru
Lanius elegans Swainson — Grey shrike
L. nubicus Lichtenstein — Masked shrike
L. senator Linnaeus — Woodchat shrike
Laniarius erythrogaster (Cretzschmar) — Black-headed gonolek
Dryoscopus gambensis (Lichtenstein) — Puff-back
Chlorophoneus bocagei (Reichenow) — Grey bush-shrike

PARIDAE

Parus leucomelas Rüppell — Black tit

ORIOLIDAE

Oriolus auratus Vieillot — African golden oriole

CORVIDAE

Corvus albus Müller — Pied crow

STURNIDAE

Lamprocolius purpureus (Müller) — Purple glossy starling
Lamprotornis caudatus (Müller) — Long-tailed glossy starling

Buphagus africanus Linnaeus — Yellow-billed oxpecker

ZOSTEROPIDAE

Zosterops senegalensis Bonaparte — Yellow-white eye

NECTARINIIDAE

Nectarinia pulchella (Linnaeus) — Beautiful sunbird
Hedydipna platura (Vieillot) — Pygmy sunbird
Chalcomitra senegalensis (Linnaeus) — Scarlet-chested sunbird
Anthreptes longuemarei (Lesson) — Violet-backed sunbird

PLOCEIDAE

Plocepasser supercilious (Cretzschmar)	Chestnut-crowned sparrow weaver
Petronia xanthosterna (Bonaparte)	Yellow-spotted petronia
P. dentata (Sundevall)	Bush petronia
Ploceus cucullatus (Müller)	Black-headed village weaver
P. vitellinus (Lichtenstein)	Vitelline masked weaver
Sitagra luteola (Lichtenstein)	Little weaver
Quelea quelea (Linnaeus)	Red-billed quelea
Euplectes hordeacea (Linnaeus)	Black-winged red-bishop
E. afra (Gmelin)	Yellow-crowned bishop
Lonchura cucullata (Swainson)	Bronze mannikin
Pytilia phoenicoptera Swainson	Red-winged pytilia
P. melba (Linnaeus)	Green-winged pytilia
Lagonosticta senegala (Linnaeus)	Red-billed fire-finch
L. larvata (Rüppell)	Black-faced fire-finch
Estrilda caerulescens (Vieillot)	Red-tailed lavender waxbill
E. troglodytes (Lichtenstein)	Black-rumped waxbill
E. paludicola Heuglin	Fawn-brested waxbill
Uraeginthus bengalus (Linnaeus)	Red-cheeked cordon bleu
Hypochera funerea (de Tarragon) *wilsoni* Hartert	Dusty indigo-bird
Vidua macroura (Pallas)	Pin-tailed whydah
Steganura orientalis (Heuglin)	Broad-tailed paradise whydah

FRINGILLIDAE

Serinus leucopygius (Sundevall)	White-rumped seed-eater

EMBERIZIDAE

Emberiza cia Linnaeus	Rock bunting

APPENDIX C

List of reptiles identified in the St. Floris National Park.

CHILONIA[1]	
Testudo sulcata Gmelin	African spurred tortoise
Trionyx triunguis Forskal	Nile soft-shelled turtle
CROCODILIA[1]	
Crocodylus niloticus Laurenti	Nile crocodile
SQUAMATA[2]	
Varanus niloticus (Linnaeus)	Nile monitor lizard
Agama agama (Linnaeus)	Red-headed agama
Python sebae (Gmelin)	African python
Psammophis sp.	Grass snake
Naja nigricollis Reinhardt	Spitting cobra
Pseudohaje nigra Günther	Hoodless cobra
Dendroaspis viridis (Hallowell)	Green mamba
Bitis arietans (Meerem)	Puff adder

[1] Nomenclature follows Villiers (1958).
[2] Nomenclature follows Villiers (1963) and Cansdale (1955).

APPENDIX D

List of fish identified in the St. Floris National Park.[1]

OSTEOGLOSSIDAE

Heterotis niloticus (Cuvier, 1829)

MORMYRIDAE

Hyperopisus sp.
Mormyrus sp.

GYMNARCHIDAE

Gymnarchus niloticus Cuvier, 1829

TETRAODONTOIDEA

Tetraodon fahaka Linnaeus *strigosus* (Bennett, 1834)

CHARACIDAE

Alestes macrolepidotus (Cuvier & Valenciennes, 1869)
Hydroycyon forskali Cuvier, 1819
H. sp.

CITHARINIDAE

Citharinus citharus Geoffroy Saint-Hilaire, 1909
Distichodus brevipinnis Günther, 1864

CYPRINIDAE

Labeo lereensis Blache & Miton 1960
L. sp.

BAGRIDAE

Auchenoglanis biscutatus Geoffroy Saint-Hilaire, 1827
Bagrus bayad Forskal *bayad* (Forskal, 1775)
Clarotes laticeps (Rüpp, 1829)
C. macrocephalus Daget, 1954

CLARIIDAE

Clarias lazera Cuvier & Valenciennes, 1840

[1] Nomenclature follows Blache (1964).

MOCHOCIDAE

Synodontis gambiensus Günther *latifrons* n. spp.

MALAPTERURIDAE

Malapterurus electricus (Gmelin, 1789)

SERRANIDAE

Lates niloticus (Linnaeus, 1762)

CICHLIDAE

Tilapia galilaea (Artedi, 1757)
T. nilotica (Linnaeus, 1757)

ORHICEPHALIDAE

Ophicephalus obscurus Günther, 1861

POLYPTERIDAE

Polypterus endlicheri Heckel *endlicheri* Heckel, 1849

LEPIDOSICENIDAE

Protopterus annectens (Owen, 1839)

APPENDIX E

Vascular plants identified in the St. Floris National Park.[1]

The column vegetation type gives the general habitat of the species:

1) Open savanna woodland
2) Dry forest
3) Laterite shields (shallow soil over indurated ironstone)
4) Flooded plains
5) Lowland savanna of impeded drainage
6) Aquatic (at least 6 months of the year)

+ Abundance
- Presence
T Indicates that the plant is indigenous to termitaria

Vegetation type	1	2	3	4	5	6	Notes
MONOCOTYLEDONS							
AGAVACEAE							
Sansevieria liberica Ger. & Labr.		-/T			T		
AMARYLLIDACEAE							
Crinum distichum Herb.				-	+		
C. sp.			+				
Haemanthus multiflorus Martyn	T	+	T		T		
H. sp.							4527[2]
Pancratium trianthum Herb.				-	+		
COMMELINACEAE							
Commelina schweinfurthii C. B. Cl.	-						
Floscopa sp.							3314
CYPERACEAE							
Bulbostylis coleotricha (A. Rich) C.B.Cl.				-			
B. oritrephes (Ridley) C. B. Cl.			-				
B. sp.				-	-		
Cyperus digitatus Roxb. subsp. *auricomus* (Spreng.) Kük var. *bruntii* Hooper				+		-	

[1] The nomenclature follows Hutchinson and Dalziel (1954, 1958, 1963, 1968, and 1972) unless otherwise noted.

[2] Collection numbers at Eaux et Forêts herbarium in Bangui.

Vegetation type	1	2	3	4	5	6	Notes
C. exaltatus Retz				+		-	
C. imbricatus Retz						-	
C. spacelatus Rottb.				-			
C. tenuispica Steud.							3263
Fimbristylis cioniana Savi						-	
Mariscus alternifolius Vahl	+						
M. luridus C. B. Cl.						+	
Scirpus brachyceras Hochst. ex A. Rich.						-	
S. sp. A						-	
GRAMINAE							
Acroceros amplectens Stapf							3270
Andropogon gayanus Kunth.	-				+		
A. schirensis Hochst. ex A. Rich.	-		-				
Beckeropsis uniseta (Nees) K. Schum.		+					
Brachiaria jubata (Fig. & De Not.) Stapf				-	+		
Chloris pilosa Schumach.				-	-		
Ctenium newtonii Hack.	+		-				
Cymbopogon giganteus Chiov.	+						
Digitaria ciliaris (Retz) Koel					-		
D. debilis (Desf.) Willd.						-	
Echinochloa obtusiflora Stapf					-		
E. pyramidalis Hitchc. & Chase				+			
E. stagnina (Retz) R. Beauv.						+	
Elionurus argenteus Nees	+						
Eragrostis gangetica C. E. Hubbard				+	-		
E. sp.	-					-	
Hyparrhenia barteri (Hack.) Stapf	+				-		
H. coriacea[1] (Mazade)	-		-				
H. filipendula (Hochst.) Stapf	-		+				
H. rufa (Nees) Stapf				+	+		
H. sp.					-		
Jardinea congolensis (Hack) Franch.				+			
Loudetia annua (Stapf) C. E. Hubbard			+				
L. arundinacea (Sochst. ex A. Rich.) Steud.	-				-		
L. simplex (Nees) C. E. Hubbard				-	+		
L. togolensis (Pilger) C. E. Hubbard					-		
Microchloa indica (Linn.) P. Beauv.	-		-				
Oryza barthii A. Chev.				-	-		
O. longistiminata A. Chev. & Roehr				+	-		
Panicum anabaptism Steud.				+	-		
P. fluviicola Steud.				-		-	
P. phragmitoides Stapf	-				-		
P. walense Mez							3340
Paspalum orbiculare Forst.				+			
Pennisetum pedicellatum Trin.	+	+					
Phragmites karka (Retz.) Trin. ex Steud.				-	-		
Rottboellia exaltata Linn.				T	T		
Sacciolepis ciliocincta (Pilger) Stapf			-				
S. micrococca Mez							3337

1. Mazade personal communication.

Vegetation type	1	2	3	4	5	6	Notes
Schoenefeldia gracilis Kunth					-		
Setaria anceps Stapf ex Massey				+			
S. aurea Hochst. ex A. Br.				-			
S. barbata (Lam.) Kunth					-		
S. pallidefusca (Schumach.) Stapf & C. E. Hubbard				-	-		
Sorghastrum bipennatum (Hack.) Pilger				-			
Sorghum sp.				-			
Sporobolus festivus Hochst. ex A. Rich.	+		+				
S. infirmis Mez	+						
S. pectinellus Mez					-		
S. pyramidalis P. Beauv.					-		
S. sangenius Rendle					-		
Tristachya superba (De Not.) Aschers. & Schweinf.					-		
Vetiveria nigritana (Benth.) Stapf				+	-		
Vossia cuspidata (Roxb.) Griff				+		+	
LILIACEAE							
Albuca sp. (*nigritana*?)					-		
Anthericum sp. (*limosum*?)					+/T		
Asparagus flagellaris (Kunth) Bak.	+						
Chlorophytum bequaertii De Wild.	-		-				
C. gallabatense Schweinf. ex Bak.		-					
Urginea altissima (Linn.) Bak.	+						
PALMAE							
Borassus aethiopum Mart.				-			
ZINGIBERACEAE							
Costus sp.	T	-	-/T		T		
Kaempferia aethiopica (Schweinf.) Solms-Laub.	+			+			
DICOTYLEDONS							
ACANTHACEA							
Hygrophila abyssinica (Hochst. ex Nees) T. Anders							3521
H. senegalensis (Nees) T. Anders							3312
Lepidagathis sp.							3359
AMARANTHACEAE							
Amaranthus hybridus Linn. subsp. *cruentus* (Linn.) Thell.				-	-		
Centrostachys aquatica (R. Br.) Wall.							3253

Vegetation type	1	2	3	4	5	6	Notes
AMPELIDACEAE							
Ampelocissus multistriata (Bak.) Planch.	-/T		-/T				
Cissus caesia Afzel.	+						
C. cornifolia (Bak.) Planch.	+						
C. crotalarioides Planch.			-/T				
C. palmatifida (Bak.) Planch.			-/T				
C. quadrangularis Linn.	T	-/T			T		
C. rufescens Guill. & Perr.			-/T				
C. waterlotii A. Chev.	-						
ANACARDIACEAE							
Heeria pulcherrima (Schweinf.) O. Ktze.							No nbr.
Lannea kerstingii Engl. & K. Krause	-						
L. schimperi (Hochst. es A. Rich.) Engl.	-	-			T		
Rhus sp. *(natalensis?)*	T		T				2545
Sclerocarya birrea (A. Rich.) Hochst.	-						
ANNONACEAE							
Annona senegalensis Pers.	-	-					
Hexalobus monopetalus (A. Rich.) Engl. & Diels	T	+			T		
APOCYNACEAE							
Carissa edulis Vahl	T	-					
Strophanthus sp.		-					
BIGNONIACEAE							
Kigelia africana (Lam.) Benth.				T	+/T		
Stereospermum kunthianum Cham.	-		+				
BORAGINACEAE							
Heliotropium indicum Linn.						-	
H. sp.						-	
BURSERACEAE							
Boswellia papyrifera (Delile) A. Rich.							2407
Commiphora pedunculata (Kotschy & Peyr.) Engl.	T	-					
CAESALPINIACEAE							
Afzelia africana Sm.	-						
Burkea africana Hook.	+						
Cassia sieberiana DC.	T	+	T		T		

Vegetation type	1	2	3	4	5	6	Notes
Daniellia oliveri (Rolfe) Hutch. & Dalz.	-						
Detarium microcarpum Guill. & Perr.	+		+		—		
Isoberlinia doka Craib & Stapf	-						
Piliostigma reticulata (DC.) Hochst.	-				+		
P. thonningii (Schum.) Milne-Redhead	+	-			-		
Swartzia madagascariensis Desv.							3511
Tamarindus indica Linn.	T	+	T		T		
CAPPARIDACEAE							
Boscia salicifolia Oliv.							3477
B. senegalensis (Pers.) Lam. ex Poir.	T	+	T		T		
Cadaba farinosa Forsk.		-	T		T		
Capparis corymbosa Lam.							2535
C. tomentosa Lam.	T	+	T		T		
Courbonia virgata Brongn.							4227
Crataeva religiosa Forsk.				T	T		
Maerua oblongifolia (Forsk.) A. Rich.	T	+	T		T		
CARYOPHYLLACEAE							
Polycarpaea eriantha Hochst. ex A. Rich.							3360
CELASTRACEAE							
Hippocratea africana (Willd.) Loes. ex Engl.	T	-					
Maytenus senegalensis (Lam.) Exell	+		-				
COCHLOSPERMACEAE							
Cochlospermum tinctorium A. Rich.	+						
COMBRETACEAE							
Anogeissus leiocarpus (DC.) Guill. & Perr.	T	+	T		T		
Combretum aculeatum Vent.			-				
C. ghasalense Engl. & Diels	-		+				
C. glutinosum Perr. ex DC.	-				+		
C. hypopilinum Diels	-		-		-		
C. lecardii Engl. & Diels		-			T		
C. molle R. Br. ex G. Don	-		-				
C. nigricans Lepr. ex Guill. & Perr. var. *elliotii* (Engl. & Diels) Aubrèv.			+				
Guiera senegalensis J. F. Gmel.					-		
Terminalia avicennioides Guill. & Perr.	-						
T. laxiflora Engl.	+		-				
T. macroptera Guill. & Perr.							

Vegetation type	1	2	3	4	5	6	Notes
COMPOSITAE							
Laggera oloptera (DC.) C. D. Adams							3523
Vernonia kotschyana Sch. Bip.							3361
CONVOLVULACEAE							
Ipomoea hellebarda Schweinf. ex Hiem.							3519
I. sp.							3252
Merremia pterygocaulos (Steud. ex Choisy) Hallier							3251
CUCURBITACEAE							
Melothria deltoidea Benth.	T	-					
M. maderaspatana (Linn.) Cogn.	T	-					
EBENACEAE							
Diospyros mespiliformis Hochst. ex A. DC.	T	+	T		T		
ERYTHROXYLACEAE							
Erythroxylum emarginatum Thonn.	T	+	T		T		
EUPHORBIACEAE							
Antidesma venosum Tul.		-		T	T		
Bridelia scleroneura Mull. Arg.	+						
Euphorbia hirta Linn.		-					
Hymenocardia acida Tul.	+		-				
FLACOURTIACEAE							
Oncoba spinosa Forsk.	T	-					
HYDROPHYLLACEAE							
Hydrolea floribunda Kotschy & Perr.							3248
IRVINGIACEAE							
Irvingia smithii Hook.						+	
LABIATAE							
Haumaniastrum lilacinum (Oliv.) J. K. Morton							3245
Hoslundia opposita Vahl					T		
Hyptis spicigera Lam.							3323
Solenostemon latifolius					-		

Vegetation type	1	2	3	4	5	6	Notes
LOGANIACEAE							
Strychnos innocua Del.		-					
S. spinosa Lam.	+		-				
LORANTHACEAE							
Tapinanthus globiferus (A. Rich.) Van Tiegh							Parasite
LYTHRACEAE							
Ammannia auriculata Willd.							3514
Nesaea sp. *(icosandra?)*				-			
MALVACEAE							
Abutilon sp.							3343
Hibiscus asper Hook.							3522
MELIACEAE							
Khaya senegalensis (Desv.) A. Juss.	T	+	T		T		
Pseudocedrela kotschyi (Schweinf.) Harms					+		
Trichilia retusa Oliv.				-			
MIMOSACEAE							
Acacia ataxacantha DC.		+		T	T		
A. pennata (Linn.) Willd.							3697
A. polyacantha Willd. subsp. *campylacantha* (Hochst. ex A. Rich.) Brenan			+				
A. seyel Del.				-	+		
A. sieberiana DC.	-			T	T		
Albizia coriaria Wels. ex Oliv.							3842
Amblygonocarpus adongensis (Welw. ex Oliv.) Exell & Torre	-						
Dichrostachys glomerata (Forsk.) Chiov.			-				
Entada africana Guill. & Perr.	-						
Mimosa pigra Linn.				+			
Neptunia oleracea Lour.						+	
Parkia clappertoniana Keay	-						
Prosopis africana (Guill. & Perr.) Taub.	+						
MORACEAE							
Ficus dekdekena (Miq.) A. Rich.	T				T		
F. gnaphalocarpa (Miq.) Steud. ex A. Rich.				T	T		
F. ingens (Miq.) Miq.					T		
F. platyphylla Del.	T						
F. sp.	T						

Vegetation type	1	2	3	4	5	6	Notes
MYRTACEAE							
Syzygium guineense (Willd.) DC.					-	-	
NYMPHAEACEAE							
Nymphaea lotus Linn.						+	
N. sp.						+	
OCHNACEAE							
Lophira lanceolata Van Tiegh ex Keay					-		
OLANACEAE							
Ximenia americana Linn.	+						
ONAGRACEAE							
Jussiaea erecta Linn.						-	
J. repens Linn. var. *diffusa* (Forsk.) Brenan						+	
J. sp.						-	
OPILIACEAE							
Opilia celtidifolia (Guill. & Perr.) Endl. ex Walp.	T	-					
PAPILIONACEAE							
Afrormosia laxiflora (Benth ex Bak.) Harms	+						
Andira inermis (Wright) DC.					-		
Crotalaria spectabilis Roth.							3326
Dalbergia melanoxylon Guill. & Perr.			-				
Erythrina sigmoidea Hua			-				
Indigofera capitata Kotschy	+						3310
Leptoderris brachyptera (Benth.) Dunn	T	-	T				3815
Lonchocarpus laxiflorus Guill. & Perr.	+/T	-	T				
Pterocarpus lucens Lept. ex Guill. & Perr.		+					
Sesbania dalzieli Phill. & Hutch.				+			
POLYGALACEAE							
Securidaca longepedunculata Fres	T	-	T		T		
POLYGONACEAE							
Polygonum lanigerum R. Br. var. *africanum* Meisn.						-	
P. libatum Meisn.						+	
P. senegalensis Meisn.						-	

Vegetation type	1	2	3	4	5	6	Notes
PROTEACEAE							
Protea elliottii C. H. Wright	-						
RHAMNACEAE							
Ziziphus abyssinica Hochst. ex A. Rich.					T		
Z. mucronata Willd.	T				T		
Z. spina-christi (Linn.) Desf.				T	T		
ROSACEAE							
Parinari curatellifolia Planch. ex Benth.	-						
RUBIACEAE							
Borreria stachydea (DC.) Hutch. & Dalz.							3303
Crossopteryx febrifuga (Afzel. ex G. Don) Benth.	+						
Fadogia ledermannii K. Krause	+						
F. pobeguinii Pobeguin	-						
Feretia apodanthera Del.	T	+	T		T		
Gardenia aqualla Stapf & Hutch.							4308
G. erubescens Stapf & Hutch.	+						
G. ternifolia Schum. & Thonn.					+		
Mitragyna inermis (Willd.) O. Ktz.				T	+		
Morelia senegalensis A. Rich. ex DC.				-			
Nauclea latifolia Sm.					+/T		
Oldenlandia herbacea (Linn.) Roxb.							3332
Xeromphis nilotica (Stapf) Keay	+	-			-		
RUTACEAE							
Clausena anisata (Willd.) Hook. ex Benth.	T	+	T		T		
Teclea oubanguiensis[1] Aubr. and Pellegr.	T	+					
SAPINDACEAE							
Allophyllus africanus P. Beauv.	T	+					
Cardiospermum halicacabum Linn.						-	
Paullinia pinnata. Linn.			-/T				
SAPOTACEAE							
Butryospermum paradoxum (G. Don) Hepper	+						
SCROPHULARIACEAE							
Limnophila barteri Skan							3346
L. indica (Linn.) Druce							3316

1. Species defined in Aubrèville (1950).

Vegetation type	1	2	3	4	5	6	Notes
SIMAROUBACEAE							
Hannoa undulata (Guill. & Perr.) Planch							2788
STERCULIACEAE							
Dombeya quingueseta (Del.) Exell							4526
D. sp.							3837
Sterculia setigera Del.	-						
TILIACEAE							
Corchorus fascicularis Lam.							4319
Grewia flavescens Juss.			T				
G. mollis Juss.	+		-				
G. villosa Willd.	T		T		T		
UMBELLIFERAE							
Steganotaenia araliacea Hochst.	-						
VERBENACEAE							
Clerodendrum capitatum (Willd.) Schum. & Thonn.							3353
Stachytarpheta angustifolia (Mill.) Vahl.						+	
Vitex doniana Sweet	-				T		
V. madiensis Oliv.							4306
V. simplicifolia Oliv.					T		
ZYGOPHYLLACEAE							
Balanites aegyptiaca (Linn.) Del.					T		

APPENDIX F

Indigenous names of plants identified in the St. Floris National Park.

Species	Goula	Banda
Acacia ataxacantha	Tara	Issi, sisi
A. polyacantha subsp. *campylacantha*	N'Gara	-
A. sieberiana	Chonokachi	Issi, lissi
Afzelia africana	N'Galê	Ongbo, bongbo
Afrormosia laxiflora	Jolo	Bagunda
Allophylus africanus	Vikala	Koutêmongo
Amblygonocarpus andongensis	Malo	-
Ampelocissus multistriata	-	Bandavru
Andropogon gayanus	Woulu	-
Anogeissus leiocarpus	Wardo	Essê
Annona senegalensis	Mvo	-
Antidesma venosum	Vikala	-
Asparagus flagellaris	Chonochman	Gorozo
Balanites aegyptiaca	N'Gura	N'Gura
Borassus aethiopum	-	Kozo
Boscia senegalensis	Kodonguru	Chataracha
Bridelia scleroneura	Deeni	Indiri
Butyrospermum paradoxum	N'Guee	Baloa, baloa
Burkea africana	Malo	Zinegue
Cadaba farinosa	Massakala	-
Capparis tomentosa	Morugu	Abradola
Carissa edulis	Kosili	Alissi
Cassia sieberiana	Walu	Titao
Cissus caesia	-	Inyi
Clausena anisata	Vêleduku	Jaka
Cochlospermum tinctorium	Baguma	Bagum
Combretum aculeatum	Kodomulla	-
C. ghasalense	Dorokache	Bovro (♂)
C. glutinosum	Dorrautara	Kebikpwa
C. hypopilinum	Lemphe	Kavra
C. molle	Disaeka	Bovro (♀)
C. nigricans var. *elliotii*	N'Diché	-
Commiphora pedunculata	Mabili	-
Crataeva religiosa	Uorroto	M'Bakako
Crossopteryx febrifuga	Gurbu	Strebi, éké
Cymbopogon giganteus	Kidamgara	Kadjabongo
Dalbergia melanoxylon	Verré	-
Daniellia oliveri	Bété	Birlo
Dentarium microcarpum	N'Gutu	Tokoro
Dichrostachys glomerata	Verré	-
Diospyros mespiliformes	Ngiti	Boijo
Echinochloa pyramidalis	Ievé	-
E. stagnina	Iya	-
Erythrina sigmoidea	N'Gora kandé	Linké

Species	Goula	Banda
Erythroxylum emarginata	Kachikuling	Banduku
Feretia apodanthera	Endregnié	Katchia
Ficus dekdekena	Sirikolo	-
F. gnaphalocarpa	Moa	Eliango, ongo
F. platyphylla	Chobo	Koto
F. sp.	Chiri	Ekiri
Gardenia erubescens	N'Gura kédé	Macha
G. ternifolia	N'Gura dakalime	Adjara
Grewia mollis	Mohomula	Eviré, evera
G. villosa	Burtutu	-
Guiera senegalensis	Vamu	Chichricha
Hexalobus monopetalus	Moa	Enguilocriri
Hippocratea richardiana	Derri	-
Hymenocardia acida	Kakara	Kongo
Imperata cylindrica	Duku	Ebé
Irvingia smithii	Chila	Ibi
Isoberlinia doka	Dondio	Kaba
Jardinea congolensis	Toua	Andjia
Khaya senegalensis	Mulo	Gonéda, gonda
Kigelia africana	Dondjo	Awolongo
Lannea kerstingii	Lia	Kidi
L. schimperi	M'Dana	Bakaka
Lonchocarpus laxiflorus	Mwallu	Sérékada
Lophira lanceolata	Kehe	Kaya
Loudetia simplex	Drako	-
Maerua oblongifolia	Jilili	Péré
Maytenus senegalensis	Boto	Leka
Mimosa pigra	Ierri	Crabandé
Mitragyna inermis	Dregnié	Oro
Morelia senegalensis	Chila	-
Nauclea latifolia	Meli	Ondo
Nymphaea lotus	Medé	Mbo
Opilia celtidifolia	Titi koré	-
Oryza sp.	Iya	-
Parkia clappertoniana	Matu	Kombé
Paspalum orbiculare	N'Guelman	-
Piliostigma reticulata	Mongo	Engé gengé
P. thonnongii	Bongo	Engé, gengé
Polygonum lanigerum var. *africanum*	Gindikoro	-
Prosopis africana	Iéché	Bangueré
Protea elliotti	-	Kundu uga
Pseudocedrela kotschyi	Murru	Kandjia
Pterocarpus lucens	N'Dana	Trana
Rottboellia exaltata	Uboa	-
Sclerocarya birrea	Libi	-
Securidaca longepedunculata	Mokorro	Latsa, latia
Sesbania dalzieli	Chawé	Boshokolo
Setaria anceps	Dissamanga	-
Sterculia setigera	Daka	Kundu
Stereospermum kunthianum	Velenunu	Bando
Strychnos innocua	Doyo	Bama, g'bama
S. spinosa	Djumala	Kéréla kurulu

Species	Goula	Banda
Syzygium guineense	Meezi	Alego
Tamarindus indica	Massa	Waza, uassa
Teclea oubanguiensis	Chila	Buyo
Terminalia avicennioides	Leckéré	Dafu
T. laxiflora	Mondo	Rapa
T. macroptera	Serré	Kongoto
Vetiveria nigritana	Todjio	Kokovumba
Vitex doniana	N'Gulina	Alia
V. simplifolia	N'Gurra	Alia
Vossia cuspidata	Gorro	Sowa
Ximenia americana	Kiti kiti	Bakara
Ziziphus mucronata	N'Gété bici	N'Gama
Z. spina-christi	N'Gidé	N'Gungé

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