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The University of Michigan
Gambia River Basin Studies

Terrestrial Ecology and Gambia River Basin Development

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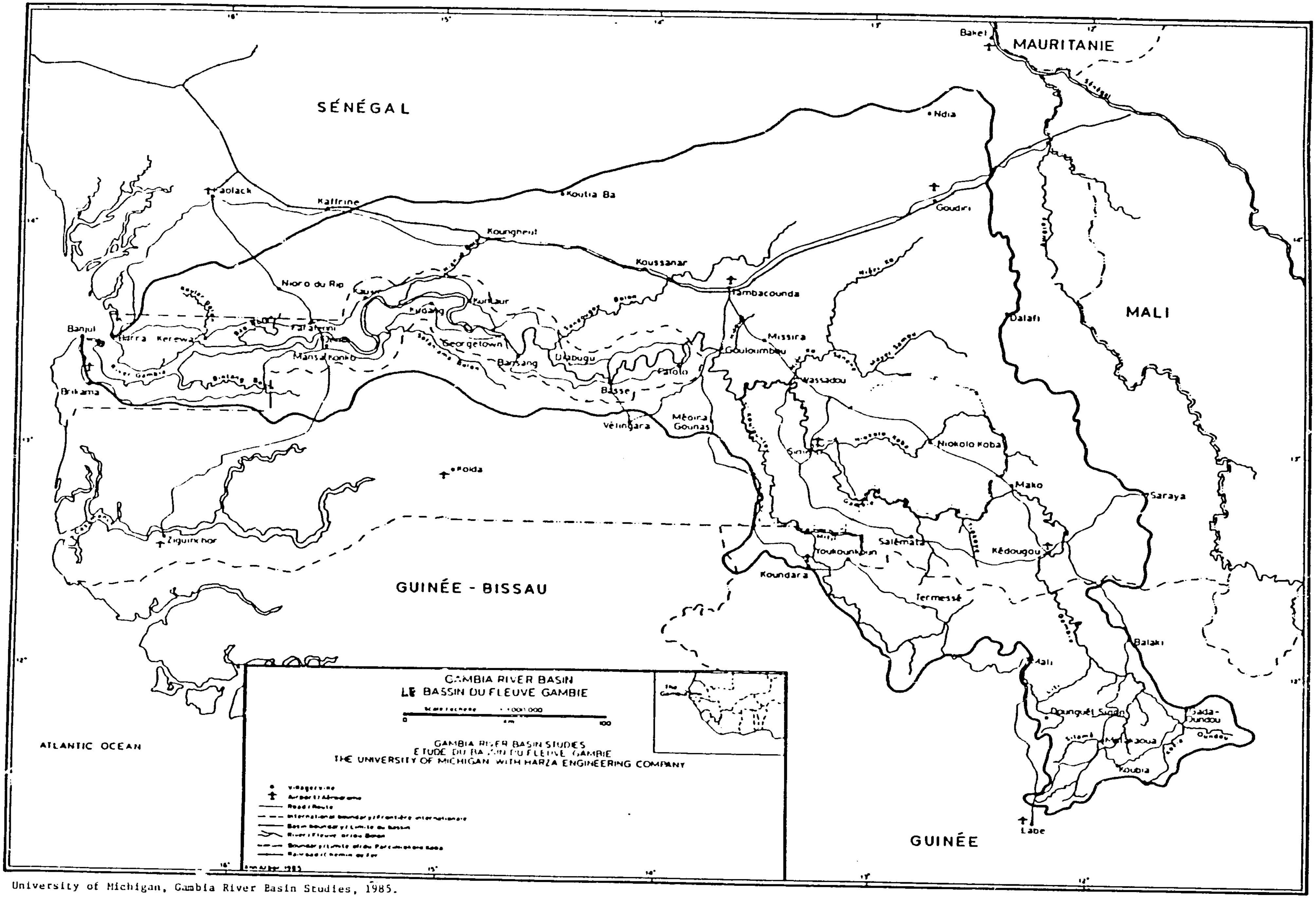

University of Michigan, Gambia River Basin Studies, 1985.

TERRESTRIAL ECOLOGY REPORT

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E. EXECUTIVE SUMMARY

The Wildlife/Vegetation Report of the Gambia River Basin Studies is the result of about eighteen months' work by three long-term ecologists and a group of short-term specialists. The Team's objective was to characterize the natural resources of the Basin[1/] in terms of ecological diversity, interspecific or community relationships, and human use or management problems; to identify ways in which these resources will be affected by certain water development projects; and to recommend actions to mitigate adverse impacts and enhance benefits.

E.1. Existing Conditions

The Wildlife/Vegetation Team concluded that both vegetation and wildlife resources are severely and usually adversely affected by day-to-day human activities, as well as by a few carefully-conducted illegal activities.

E.1.1. Vegetation

Among the activities that strongly affect the vegetation of the Basin, the most widespread and influential is the use of fire to reduce combustible material during the dry season and to promote accessible new grass for pasture. This practice, which occurs virtually throughout the Basin, has had a profound influence on virtually every natural plant community except the mangrove and riverine forests.

Burning the natural plant communities also is widely undertaken as a means of initially clearing brush or forest prior to agricultural development. Where the farmer has left a few large trees standing, the resultant fields may attain almost a savanna appearance but the annual burning pre-

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1/ Location Map of the Gambia River Basin is presented at the end of the Executive Summary.

vents the growth of tree seedlings, and the trend is inexorably toward grassland.

In areas where the native forest has not been converted to agriculture or to fire-climax savanna, selective cutting for timber and fuelwood has drastically changed nearly all plant formations. In this case even the mangrove and riverine forest communities have not wholly escaped. In the face of growing population pressure, it is difficult to be optimistic about the future of forest resources in the Basin.

E.1.2. Wildlife

In general, the abundance and diversity of animal life in the Gambia River Basin increases from the mouth of the river to the headwaters. This is a simple reflection of population density and the corresponding pressure on the plant resource, as well as direct hunting pressure on game animal populations.

An exception to this relationship is found in the Senegalese Parc National du Niokolo-Koba. This area of 8,130 square kilometers provides a reasonably protected region where hunting is restricted to a fairly small cadre of dedicated poachers. Certainly there is no other major part of the Basin where large mammals are as well protected.

Despite heavy hunting pressure, the wildlife of the Basin is diverse, widespread and occasionally spectacular. The governments of Senegal and The Gambia are becoming increasingly aware that wildlife contributes substantially to the tourist's tropical experience. The Niokolo-Koba National Park survives essentially on the premise that large, visible, interesting mammals are part of what the tourist comes to Senegal to see. Wildlife viewing in The Gambia is more dispersed, essentially throughout the country, and more oriented toward birds. The Abuko Reserve, however, with its free-living monkeys, and antelope, in addition to birds and crocodiles, provides tourists with a concentrated, vivid wildlife experience.

E.2. Potential Effects of Development

Perhaps the most surprising conclusion reached by the Wildlife/Vegetation Team, was that most of the unavoidable impacts of the development projets proposed for the Basin are less severe than the impacts of ongoing human activities that affect wildlife and plant resources. The Team identified a number of potentially severe negative impacts, including the extinction of one or two animal species in the Basin, but these impacts can be virtually prevented by appropriate actions on the part of the governments, either through intensified efforts of their usual resource management agencies or through the OMVG.

E.2.1. Balingho Barrage

The construction of the barrage will totally remove the vegetation from several hundred hectares on both sides of the river.2/ Most of the area is in agriculture at present, so the main effects on-site are socio-economic. Replacement of lost lands probably will result in clearing some open forest elsewhere. Some areas, such as the construction village, will be landscaped back to a state not far from what they were before the clearing.

The Balingho Reservoir will exert its greatest effect on the mangrove forest that lines the river bank. Some 8,000 hectares of mangrove will be flooded with a freshwater pool that will fluctuate only on an annual basis. The continuous inundation will bring death to the mangrove, through suffocation of the air-breathing stilt-roots, within about two weeks. Gradually, over the first few decades of project life, the dead mangroves will be replaced with a riverine forest community similar to that which now grows along the freshwater sections of the river.

2/ Location maps of the Balingo Barrage and the Kekreti dam are presented at the end of this Executive Summary.

Although these impacts are unmitigable, there is another group of potentially severe impacts that are amenable to mitigation actions and thus need never happen:

- Actions by the workforce, their dependents, and the predictable host of project-following entrepreneurs who hope to offer various services to the project. These actions, which include unauthorized cutting of fuelwood for personal and commercial use, grazing of livestock, land clearing for agriculture, and illegal hunting, can be prevented by an adequate education and enforcement program.
- Death and injury of manatees is likely to occur through a variety of causes, but can be prevented by proper vigilance.

E.2.2. Kekreti Dam

The Kekreti Project lies in a more pristine area than the Balingho Project, and so possesses more potential for damaging impacts. With one foot in Niokolo-Koba National Park, Kekreti can hardly avoid some risk to the Park. Yet we find that many of the most damaging effects can be avoided through a thoughtful and well-pursued environmental management program.

The most serious risk of environmental impact is posed by the intrusion of noise, dust, night lights and movement into the Park and adjacent areas; by the introduction of some 2,000 people into the area immediately outside the Park; by the relocation of access roads, borrow areas and supplementary activities over a large area; and by the placement of a transmission line across at least a corner of the Park. Added to this will be a reservoir of about 338 square kilometers, an unavoidable impact.

As with Balingho, however, the unavoidable adverse effects of the Kekreti Project are far less severe than the potential effects.

- Some intrusion into the Park is unavoidable, but it need only amount to a few hectares. Most of the noise, lights and movement can be minimized. This will require restrictive clauses in the construction contract and intensive surveillance by the OMVG and resource agencies.

- The inundation of 338 square kilometers also is unavoidable, but it is mostly open forest, the predominant plant community of the region.

What, then, are the potentially severe impacts? We see several categories, mitigation of which will be discussed in a general mitigation section.

- Illegal hunting by project workers and others who move in to serve them could severely affect many local species, already under considerable hunting pressure.
- Contact between livestock and wild hoofed mammals could result in transferring disastrous diseases to the wild populations, especially rinderpest.
- The transmission lines, if not routed carefully, could exert a severe aesthetic impact on the Park. The tower design and wire placement, at 135 kV, are liable to cause many electrocutions of monkeys and large birds (with consequent power outages).

E.2.3. The Guinea Dams

The three dams proposed for the Gambia River system in Guinea, being mostly smaller projects, have less potential for pervasive impacts. They are placed in areas where most wildlife has been heavily hunted to date, although habitat destruction has been less. The potential impacts parallel those of Kekreti, on a somewhat reduced scale.

E.3. Recommendations

E.3.1. Basin-wide Actions

All of the recommendations affecting project impacts depend on two basic actions by the OMVG. The timing of these actions depends strongly on the sequence of project construction.

- Project Environmental Scientist. The OMVG should assign to each project, for the duration of its planning and operation phases, a full-time ecologist. He or she may have to be an expatriate, but a national of the project country should understudy the position, so as to take it over and continue through the operation phase. The Environmental Scientist will perform a variety of planning, advisory, monitoring, and surveillance duties. He will require assistants, vehicles and other forms of independent support.
- Regional Master Plan. This particularly important for Senegal Oriental, because of the widespread effect that Kekreti will have on the region's roads, communication facilities, and villages. All of the projects need to be examined in terms of their regional effects, which may be considerable.

Additionally, there are some studies and actions that should be undertaken in order to ehance the management of wildlife resources in project areas. Perhaps the most important of these is research on behavior of mammalian crop pests and their management. The large mammal crop pests have been somewhat neglected in most studies, which have tended to concentrate on birds and rodents. The magnitude of estimates of crop damage caused by monkeys, warthog, and hippos is such that control methods should be investigated.

E.3.2. Balingho

- Control of Illegal Hunting. The government should make it clear to the construction contractor that illegal hunting will not be tolerated, nor will the purchase or possession by project staff of illegal animal products (furs, horns, meat) or live animals.

- Veterinary Services. If project workers are permitted to keep livestock (which we consider inadvisable), provisions must be made for vaccination and health protection of the animals. The Project Environmental Scientist should monitor the effects of such herds on grazing/browsing resources.
- Improved Floodplain Mapping. Management of reservoir vegetation will be impossible until detailed maps (0.1-meter contour interval) are available. This will require on-the-ground surveying, based on existing bench marks.
- Hippopotamus Studies. The locations of the relatively sedentary hippo herds should be pinpointed and measures undertaken to minimize contacts between these animals and agricultural developments.
- Research on Manatee and Sitatunga. These two rare species can hardly avoid being affected by the Balingho Barrage, since it will cause major changes in their wetland habitat. Assistance should be sought from some international organization such as the IUCN or the World Wildlife Fund.
- Wildlife Sanctuaries. The best possibility for additional wildlife protection in The Gambia appears to lie in the proposed Kiang West National Park. The OMVG should actively support the formation of this Park, as a compensatory area for areas to be lost in the Balingho pool.

E.3.3. Kekreti

In addition to the appointment of a full-time Project Environmental Scientist for Kekreti, there are other actions which, if effectively implemented, would reduce most impacts to acceptable levels.

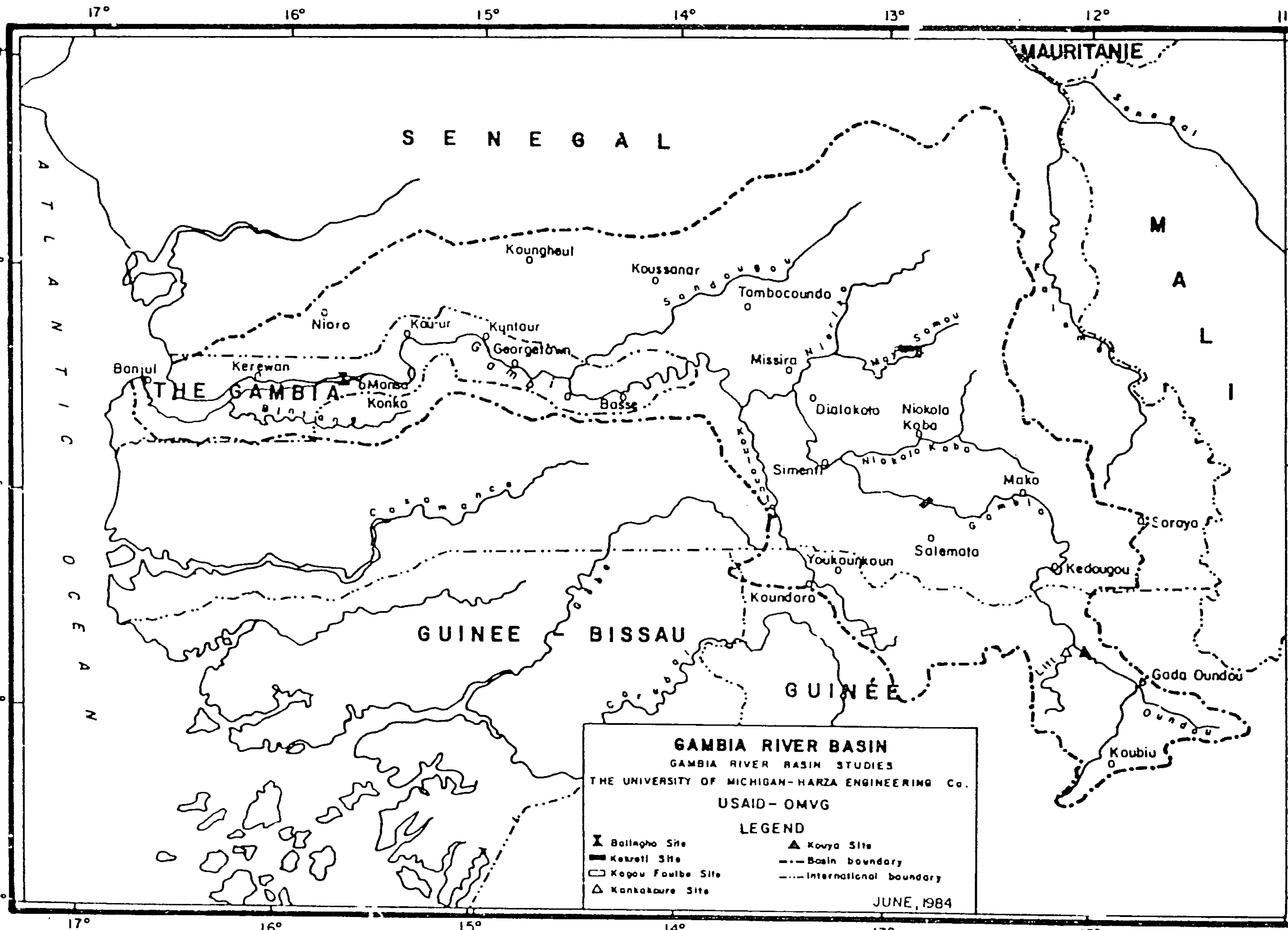
- Tightening of control of Illegal Hunting. As on the Balingho, Project, OMVG and the Senegalese agencies should make it clear that opportunistic hunting around the project area will not be permitted. It may be required to ban the possession of firearms by project workers.

- Fencing of Right Dam Abutment. The area of the right abutment that intrudes into the Park should be provided with a strong, chain-link fence to prevent project workers from entering the Park and to prevent animals from straying into the construction area. It probably would be appropriate to establish a Park guard post at or near the perimeter.
- Diked Pools on the Diarrha and Tiokoye Rivers. The road crossing dikes of these two rivers should be high enough to retain pools through the dry season. Current plans do not call for water retention structures at these crossings, but with control gates and small spillways, these dikes could maintain pools for watering livestock. This would relieve herders of the necessity of driving cattle to the reservoir edge and would minimize the likelihood of transferring diseases between livestock and wild ungulates.
- Reclamation of Some Borrow Pits to Retain Water. This should be done with borrow pits within the reservoir area, to provide more diffuse watering points for wildlife.

E.3.4. Guinea Dams

- Reservoir Clearing. The costs and benefits of clearing the Guinea reservoirs should be examined carefully during feasibility-level studies. This must be done for each dam on an individual basis. We suggest that only tangible benefits and costs be used. The only tangible benefit is the return on timber and fuelwood. To determine the new value of this return will require a detailed study of the timber resource, local and regional demand, transportation, and felling/handling costs. The cost of felling, trimming, piling and burning of trees and brush can be calculated on the basis of man-hour requirements and local wage scales.

- Revegetation. All borrow pits, road shoulders and other disturbed areas should be revegetated with native grasses, shrubs and/or trees according to a plan worked out between the OMVG Project Environmental Specialist and the Guinean Wildlife Agency. Areas revegetated during or immediately following construction should be followed closely for a year or so, then examined after several years, at which time some plantings may have to be replaced with the same or other species.
- Control of Hunting. The control of illegal hunting by project workers and others will require great effort by the contractor, the OMVG Project Environmental Specialist, and the Guinean Wildlife Agency. As with Kekreti, adequate control will require a major change of local attitudes, which now see any animal as fair game.
- Regional Planning for the Fouta Djallon. The OMVG is in a position to influence substantially the course and direction of development. Undoubtedly the next few decades will see important changes in the Fouta Djallon, in response to population pressure, political change, and increased resource accessibility. Uncoordinated or unrestricted development could lead to the development of one resource (i.e., mining) at the expense of others (e.g., tourism).


GAMBIA RIVER BASIN
GAMBIA RIVER BASIN STUDIES
THE UNIVERSITY OF MICHIGAN-HARZA ENGINEERING Co.
USAID-OMVG
LEGEND
Balingho Site
Kekreti Site
Kogou Foulbe Site
Kankakoure Site
Kouya Site
Basin boundary
International boundary
JUNE, 1984
SENEGAL
MAURITANIE
MALI
THE GAMBIA
GUINEE - BISSAU
GUINEE
ATLANTIC OCEAN
Banjul
Kerewan
Mansa
Konko
Kau-ur
Kuntaur
Georgetown
Basse
Nioro
Koungheul
Koussanar
Tambacounda
Missira
Dialakoto
Niokolo Koba
Simenti
Mako
Salemata
Youkounkoun
Koundara
Kedougou
Soraya
Gada Oundou
Koubia
Gambia
Sandougou
Niokolo Koba
Koulountou
Casamance
Corubal
Oundou
Falémé
Sénégal
17°
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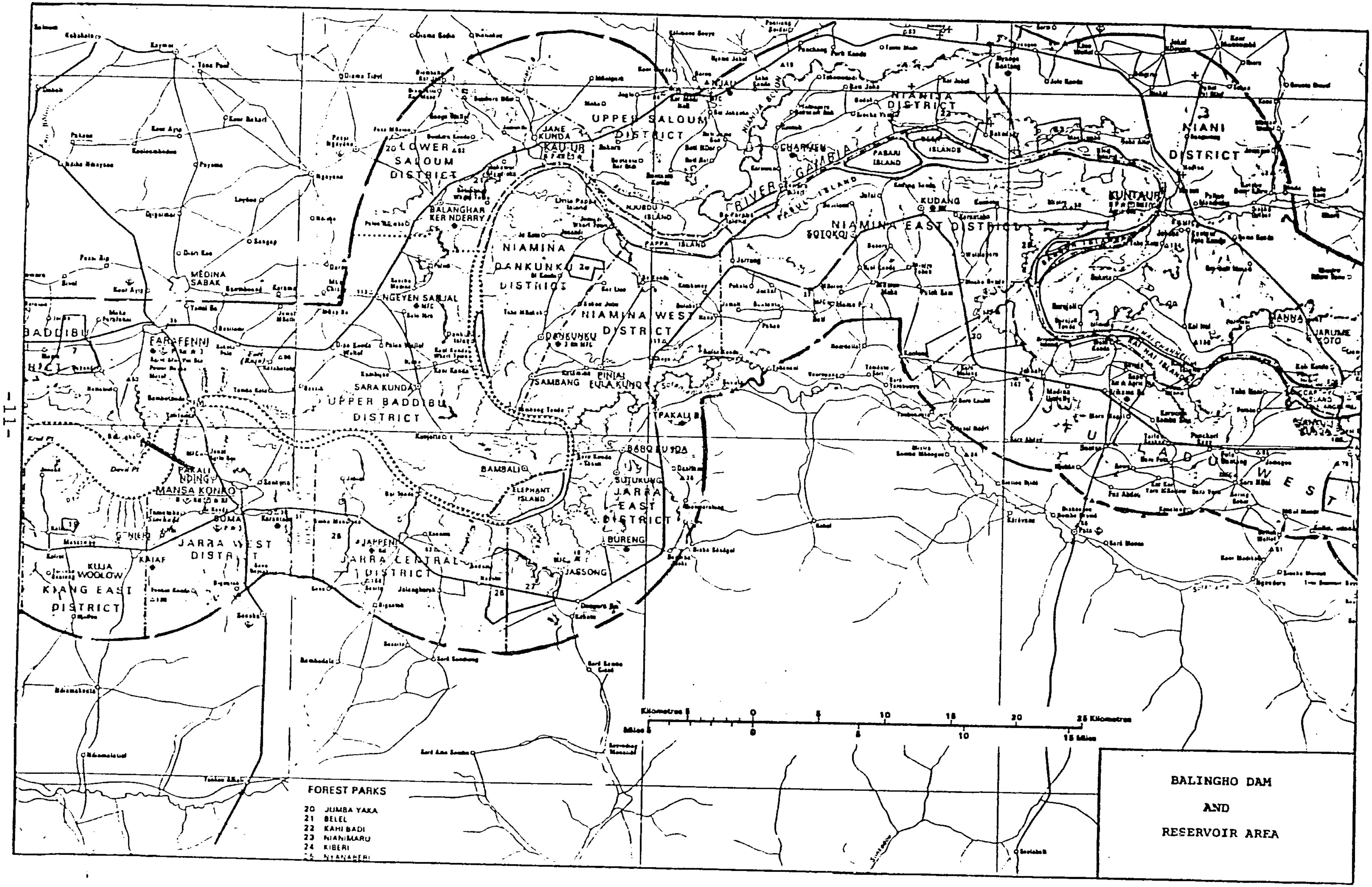
14°
13°
12°
11°


BALINGHO DAM
AND
RESERVOIR AREA
FOREST PARKS
20 JUMBA YAKA
21 BELEL
22 KAHI BADI
23 NIANIMARU
24 KIBERI
LOWER SALOUM DISTRICT
UPPER SALOUM DISTRICT
NIAMINA DISTRICT
NIANI DISTRICT
NIAMINA DANKUNKU DISTRICT
NIAMINA WEST DISTRICT
NIAMINA EAST DISTRICT
UPPER BADDIBU DISTRICT
JARRA WEST DISTRICT
JARRA CENTRAL DISTRICT
JARRA EAST DISTRICT
KIANG EAST DISTRICT
RIVER GAMBIA
PAPPA ISLAND
PAUL ISLAND
PASARI ISLAND
ELEPHANT ISLAND
KUNTAUR
KUDANG
FARAFENNI
MANSA KONKO
MEDINA SABAK
JANE KUNDA
BALANGHAR KER NDERRY
NGEYEN SANJAL
DANKUNKU
SAMBANG
PINIAI
SARA KUNDA
BAMBALI
SUTUKUNG
BURENG
JASSONG
JAPPENI
KUJA WOOLOW
SOMA
CHARMEN
SOTOKOI
BABO KUNDA
PAKALI BA
Kilometres 5
0
5
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15
20
25 Kilometres
Miles 5
0
5
10
15 Miles


KEKRETI DAM AND RESERVOIR AREA
Échelle 1/1 000 000
Source
INSTITUT GEOGRAPHIQUE NATIONAL - FRANCE
Tambacounda
PARC NATIONAL
NIOKOLO KOBA
Youkounkoun
Koundara
Mali

1. INTRODUCTION

1.1. Basis for Report

This report presents the findings of the Wildlife/Vegetation Team of the Gambia River Basin Studies (GRBS). The overall study of the Gambia River Basin is being performed by the University of Michigan under contract No. 685-0012-C-00 of the United States Agency for International Development. Responsibility for the wildlife/vegetation work lies with Harza Engineering Company, a subcontractor to the University.

The objectives of the wildlife/vegetation studies were to describe the major biological resources in the Basin, their present use and condition, and their reaction to certain river development projects, namely five dams, irrigation and mining. The potential direct and indirect effects of river development upon vegetation and wildlife were to be identified and evaluated. Possible actions that might be taken to lessen the severity of damaging impacts or to enhance secondary benefits were to be considered.

In order to achieve the objectives of the study, the Wildlife/Vegetation Team performed reconnaissance-level field surveys, sampled vegetation, and interviewed native hunters. The ecologists also visited museums to check for specimes from the Basin and searched the published literature for relevant documents. They examined the archival material provided by Senegal's Department des Parcs Nationaux and talked with many of the staff of that agency. A detailed discussion of the team's data gathering methods is presented in Ames et al. (1984, Working Document No. 26).

1.2. Structure of the Report

This report consists of a text volume and a set of 44 land use/vegetation maps. The text report comprises three parts, describing, respectively, the existing conditions in the Basin, the potential effects of development projects, and actions recommended for enhancement and mitigation.

Part One, which describes the plant and animal life of the Basin, is intended to provide only the basic information necessary for understanding the ecological effects of the proposed projects. The reader who wishes more comprehensive information will find it in the working documents.

Part Two presents a discussion of the potential ecological (environmental) effects of the major water resource development project proposed for the Gambia River Basin. The predictions are given on a project-by-project basis in order to enable the administrator or planner to obtain a complete picture of the effects of a given project wihout searching through the entire section.

In Part Three, we recommend programs to reduce the severity of adverse impacts or to increase certain project benefits. These mitigation actions range from minor changes in project design or operation to major programs designed to protect especially valuable resources.

1.3. Personnel

The Wildlife/Vegetation Team consisted of three primary, long-term specialists, six short-term consultants, and several field assistants. The staff, their duration of stay in the Basin, and their specialties were as follows:

<u>Long-Term Staff</u>

Dr. Peter L. Ames, Team Leader, Ornithologist, Editor; January-February, 1983; May, 1983-May 1984; August-September, 1984.

Mr. B. Dean Treadwell, Assistant Team Leader, Mammalian Ecologist, Range Specialist; January-March, 1983; July, 1983-November, 1984.

Mr. Dario Rodriguez Bejarano, Remote Sensing Specialist, Forester; September, 1983-October, 1984.

<u>Short-Term Staff</u>

Dr. Marinus van den Ende, Veterinarian (Consultant);

Ms. Janis A. Carter, Primate Ecologist (Consultant);

Ms. Janneke van Krimpen, Soil Scientist/Watershed Management Specialist (Consultant);

Mr. Robert E. Moran, Mineral Resources Specialist (Consultant);

Mr. James A. Powell, Manatee Specialist (Consultant).

Dr. Samuel C. Snedaker, Mangrove Specialist (Consultant).

PART ONE

EXISTING CONDITIONS

2. VEGETATION[1/]

2.1. Approach to Classification

A land use/cover classification system is a multi-level categorization of a given part of the surface of the earth. Each general category (level one) can be subdivided into particular subcategories (levels two and so on) representing uses or cover types in that category. For example, a land use/cover level one class of agricultural lands and may be subdivided into rainfed, irrigated and swamp agricultural areas (level two categories) which can be subdivided further into ground- nuts, millet, maize, rice, bananas, cotton, etc. For the Gambia River Basin (GRB) we can thus say: Level one, agricultural area; level two, rainfed agricultural; level three, groundnuts, maize, millet, rice, cotton. This can be written as:

2. Agricultural Areas
   - 2.1 Rainfed agriculture
     - 2.1.1 groundnuts
     - 2.1.2 maize
     - 2.1.3 millet
     - 2.1.4 rice
     - 2.1.5 cotton
   - 2.2 Irrigated agriculture
     - 2.2.1 rice
     - 2.2.2 bananas
   - 2.3 Swamp agriculture
     - 2.3.1 rice

This kind of classification system allows itself to be subdivided according to needs.

1/ This chapter has been condensed from Working Document No. 64, Rodriguez B.D., 1985.

2.1.1. Existing Classification Schemes and Their Use

In Senegal, the Institut Geographique National (IGN) of Paris uses the system in which each category is independent of the next. ORSTOM's (Office de la Recherche Scientifique et Technique Outre-Mer) system greatly resembles the system described above, especially in its soils classification. Basically the same system is used by the Surveys Department of The Gambia and by the Land Resources Division of the Ministry of Overseas Development of England. In Guinea we find the same trend as in Senegal, with a recent addition by FAO, which resembles both that of ORSTOM and the system used in this report.

This system used here is derived from that in use by the U.S. Geological Survey (Anderson et al., 1972) and the U.S. Department of Agriculture.

2.1.2. Changes of Land Use/Cover in the GRB

It appears that the most dramatic change in land use/cover is from the primary cover vegetation (forest) to the general use for agriculture. This is a general trend in the area from forested (vegetated) to deforestated (devegetated). This change is taken into account in mapping by shifting an area from one primary level to another (forest to agriculture). Within these new agricultural areas another change occurs: the sprouting of new urban areas. And yet another change is the one occurring in dryland areas (north-east of the GRB) where human actions (mainly fire and animal grazing) cause the disappearance of natural vegetation, which is then replaced by a cover that does not quite revert to the orginal cover, even if left undisturbed for a long period of time. This new cover resembles grasslands or savanna.

2.1.3. Information Gathering: Remote Sensed Data and Field Work

The information used in the production of this report and the 1/100,000 map series of the GRB was acquired by a combination of interpretation of remote sensing data, previous mapping work and field work.

The remote sensing data were Landsat imagery and aerial photography. The Landsat imagery used were False Color Composites (FCC) at a scale 1/250,000, taken on various dates from 9 March 1973 to 27 April 1981. Table 2.1 shows the imagery obtained for this project. Aside from these images, several others belonging to the Remote Sensing and Cartography of Natural Resources (RSCNR) Project of USAID/Dakar, were used as well. These images were computer enhanced and served as a complement to the interpretation of the imagery at hand.

TABLE 2.1

LANDSAT IMAGERY USED

Image ID[a]	Date	Image ID[a]	Date
220/050	24 Sep 1980[b] 23 Nov 1979	217/050	27 Nov 80 4 Mar 79 27 Dec 77
220/051	3 Jan 1979 21 Feb 1973[b]	217/051	27 Dec 77
219/050	22 Nov 1979	217/052	7 Mar 75
219/050	27 Apr 1981 22 Nov 1979 3 Feb 1978[b]	216/051 216/052	20 Nov 77 29 Feb 76
218/050	21 Nov 1979 10 Dec 1977[b] 9 Mar 1973		
218/051	2 Feb 1978 18 Feb 1975		

The aerial photography used was produced by Mark Hurd Aerial Photos, I between December 1982 and January 1983. It is 1/50,000 scale, in black and white (B&W) and color infra-red (CIR) over the entire GRBS. There is black-and- white photography covering selected areas of the GRB at scales 1/25,000 and 1/12,500. This photography was used selectively over the GRB for office checking of areas of difficult access or for completing interpretation begun with Landsat. About 1,000 photos (around 25 percent of the total) were interpreted over the year. These were scattered throughout the basin, but there was heavy emphasis on the mountainous areas of the Fouta Djallon. Photo-index mosaics (approximate scale: 1/150,000) prepared by Mark Hurd were also used in several instances as a complement to Landsat.

Aside from the Mark Hurd photography and photo-index mosaics, some color infrared photography, taken in October 1980 by Teledyne, was used, as well as some December 1946 photography from the Surveys Department of The Gambia, dated November 1956, March 1968 and January 1972, and made by several British organizations. These last photographs covered areas in the impact zone of the proposed Balingho dam and Elephant Island, which were studied in more detail. Table 2.2 shows the photography used.

TABLE 2.2

AERIAL PHOTOGRAPHY USED

Source	Date	Scale	Film
Mark Hurd	Dec '82-Jan '83	1/50,000 1/25,000 1/12,500	B&W and CIR B&W B&W
Teledyne	Oct '80	1/25,000	CIR
Surveys Dpt.	Dec '46 Nov '56 Mar '68 Jan '72	1/32,000 1/20,000 1/40,000 1/10,000	B&W B&W B&W B&W

The bulk of previous mapping used belongs to the Surveys Department, Banjul and the IGN, Paris. Maps from other institutions used include those of FAO, ORSTROM, Land Resource Division of England, and the US Defense Mapping Agency. The scales included are 1/20,000, 1/25,000, 1/50,000, 1/200,000, 1/250,000, 1/500,000 and 1/1,000,000. The 1/200,000 IGN topographic maps covering the basin were photographically reduced to 1/250,000 to use as overlays on the Landsat imagery at the same scale.

These maps included topographic, land use, soils, forest, vegetation, geology, geomorphology, road and tourist maps. Table 2.3 shows the type of maps used.

TABLE 2.3

MAPS USED

Source	Scale	Thematic
Surveys Dpt-Banjul	1/250,000 1/50,000 1/25,000	Roads, toponymy, land use Photomaps Land Use
Land Resources Div.	1/125,000	Soils
IGN - Paris	1/1'000,000 1/200,000 1/200,000	Roads Topography Geology
ORSTOM	1/200,000 1/100,000 1/40,000	Pedology Photomaps Land Use
FAO	1/500,000 1/200,000	Pedology Soils
U.S.D.M.A.	1/250,000	Topography

A preliminary interpretation of the Landsat imagery was done in the office, then verified or checked in the field. Field work had basically three objectives: (1) to verify the preliminary interpretation; (2) to obtain an "on-the ground" impression of the classes interpreted, so that corrections of class definition and interpretation could be done, and (3) to obtain data such as plant specimens, vegetation uses, forest richness, etc.

The verification of interpretation tells us whether a particular class exists as it was defined prior to our going to the field. At this point one obtains an impression of the class being defined, interpretated and verified, and decisions are made whether to change the definition in order that these actual terrain conditions were not known at the time of the preliminary definition and interpretation. Field data are recorded on data forms and some information to assess the richness of the forest is obtained and samples of the principal plant species are collected for later identification.

2.1.4. Map Production: Working and Production Scales

The interpretation for map production was done directly on the 1/250,000 Landsat FCC's. Since Landsat imagery is geometrically corrected prior to printing, bringing the imagery close to the Universal Transverse Mercator (UTM) projection, the 1/250,000 imagery resembled a map. Then the interpretation was traced on a transparent acetate which became the 1/250,000 Land Use/Cover classification map. This transparent acetate later was photographed into 30- by 30-minute quads, which were enlarged to the 1/100,000 scale. The process of negative and enlargement production was done by the Surveys Department of the Ministry for Local Government and Lands, Banjul. The 1/100,000 enlargements were then traced on clear acetate film with legend, coordinates, etc. to make the original which can now be reproduced on paper, film or mylar. Figure 2.1 shows the process schematically.

LANDSAT 1/250,000 interpretation	→	1/250,000 clear acetate working map	→	negatives 6"x7" 30min x 30min quads	→	1/100,000 enlargements on paper	→	1/100,000 Land Use/ cover maps clear film

Figure 2.1: Production of 1/100,000 maps

2.1.5. Vegetation Richness Assessment: Basal Area Determination

At the outset of the field work, we felt that it would be useful to develop a quantitative evaluation of forest richness, expressed in terms of Basal Area. At each site where general data were collected on the vegetation formation (using the GDVS), we secured quantitative data by means of a Bitterlich Relaskop. This instrument allows one to count trees on the basis of the angle subtended in an optical viewer by their trunks. At each vegetation study site, data were taken at a series of points, usually ten, and combined with a Basal Area Factor (established by Bitterlich) to result in a Basal Area (BA) in square meters per hectare of trees more than five centimeters in diameter at breast height (dbh). This value provides a means of comparing the richness of various plant communities.

A grand total of 62 sites or samples using the Bitterlich Relaskop were recorded, containing 533 "points" with a mean BA of 8.47 m^2/ha.

2.1.6. Proposed Land Use/Cover Classification for the GRB

A multilevel categorization such as the one described above was devised for the classification of the GRB. The particular classification system has two levels, with four main categories and 15 sub-categories.

1. Natural Vegetation
   - 1.1 Plantations and artificial regeneration
   - 1.2 Closed or dense forests
   - 1.3 Open forest or wooded savana
   - 1.4 Gallery or riparian forest
   - 1.5 Grassland or savanna
   - 1.6 Mangrove
2. Agricultural Areas
   - 2.1 Irrigated agriculture
   - 2.2 Rainfed agriculture
   - 2.3 Swamp agriculture
3. Urban Areas
   - 3.1 Large communities (more 40 ha in area)
   - 3.2 Small communities (less than 40 ha in area)
4. Other Areas
   - 4.1 Water bodies
   - 4.2 Swamp areas

4.3 Barren flats

4.4 Barelands and rock outcrops

2.2. Land Use/Cover Classification

2.2.1. Factors Affecting Vegetation

The present classification establishes land use classes that reflect the diverse combinations of climatic, edaphic, biotic and anthropogenic factors in the GRB.

2.2.1.1. Climate. The climatic influence is mostly felt through precipitation, which has seen a steady decrease in the area for the last 30 years. Within the Basin, precipitation increases from north to south, being higher in the Fouta Djallon and lowest in the northeastern portion of the basin, around and north of Tambacounda. There are two well defined seasons: the rainy season from June to September, and the dry season from October to May. Precipitation variations cause changes in agricultural land use and in length of utilization, and may cause slight changes of vegetation by encouraging the spread of drought resistant species.

Repeated years of lower than normal precipitation apparently are indirectly responsible for mangrove die-offs in some parts of the estuary, especially along Bintang Bolon. The direct factor appears to be the build-up of salt in the soil that occurs when fresh water flows in the river are reduced.

Another climatic factor, temperature, has only a marginal effect on vegetation and agriculture in the Fouta Djallon. Wind, on the other hand, becomes quite important during the "harmatan" period, especially during the months of February-March. Strong, hot winds sweep the Basin, drying soil and vegetation, feeding fires, and removing the top soil through wind erosion.

2.2.1.2. Human factors. Extreme conditions for animal and plant life occur during the dry season when water becomes a precious commodity. Many plants loose their leaves and high temperatures dry the environment. During this period fire complicates the picture, a factor introduced by human use of the land and its natural resources. Deliberate fires have three objectives: 1) to clear agricultural fields; 2) to eliminate debris and dry vegetation around human settlements so as to avoid accidental burning of dwellings and eliminate vipers and other pests; and 3) to improve forage conditions for grazing of domestic livestock. Accidental fires also occur, but most result from those in the first two categories, left unattended and allowed to burn themselves out.

Anthropogenic factors play a decisive role in the Basin's environment. The predominant uses of land are agriculture, grazing, and human settlement. In all these, natural vegetation, mainly the tree-like vegetation, is cut down, burned, and eventually reduced to open areas for agriculture and settlements, with grazing an accompanying land use.

In the semi-deciduous and deciduous forest of the GRB one finds a less complex vegetation type than in the evergreen, more luxuriant rain forest to the south; there are fewer plant species per unit area and epiphytes are less common. A good exception to the latter was found in some riverine forests in Guinea, but these areas are localized. Thus, particular conditions are modified by human intervention, which causes a further decrease of the number of species per unit area, an increase in the number of fire-tolerant species and the replacement of forest by savanna. The changes of vegetation affects animal wildlife composition and distribution, creating the exodus of a particular species or group of species from a region and the appearance of other species which may become pests.

Changes in vegetation such as preponderance of domestic and useful species near population centers, (for example, baobab, mango, kapok, cashewnut and Parkia) give rise to some types of wildlife, while the disappearance of other commercial species (<u>Khaya senegalensis</u>, <u>Cordyla pinnata</u>, <u>Pterocarpus erinaceus</u>, <u>Prosopis</u> sp.) may mean disappearance of large animals.

The net result is degradation of the forest to species that are less desirable commercially, and those resistant to fire and drought. This makes it more difficult for the original climax community to reclaim the area, since both parent trees and seed dispersal agents are gone. Certain climatic conditions over a large area such as the GRB tend to make degradation of vegetation self-perpetuating and extremely slow to reverse, even after precipitation returns to the "up" side of the cycle. Repeated fires in areas that have been cleared tend to favor rapid-growing herbaceous species and annual grasses, which may not be the most desirable for the purpose for which fires most frequently are started, namely grazing. Moreover, they eliminate slow- moving animal species and cause increases of some others. Other types of degradation may occur through the increase of some animals, such as the bushpig (warthog), which digs out roots for food.

The edaphic factor is affected by the topography of the region, the erosion susceptibility of the soil, and the climate. The Basin can be subdivided in three broad topographic categories: the alluvial plain, with a gentle, rolling topography and steep slopes; the escarpment region of rugged topography and steep slopes; and the flat, dissected terraces and steep slopes of the Fouta Djallon area. The first region contains agricultural areas (irrigated, swamps and rainfed), forest areas (mostly riverine, mangroves, open and close forests), and barren flats and swamps areas. It supports the highest concentration of the population in the GRB.

In the second region, the agriculture is mostly rainfed, with some irrigated areas. There are no mangrove but there is considerable open and closed forest, with areas of bare lands and rock outcrops. There are fewer human population centers. The plateau or terrace region of the Fouta Djallon is entirely located in Guinea and supports only rainfed agriculture. There is open, closed and riverine forest, quite a few instance of rock outcrops, and fewer human population centers than in the two other regions.

The commonest soils of the GRB are the ferrallitic and the ferruginous tropical soils (sequioxide soils). Our field observations revealed well-drained soils, with a well aerated structure. These soils are moderately to poorly fertile and rapidly degrade when the natural vegetation cover is removed. The nutrients are leached quickly and the ability of deep-rooted vegetation to restore minerals from the deep soil and parent material is impaired (Dasman et al., 1978). Once the vegetative cover is removed, soils are exposed to direct solar radiation, high surface temperatures and drying by warm, dry winds. The initial and repeated removal of vegetation is normally accomplished by fire, which further affects these soils. Slope is not a serious problem in most of the GRB, with the exception of the southernmost part of the basin in Senegal and all of the basin in Guinea (about 25 percent of the total GRB area).

Under natural vegetation cover, these soils usually are not extremely acid, with a pH between 6 and 7 (Buckman and Brady, 1967). Mangrove soils in the GRB have been found to have a pH between 6 and 7 under normal conditions (Thorton and Giglioli, 1965). The Continental Terminal soils of the Basin (one of the two major divisions of the soils of The Gambia) presented pH values within the range 5.8-6.4 at the surface horizon, and the soils of the aluvium (the other division of the soils of The Gambia) were found to have a pH between 4.5 and 6.0 and 5.1-7.3 (Dunsmore et al. 1976).

Under present conditions of soil utilization within the GRB, these soils are subjected to high temperatures during the dry season; continuous fires at the beginning and end of the dry season; strong and dry winds during the harmatan season (February to March) and a continuous human pressure in the form of agricultural uses, grazing and human settlements. These particular conditions encourage the process of laterization and lead to removal of the upper soil layer exposing the hard iron pan (cuirasse) layer over which the higher forms of vegetation can hardly grow.

Termite activity is quite evident throughout the GRB but from our observations, termite mounds appear to be higher in the Guinea portion of the Basin. There were two distinctive shapes: a mound type that can attain several meters in height (we observed one of about 3 meters in height), and the mushroom type that only reaches about 30 centimeters in height. The former was observed throughout the area but mostly in wooded or formerly wooded areas. The mushroom type was observed in grassy flats and clayish agricultural areas. Termites use subsoil for these mounds and do not change its characteristics (pH, etc.) and prevent the establishment of vegetation on occupied mounds (old mounds offer more favorable physical conditions such as better drained and aerated soils for the establishment of vegetation). Soils from termite mounds have been spread on agricultural lands but they lacked fertility for plant growth since this soil is derived from sterile subsoil (Walter, 1971).

Using data from Cueto (no date), most of the Basin can classified as having potential for agriculture or for forest, the former covering 23 percent of the area and the latter 77 percent (only 63 percent of the GRB was classified). For The Gambia these figures are 43 percent and 57 percent, for Senegal 19 and 81 percent and for Guinea 15 and 85 percent. This potential, as opposed to present use (Table 2.4), highlights the points that further agricultural development will take place in those areas classified by Cueto as potential forest resource. It is in this vast area, more than three-quarters of the Basin, where one would expect the most severe impact of land use/cover activities to take place.

Our own data, shown in Table 2.4 for the GRB, indicate that there is over 77,000 Km^2 in the Basin,[1/] of which 78 percent is covered with natural vegetation (Cover Class 1), 18 percent are agricultural areas (Class 2), only 0.2 percent are human settlement areas (Class 3), and the rest is classified as other areas (Class 4). Table 2.5 breaks down these figures by country. These results are based on a sampling system, as opposed to an actual measure ment, of the GRB's areas, using a dot grid where 1 point represented 6.429 Km^2 at map scale 1/100,000. The total sampling error for the entire GRB is expected at around one percent. Individual errors for each class may be higher or lower than one percent.

1/ A possible discrepancy exists between our results and other studies. This is caused by discrepancies between Basin boundaries in the northeastern area where the watershed boundary is not fixed. Drainage-ways change direction and the basin they empty into from year to year depending on the rains. Our boundaries are based on the combined analysis of existing catographic information, landsat imagery and the most recent aerial photography and represent the most recent and best approximation of boundary delimination.

2.2.2. Natural Plant Communities

These are areas in which the original plant communities have been left relatively free of human intervention. The word "relatively" is important, for there are few examples in the Basin that do not show evidence of recent human activity. The defining term, "natural", is somewhat abridged when applied to areas of reforestation or plantation forestry.

TABLE 2.4

LAND USE/COVER CLASSES OF THE GRB

Class	Area (Km^2)	Percent	
1 Natural Formations			77.98
1.1 Plantations/Regeneration	6.4	0.01	
1.2 Closed Forest	13173.0	17.02	
1.3 Open Forest	42624.3	55.09	
1.4 Gallery/Riparian Forest	1298.7	1.68	
1.5 Grassland	2610.2	3.37	
1.6 Mangrove	623.6	0.81	
2 Agriculture			17.58
2.1 Irrigated	19.3	0.02	
2.2 Rainfed	13340.2	17.24	
2.3 Swamp	244.3	0.32	
3 Urban			0.16
3.1 Large	109.3	0.14	
3.2 Small	19.3	0.02	
4 Special Classes			4.28
4.1 Water bodies	1060.8	1.37	
4.2 Wetlands	1594.4	2.06	
4.3 Barren flats	90.0	0.12	
4.4 Bare land/rock	565.8	0.73	
	77379.6	100.00	

2.2.2.1. Plantation and artificial regeneration areas. This community includes tree and/or tree-like vegetation considered permanent and

TABLE 2.5

LAND USE/COVER CLASSES OF THE GRB BY COUNTRY

Class	SENEGAL		THE GAMBIA		GUINEA		GUINEA-BISSAU	
	Area (Km^2)	%	Area (Km^2)	%	Area (Km^2)	%	Area (Km^2)	%
1 Natural Formations								
1.1 Plantations/ Regeneration	0.0	0.00	6.4	0.01	0.0	0.00	0.0	0.00
1.2 Closed Forest	4828.2	36.65	835.8	6.34	7496.2	56.91	12.9	0.10
1.3 Open Forest	36709.6	86.12	3079.5	7.22	2835.2	6.65	0.0	0.00
1.4 Gallery/ Riparian Forest	945.1	72.77	122.1	9.41	231.4	17.82	0.0	0.00
1.5 Grassland	2179.4	83.50	45.0	1.72	385.7	14.78	0.0	0.00
1.6 Mangrove	57.9	9.28	565.7	90.72	0.0	0.00	0.0	0.00
2 Agriculture								
2.1 Irrigated	6.4	33.33	12.9	66.67	0.0	0.00	0.0	0.00
2.2 Rainfed	9386.3	70.36	3587.4	26.89	366.5	2.75	0.0	0.00
2.3 Swamp	19.3	7.89	225.0	92.11	0.0	0.00	0.0	0.00
3 Urban								
3.1 Large	45.0	41.18	57.9	52.94	6.4	5.88	0.0	0.00
3.2 Small	6.4	33.33	0.00	0.00	12.9	66.67	0.0	0.00
4 Special Classes								
4.1 Water bodies	77.1	7.27	822.9	77.58	160.7	15.15	0.0	0.00
4.2 Wetlands	495.0	31.05	1099.4	68.95	0.0	0.00	0.0	0.00
4.3 Barren flats	6.4	7.14	83.6	92.86	0.0	0.00	0.0	0.00
4.4 Bare land/rock	186.4	32.95	0	0.00	379.3	67.05	0.0	0.00
	54948.6	71%	10543.6	13%	11874.4	15%	12.9	1%

having or tending to have conditions similar to those of natural stands. Afforestation and/or reforestation programs tend to protect or reclaim soils so natural conditions may return or to produce wood for one or several particular uses. Plantations grow from a few centimeters in height when recently planted to a few meters after a few years. Normally plantations and artificial regeneration areas have uniform heights and a crown cover closure of more than 50 percent, as seen from the air. There are quite a few different species of trees being planted and in trial testing for future utilization in the GRB and environs.

The objectives of plantations within GRB are (1) to produce wood for commercial uses, such as sawnwood; (2) to produce wood for firewood and charcoal; (3) to protect agricultural fields as windbreaks; (4) to produce food for both local and outsid consumption, and (5) to regenerate and protect degraded or endangered soils.

The species most commonly in use are as follows:

• Gmelina	Gmelina arborea
• Eucalyptus	Eucalyptus species
• Neem	Azadirachta indica
• Casuarine, Filao	Casuarina equisetifolia
• Cashew	Anacardium occidentalis
• Cassias	Cassia species
• Acacias	Acacia species
• Teak	Tectona grandis
• Pines	Pinus species
• Kembo, Mesquite	Prosopis africana
• Ronier, Borassus Palm	Borassus aethiopium
• Nevadayo	Moringa oleifera
• Rosewood	Dalbergia species
• African mahogany	Khaya senegalensis
• Ipil-ipil	Leucaena leucocephala
• Bombax	Bombax species
• Kapok, Fromagier	Ceiba pentandra

Within the GRB, plantations are widespread, with some areas having a greater share than others. In The Gambia, the majority of the areas planted are located in the Western Division, in Senegal around the Sine Saloum and Senegal Oriental Regions, and in Guinea around Koubia, Mali and Labe, within and immediately adjacent to the GRB.

The Gambian experience has concentrated on Gmelina arborea plantations, mostly around Banjul in sandy clay or clay soils with shallow/coarse surface and a mean yearly rainfall of around 1,000 mm. Examples are found in the Nyambai Forest Park, near Brikama, and Finta Manereg Forest Park, south of Faraba Banta. Other major species tried in The Gambia are teak and ipil-ipil, the former being more widespread. Less important species, in terms of area, are Eucalyptus camaldulensis and bamboo (Oxytenanthera abyssinica or Bambusa vulgaris). The success of these plantations has been questionable, due to the problems with initial survival and lack of protection against periodic fires that have required periodic replantings.

Most of the problems experienced in The Gambia can be summarized as follows: (1) deficient and insufficient personnel to supervise planting, (2) inefficient transportation of seedlings, causing delays and initial mortality of seedlings (sometimes dead seedlings are being planted), (3) poor weeding at the start of the plantation and in subsequent years, and (4) periodic fires, the effects of which have been increased by abundance of debris due to deficient weeding.

In Senegal, the preferred species tried in the GRB are Gmelina, neem, eucalyptus (various species, especially E. camaldulensis), teak, cashew, Melaleuca leucadendron, mesquite (P. juliflora), several acacias (principally A. senegal and A. albida) and some species of Combretum. The majority of these plantations are concentrated in Sine Saloum and Senegal Oriental Regions. The soils of these regions are mostly sandy loams, with quite a large area in the northeast underlain by lateritic pans (cuirasses). These soils are highly susceptible to wind once the vegetation cover disappears, making it almost impossible to regenerate the cover. The majority of the plantations we observed in these regions were windbreaks. The precipitation ranges from 800 mm in the northernmost portion of the GRB to about 1,000 m south of Tambacounda.

Field observations tell us that the failure of plantation programs in Senegal probably is due to (1) lack of protection from grazing animals and periodic clearing fires, and 2) people utilizing plantations to obtain firewood. The majority of local plantations observed were very small woodlots started by the local people for eventual firewood production, rather than soil rehabilitation or windbreaks. For soil rehabilitation A. albida has been used (providing nitrogen fixation); Combretum sp and Eucalyptus camaldulensis are planted for firewood. The best results are expected when the population is involved in the protection of groundnut fields, for the production of firewood and for food production (such as the successful cashew plantings as live fences). The most serious problem is the extraction for charcoal, which has already peaked in Sine Saloum region, leaving the area highly exposed to wind erosion and sun effects.

In Guinea, aside from fruit plantations of mangoes and oranges observed in the field, cashew and Gmelina have been utilized as reforestation species in and around Koubia and Mali (within and very close to the basin). Eucalypts and pines also have been tried out near Labe and sufficiently close to the basin to be mentioned. These plantations are between 18 and 20 years of age and are run by the Forest Service of Guinea. In all these cases nurseries providing the seedlings were created at or very near the site of plantation.

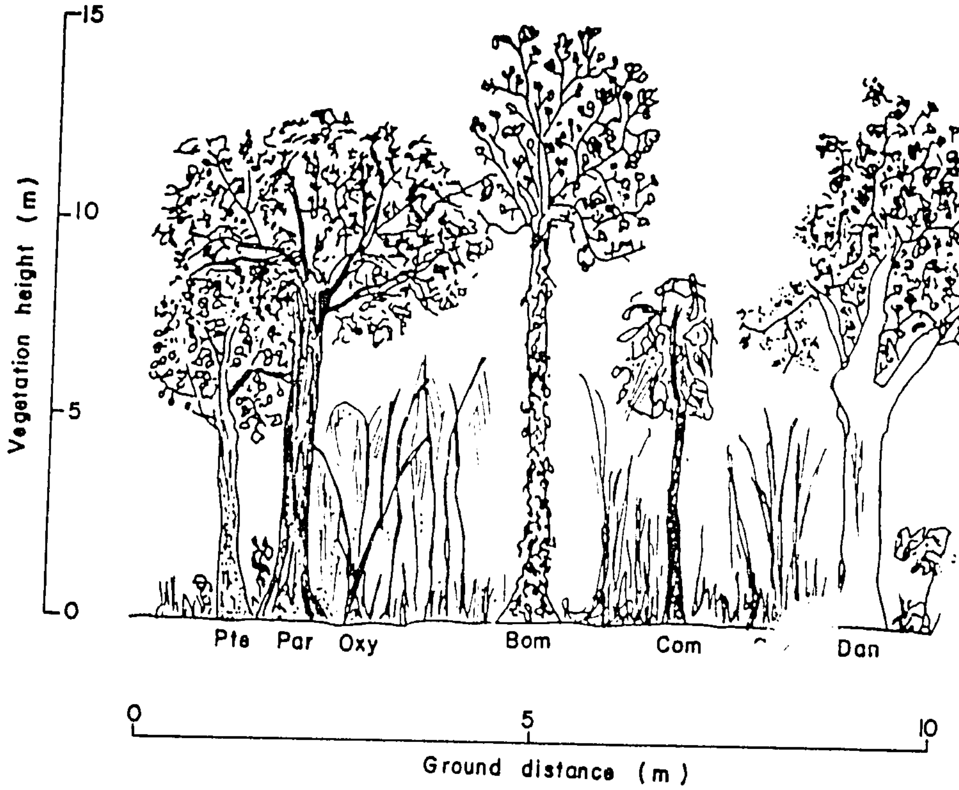
From our field observations, it seems that uncontrolled fires and grazing are the most formidable problems for reforestation efforts. These efforts would be more successful if the population were directly involved in the plantations, and they, not the Forest Service, were taking care of and benefiting from the forest production.

2.2.2.2. Natural closed or dense forested areas. This community includes trees, tree-like and shrub covered areas with a crown closure or cover, as seen from the air, of more than 50 percent, composed mostly of tree species of more than five meters in mean height. The majority of plants are deciduous during the dry season, with a clear dominant canopy and an arbustive understory.

The height of this class is highly variable within the Basin, but it is more than five meters in average height and can go as high as 15-20 m, with some individuals even higher (such as Khaya senegalensis). The mean height observed was about 12 m. There is a clear dominant canopy, under which are juveniles of the same species, available to replace the dominant canopy. Under the canopy one finds an arbustive understory of smaller trees, with some perennial grasses and herbaceous plants, the amount depending on the crown closure (the more closure, the less understory). This crown is quite varied within the Basin, and was not found to be more than 80 percent. The average crown closure is estimated at 70 percent.

As noted earlier, fire has altered species composition throughout the basin and today this class represents the interaction of anthropogenic factors with the edaphic, climate and biotic factors. Areas where human influence has been the greatest present a different composition than those where this influence has been minimal, even though both areas are classified as closed forest. Figure 2.2 shows a forested area in Guinea classified as 1.2.

Because of the great alteration of the forests, especially in highly populated areas, species composition often does not reflect natural conditions. Therefore, we have devised a dual qualification of species composition: species habitat range, and species abundance. Species habitat range refers to how widely distributed a given species appears to be within closed or dense forest areas. The abundance refers to how numerous a species appears in a particular area within the closed or dense forest, due to particular land use activities or habitat conditions. In this particular qualification one can separate the fact that a species may be quite widespread within the basin but still does not represent a large percentage of the total number of individuals. This could be due to the fact that the particular species has either been over-exploited, such as African mahogany, has been singled out for survival by the population (Cola cordifolia and Parkia biglobosa), or has survived a particular land use activity such



A closed or Dense Forested Area in Guinea. (Pte = Pterocarpus sp.; Par = Parkia sp.; Oxy = Oxytenanthera; Bom = Bombax sp.; Dan=Daniellia sp.; Com = Combretum sp.)

as fire (Daniellia oliveri and Combretum sp). The analysis of data from 16 sites classified as closed or dense forest showed 43 forest species as most common, of which 14 are further analyzed in Table 2.6. The the western and southern part of the basin, areas with precipitation generally above 900 mm. If one draws a line roughly following the road Kaolack-Tambacounda-Mako-Kedougou, this class generally appears south of that line. There is some 13,000 Km^2 of closed or dense forest in the GRB, representing 17 percent of the total area (see Table 2.4) with 4,800 Km^2 in Senegal, 800 Km^2 in The Gambia, 7,500 Km^2 in Guinea and about 15 Km^2 in Guinea-Bissau (the only class identified in Guinea-Bissau) (see Table 2.5). Fifty-seven percent of this class is in Guinea. This is rather important, in that the closed or dense forest area represents more than 60 percent of the total Guinean area in the basin. In contrast, the closed or dense forest only represents nine percent and eight percent of Senegal's and The Gambia's areas of the GRB, respectively.

TABLE 2.6

HABITAT RANGE AND ABUNDANCE OF 14 SPECIES PRESENT IN CLOSED OR DENSE FORESTS OF THE GRB

Species	Habitat Range	Abundance	Family
Pterocarpus erinaceus	14/16	3.2	Papilionaceae
Combretum sp.	13/16	3.0	Combretaceae
Parkia biglobosa	11/16	2.1	Mimosaceae
Ficus sp.	12/16	1.4	Moraceae
Bombax costatum	11/16	2.6	Bombacaeae
Daniellia oliveri	9/16	3.2	Caesalpiniaceae
Terminalia sp.	9/16	2.1	Combretaceae
Bauhinia thonningii	8/16	2.3	Caesalpiniaceae
Khaya senegalensis	8/16	1.3	Meliaceae
Vitex sp.	6/16	2.1	Verbenaceae
Erythrophleum guineensis	5/16	2.2	Caesalpiniaceae
Acacia sp.	5/16	1.0	Mimosaceae
Oxytenanthera abyssinica	4/16	3.0	Andropogonaceae
Cola cordifolia	4/16	1.2	Sterculiaceae

The vast majority of the closed or dense forest of The Gambia and Senegal has been affected by logging, firewood collection, land clearing for agriculture and repeated fires. In Guinea the picture is similar, but most of the alteration is probably concentrated in the highly populated areas of the Fouta Djallon (densities of 80 inhabitants per Km^2 (UNDP, 1983). The degradation results largely from uncontrolled fires set for land clearing, to eliminate vegetation debris, to drive game and to promote new grass growth for grazing.

These practices have caused both degradation and deforestation in the area. Degradation is best exemplified by the scarcity of African mahogany in the 16 sites mentioned above and the even greater scarcity of Parinari excelsa. At one time, Parinari may have formed a dense forest in the Fouta Djallon (UNDP, 1983), but it is now limited to patches in Lower Casamance of Senegal, where humidity is much higher (Aubreville, 1950). Degradation causes a decrease in volume of growing stock, the possibility of permanent alteration due to continuous use of fire and, as a corollary, the presence of secondary forest continuously becoming less dense, open forest. Degradation is difficult to quantify, as the recent forest inventory of The Gambia pointed out, due to the variety of land use classifications used in past studies. But the areas of dense forest of The Gambia (mangrove and closed woodland) are decreasing and those of less dense, open forest are increasing (Forster, 1983).

In Senegal the excessive exploitation of the forest (especially for the production of firewood and charcoal, estimated at two million cubic meters, (about the productive capacity of the forest), affected some 350,000 ha in the period 1976- 1980 (CTFT/SCETINTAL., 1981). The GRB portion of Guinea is almost entirely within the Fouta Djallon, which has seen repeated calls for an integrated management scheme, beginning officially in 1959 in the Interafrican Conference on Soils, in Dalaba, where the Government of Guinea asked for such a management scheme). The latest request is a proposal by UNDP/FAO to conduct several integrated natural resources studies in the Fouta Djallon, aimed at slowing and eventually stopping the degradation processes which have been observed there (UNDP, 1983).

Deforestation, the outright loss of forest vegetation to other land uses, is somewhat easier to quantify. The forest inventory of The Gambia found no decrease in the forest area since 1968 (Forster, 1983). In Senegal, it is estimated that at least 40,000 ha/yr will be lost to advancing agriculture and grazing, especially in the Departments of Kaffrine, Tambacounda, and Middle and Upper Casamance, containing portions of GRB (CTFT/SCETNTAL., 1981). A study of an area in the Lower Casamance reported a loss of 1,800 ha of forest land in an area of 14,000 ha between the period 1969-82, caused by fire, exploitation of wood resources, grazing and land clearing for agriculture (Harza, 1984a).

Further quantification of the closed or dense forest class can be obtained by finding the basal area and volume per hectare. The data gathered to assess the richness of the forest show this class as having 11.1 m^2/ha of basal area. The Gambia forest inventory puts a similar class (closed woodland) also at 11.1 m^2/ha. Our figures are 11.5 m^2/ha for Guinea and 10.6 m^2/ha for Senegal. This simply indicates that the closed forest is somewhat richer in Guinea and slightly poorer in Senegal.

There are many uses of the vegetation in the closed forest community but the most important in this class of forests are firewood and/or charcoal production, commercial wood extraction, and the collection of food and forage. There are other, more specialized uses (i.e. medicinal, ritualistic, rope making, etc.).

2.2.2.3. Open, less dense forest and wooded savanna. This community is composed of trees and shrubs dispersed to the point that crown closure or cover, as seen from the air, is less that 50 percent. There is a ground cover of small shrubs, herbaceous and grassy vegetation. The larger trees and shrubs are mostly deciduous during the dry season.

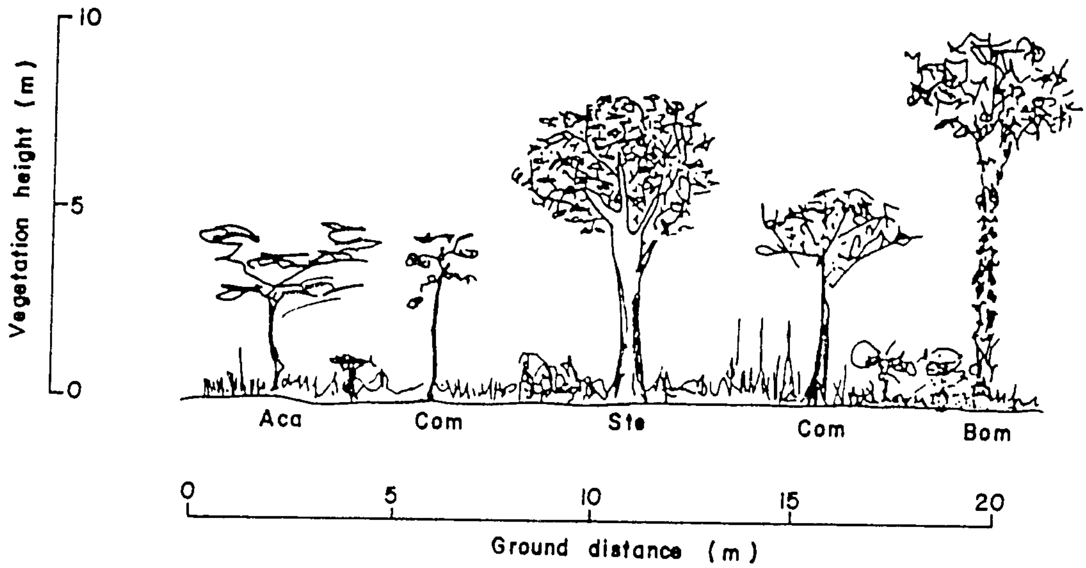
The main difference between this class and the preceding one is that crown cover is reduced in the open forest. This normally translates into fewer trees per unit area and thus less basal area. Less crown cover also means greater sunlight penetration, which causes a more abundant grass and herbaceous vegetation than in the closed or dense forest.

The height of this formation is variable, but it is not as great as that of closed forest. Within the Basin, it is normally less than 12 m and can also contain tree and tree-like vegetation of less than three meters in height. There is no clear dominant canopy, but several heights share dominance over small shrubs, herbaceous and grassy vegetation. Grasses often attain more than 1 m in height. Among our sample sites, the crown cover varied but was never estimated to be less than ten percent. The average crown closure was estimated at around 30 percent.

The human factors have throughly affected the composition of the open forest class. For the most part the open forest is a secondary stage of degradation of the closed forest that has come about through frequent fires, wood cutting, and land clearing, with the periodic fallow of agricultural land. Figure 2.3 shows an area in Senegal classified as open forest. Note the abundance of grassy and herbaceous ground cover. The grass in some areas attains two meters in height and is dense enough to impede movements of humans and large animals. The analysis of 31 sites classified as open forest showed 57 species as most common, of which 23 are further analyzed in Table 2.7.

Dual qualification of the species found in this class gives species habitat range and abundance. The composition is generally the same as in the Class 1.2. Twelve of the 14 species shown in Table 2.6 for closed or dense forests in the first 14 shown in Table 2.7; the other two also are among the 23 shown in Table 2.7.

Figure 2.3



An Open forest Area in Senegal (Aca= Acacia sp. Com.=Combretum sp., ste = Sterculia sp., Bom = Bombax sp.)

TABLE 2.7

HABITAT RANGE AND ABUNDANCE OF 23 SPECIES PRESENT IN OPEN, LESS DENSE FORESTED OR WOODED SAVANNA AREAS OF THE GRB

Species	Habitat Range	Abundance	Family
Combretum sp.	27/31	2.9	Combretaceae
Bombax costatum	27/31	2.0	Bombacaeae
Pterocarpus erinaceus	23/31	2.2	Papilionaceae
Terminalia sp.	21/31	2.3	Combretaceae
Parkia biglobosa	20/31	2.1	Mimosaceae
Acacia sp.	20/31	1.7	Mimosaceae
Ficus sp.	18/31	1.4	Moraceae
Daniellia oliveri	17/31	2.1	Caesalpiniaceae
Bauhinia thonningii	17/31	1.7	Caesalpiniaceae
Sterculia setigera	12/31	1.6	Sterculiaceae
Vitex sp.	10/31	1.8	Verbenaceae
Khaya senegalensis	10/31	1.6	Meliaceae
Borassus flabelifer	9/31	1.6	Cycadaceae
Prosopis africana	9/31	1.4	Mimosaceae
Lannea acida	9/31	1.1	Anacardiaceae
Afzelia africana	8/31	1.9	Caesalpiniaceae
Cola cordifolia	7/31	1.6	Sterculiaceae
Cassia sp	7/31	1.1	Caesalpiniaceae
Erythrophleum guineensis	5/31	1.6	Caesalpiniaceae
Vittelaria paradoxa	4/31	1.7	Sapotaceae
Parinari paradoxa	4/31	1.5	Rosaceae
Oxytenanthera abyssinica	4/31	1.2	Andropogonaceae
Cordyla pinnata	4/31	1.0	Caesalpiniaceae

The two most important factors for the appearance of open forest areas, therefore, are a climatic one (precipitation) and an anthropogenic one (fire for land clearing). This is borne out by the fact that most of this class appears in the central and north-eastern parts of the GRB. There is about 43,000 Km^2 of open forest class in the GRB, representing 55 percent of the total Basin, by far the most extensive of the defined classes (Table 2.4). Of this total, 37,000 Km^2 is in Senegal, 3,000 Km^2 in The Gambia and about 3,000 Km^2 in Guinea. The area in Senegal accounts for 86 percent of the class total and is located mostly in the Sine Saloum and

Senegal Oriental Regions with precipitations of 600 to 1,100 mm, on sandy and lateritic soils.

The importance of open forest in Senegal is evident from the fact that it represents 67 percent of Senegal's portion of the Basin and is mostly situated in areas experiencing heavy human pressure because of agricultural (ground-nut) expansion and demand for firewood and charcoal. As with the closed forest, degradation and deforestation have taken their toll of the vegetation.

The data on the basal area show that the open forest has 5.8 m^2/ha of basal area within the Basin. For The Gambia the figure is 5.2 m^2/ha, for Guinea it was found to be 6.1 m^2/ha, and for Senegal 6.0 m^2/ha (see Appendix 4). These data suggest that The Gambia has the most depleted forest of the Class 1.3 of the three countries, while Guinea has the richest. As would be expected, the uses of the vegetation in this class are very similar to those of closed forest.

Due to its height and smaller average diameter of trees, Class 1.3 is more accessible to collection of firewood than Class 1.2. Furthermore, the tall grasses (<u>Andropogon</u> and <u>Paspalum</u>) and palms (<u>Raphia gracilis</u> and <u>Borassus aethiopium</u>) makes this class an important provider of building material for the rural population. The abundance of grass makes the open forest more favorable for grazing than the closed forest. The wood of <u>Bombax costatum</u>, one of the typical trees of this formation, frequently is used for "bantabas", or resting benches, in the main plazas of villages, especially in Senegal Oriental Region.

2.2.4. <u>Gallery or riparian forest</u>. This community includes trees, shrubs, and herbaceous vegetation growing in narrow bands along rivers, streams and drainageways that have satisfactory water regime all year round. It presents a high crown closure or cover, as seen from the air, often above 75 percent. This type of vegetation attains its maximum extension at the edges of the flood plain, in well-drained soils, and reaches considerable height (sometimes more than 20 m). There is a noticeable presence of lianas and epiphytes, and the vegetation is for the most part evergreen.

The height attained by the riparian forest in our sample was the greatest of all classes (on the average) except for Site 18R near Koura (Guinea) where heights easily surpassed 20 m. Site 18R was closed forest (Class 1.2), on a rocky, rudged terrain near the boundary of the basin. The riparian forest has a clear dominant canopy, with a secondary one. The dominant canopy attains heights of 20-25 m and is composed of large diameter trees with hanging lianas and climbers; the secondary canopy is composed of less light-demanding species of medium to small diameters (see Table 2.8). The ground is for the most part clear, with a few annual grasses and some herbaceous plants. The vegetation is basically evergreen year-round, although it often contains species that are deciduous in Classes 1.2 and 1.3. This is likely due to water availability and good soil conditions (alluvial soil with ample organic matter).

TABLE 2.8

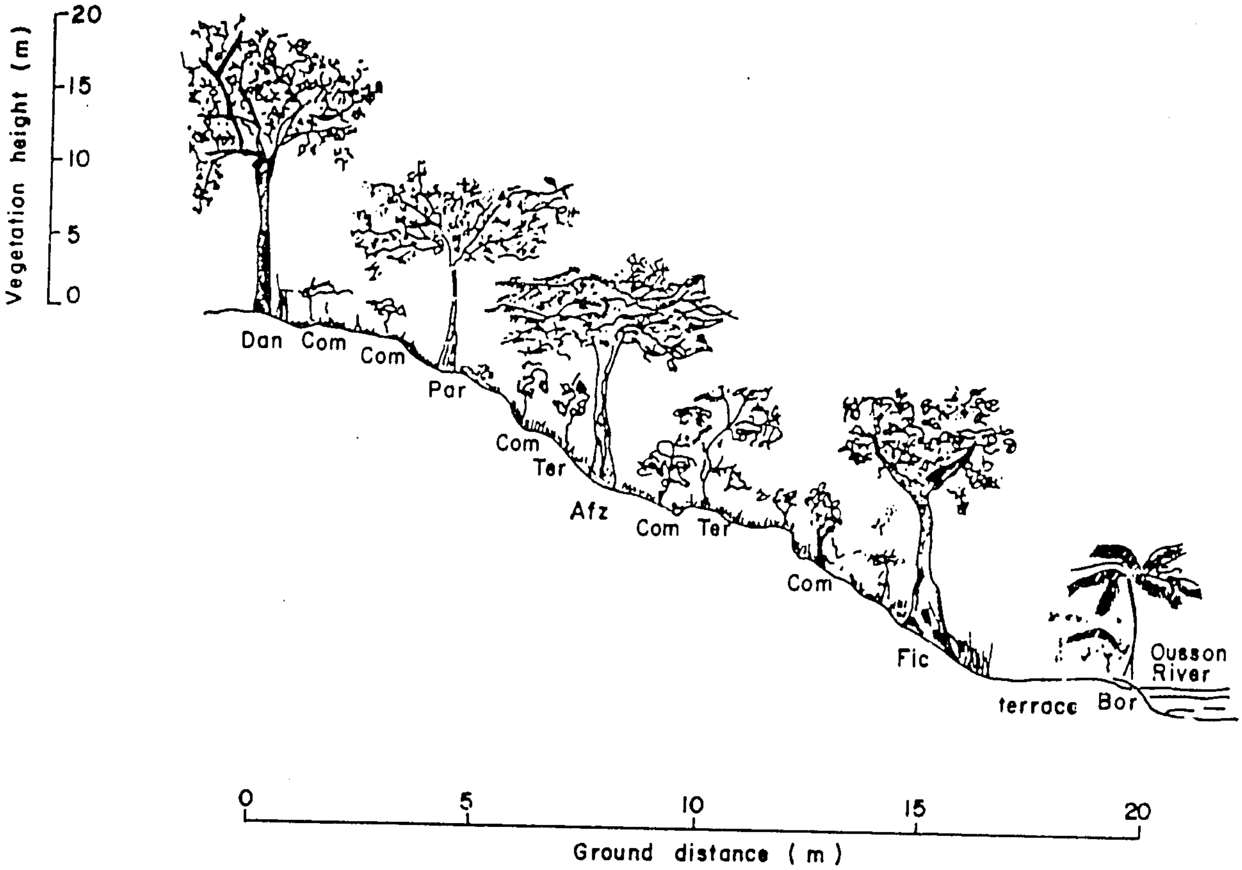
HABITAT RANGE AND ABUNDANCE OF 18 SPECIES PRESENT IN GALLERY OR RIPARIAN FOREST OF THE GRB

Species	Habitat Range	Abundance	Family
Ficus sp.	7/12	2.4	Moraceae
Combretum sp.	5/12	3.4	Combretaceae
Bauhinia thonningii	5/12	3.2	Caesalpiniaceae
Khaya senegalensis	5/12	2.2	Meliaceae
Parkia biglobosa	5/12	1.8	Mimosaceae
Pterocarpus erinaceus	4/12	3.7	Papilionaceae
Terminalia sp.	4/12	2.5	Combretaceae
Vitex sp.	4/12	2.2	Verbenaceae
Daniellia oliveri	4/12	1.7	Caesalpiniaceae
Cola cordifolia	4/12	1.5	Sterculiaceae
Borassus flabelifer	3/12	3.0	Palmaceae
Erythrophleum guineensis	3/12	2.7	Caesalpiniaceae
Anogeissus leiocarpus	3/12	2.6	Combretaceae
Afzelia africana	3/12	2.0	Caesalpiniaceae
Acacia sp.	3/12	1.6	Mimosaceae
Ceiba pentandra	3/12	1.6	Bombacaceae
Cassia sp.	3/12	1.3	Caesalpiniaceae

This class was the least affected by human factors. The reasons appear to be twofold. First, the land often is steep (an average slope of 14 percent in twelve sites) and rocky, making it less desirable for agricultural purposes; this is partly due to the fact that nearly all areas of riparian forest on alluvial soils have been cleared for agriculture. Second, the high moisture content of the foliage at the time that fires are prevalent (early to middle dry season) and the scarcity of ground level vegetation mean that fires do not sustain themselves in the riparian forest. The people in the countryside have already obtained most of the available benefits of clearing this class for agricultural purposes; furt! r reducing this vegetation would not represent a gain in agricultural area, so the vegetation is left standing. This is illustrated quite well near Labe, where the "source" or origin of the Gambia River is thought to take place. The area surrounding this "source" has been completely cut over and is being used for agriculture and grazing even though the slope is high (15 percent registered in this site 20R) the soil quite rocky. The "source" itself is covered by a few large trees. Yet there is human pressure due to the nearness of a large population center, Labe, where there is a high demand for agricultural products.

The riparian forest is similar to the preceding classes in tree species composition but differs in the size of the trees and the fact of its evergreeness. Figure 2.4 shows an area in Guinea classified as gallery or riparian forest.

The riparian forest is widely distributed throughout the Basin, although it only covers about 1,300 Km^2, or just under 2 percent of the total basin. Of this, 945 Km^2 are in Senegal (73 percent of the total), 122 Km^2 in The Gambia (9 percent) and 231 Km^2 in Guinea (18 percent). The class accounts for only about 2 percent of the total area of any country's portion of the GRB (Tables 2.4 and 2.5). The location and the distribution of the class within the basin are of paramount importance to wildlife, because it provides for shelter, food, water, and travel corridors. Numerous important animal sightings were made in or near riparian forest during our field work.



A Gallery or Riparian Forest in Guinea (Dan = Daniellia sp.; Com = Combretum sp.; Par = Parkia sp.; Ter = Terminalia sp.; Afz = Afzelia sp.; Fic = Ficus sp.; Bor= Borassus sp.)

Data collected in the field showed this class as having the highest basal area of classes sampled: 11.4 m^2/ha. The figures for The Gambia, Senegal and Guinea, respectively, are 10.3 m^2/ha, 12.5 m^2/ha, and 11.2 suggest that Senegal has the richest gallery or riparian forest while The Gambia has the poorest.

The uses of the species in this class are very similar to those described before. The palms in this class provide building materials, palm wine and fruits to local people.

2.2.2.5. Grassland or savanna. This class includes herbaceous and grassy vegetation with scattered shrubs and trees. The herbs and grasses are mostly perennial and may attain heights of up to 3 m; they are generally between 0.5 and 1.5 m in height.

In some places the grasses may be covered by shrubs giving the impression of a general canopy one or two metes high, but most of the vegetation is less than one meter in height. The percentage of ground covered seems high when observed at the ground level but closer inspection showed that ground cover varies from about 30 to 90 percent. The mean was estimated at around 50 percent.

Grassland is distributed throughout the Basin but has three areas of abundance. The first is in the north and northeastern part, where precipitation ranges from 600 to 900 mm and the soil is mostly sandy with an underlying iron pan (laterite) not too far from the surface. The second is in the region of Niokolo-Koba National Park, east of Dialakoto and north of Kedougou, where precipitation ranges from about 1,000 mm to about 1,300 mm and where the soils are sandy loams with rock outcroppings. The third area is in the southern part of the basin, where precipitation is above 1,300 mm, and soils are rocky, with extensive "bowals", or laterite flats.

There are two basic types of grassland: (1) primary or natural grassland which is edaphically soil conditioned or caused through natural fires, and (2) secondary or anthropogenic grasslands, originating from human activities (Walter, 1971). We believe that the grasslands of the GRB are particularly affected by anthropogenic factors, which have masked their origins and made it difficult today to identify clearly whether they are primary or secondary. This is particularly true in the first area defined above, the Sine-Saloum Region and Tambacounda Department of the Senegal Oriental Region, where fallow agricultural lands have failed to regain their original vegetation, because of seasonal fires and grazing pressure. To this has been added the last 10 to 12 years of drought and a general precipitation decline in the northern part of the basin since the 1950's (Hutchinson, 1982). These three factors, fires, grazing, and precipitation decline, have perpetuated the grassland condition, making it increasingly difficult for the original vegetation to regain the area.

The grasslands of the second area appear to be more edaphically controlled, but nevertheless affected by anthropogenic factors. There are two trends in this area. Within Niokolo-Koba National Park the grasslands are, for the most part, protected against human intrusion, but they are still subject to early burning (feu precoce) by the park staff. Landsat imagery shows severe burning within the park and we are not sure whether this is due to "feu precoce" getting out of control or to poachers flushing out game, which is known to occur in the area. Our aerial data (Landsat imagery, aerial photography and a lightplane overflight) indicate that grasslands are distributed within soils subject to periodic floodings during the rainy season. The other trend occurs east of Mako, towards Saraya, where annual fires and agricultural practices on shallow soils are conditioning grasslands on clayish soils. This has been accelerated by the widening of the Kedougou-Saraya road.

The grasslands of the third area, the southern part of the basin, are within Guinea and appear over extensive laterite flats. These flats are affected by unattended annual fires, occasional agricultural activities (which soon fail), and by grazing pressure. Again, a primary or natural grassland is being conditioned and perhaps modified by anthropogenic factors.

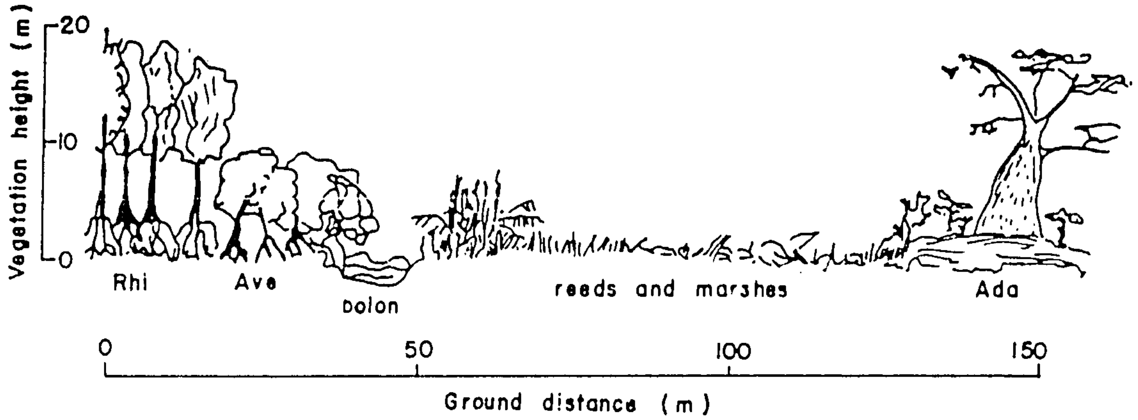
Grassland covers about 2,600 Km^2 or about two percent of the GRB (Table 2.4). Of this total, about 2,200 Km^2 (82 percent) is in Senegal, just over 40 Km^2 (2 percent) is in The Gambia and the rest (15 percent) in Guinea.

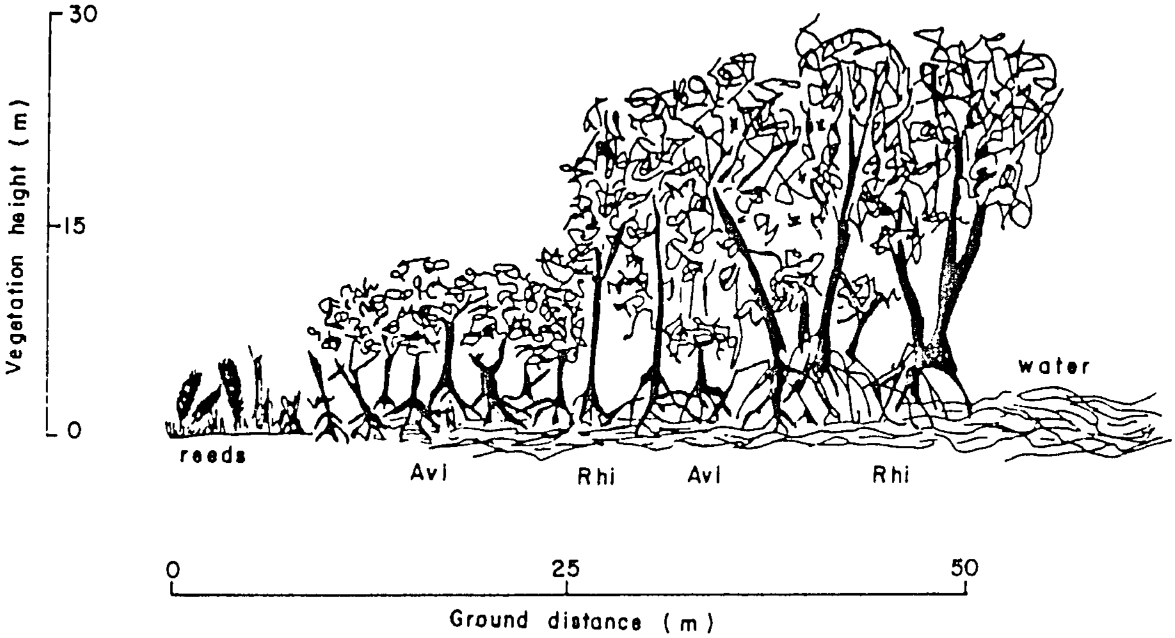
This class is quite important because its main use is grazing. Our field data support prior researchers' observations (CTFT/SECT Intal., 1981; Dunsmore et al., 1976; Forster, 1983; Dasman et al., 1978; Walter, 1971; UNDP, 1983) who point out that grazing has become a serious threat to this class in particular, and to forest vegetation in general. The area demanding the most immediate attention is the area in the north and northeast part of the Basin, where about 960 Km^2 or 45 percent of the total 1.5 class is concentrated.

2.2.2.6. Mangrove. This class consists of tree and shrubby vegetation growing in habitats periodically flooded by sea water (tidal influence) and river water. Mangroves are obligate halophytes; although some can grow in fresh water, they develop better in salt or brackish water. This vegetation will keep its canopy above the water at high tide while its root system stays submerged. The root system serves as breathing organs (pneumatophores), and must be exposed at low tide.

Mangrove vegetation attains heights of up to 40 m, although the formation in the GRB rarely attains such heights. Around Banjul it averages about 5 m in height. Near the mouth of the river, trees over five meters are scarce. The highest mangroves observed were between Yelitenda and Elephant Island. The crown cover, or closure, exceeds 80 percent throughout the mangrove area (see Figure 2.5).

The species of Rhizophora are the tallest of the mangroves and dominate the landscape seen from the river. They are closer to the open water and extend several meters inland. In unspoiled areas, the tidal river is fringed with a band of R. racemosa one or two trees wide, behind which is a broader band of R. harrisonii. Depending on conditions of tidal prism and soils, Avicennia may occupy the zone behind R. harrisonii. Where the tidal prism is less Avicennia prevails, generally attaining less height than the Rhizophora. The two mangroves may be intermingled throughout the area, but it appears that Avicennia grows better than Rhizophora in drier sites. Laguncularia was found in Oyster Creek near Banjul and in Tintiba on the Bintang Bolon. Johnson (1978) reported it only on Bund Road near Banjul.





A Mangrove Area near Balingho · (Rhi=Rphizophora sp., Avi = Avicennia sp.)

Mangroves occur north and south of the GRB on the Atlantic coast and around the mouths of the Sine Saloum and Dioumbus Rivers to the north and the Allahein, Dioloulou, Casamance and Sougrougou rivers to the south. (For a recent global as well as an African mangrove distribution see Saenger, ed., 1983.) Within the GRB mangroves are restricted to the main-stem Gambia River up to Pappa Island, and the many tributaries to the Gambia, the most important being the Bintang, Sami, Jurunkku and Jawara-Koular bolons.

There are discrepancies among estimates of the total mangrove area of the Basin (see Table 2.9). Our data, obtained by planimeter from the Use/Cover Maps, show 63,730 ha of mangroves, 91 percent of which are in The Gambia and 9 percent in Senegal.

TABLE 2.9

MANGROVE TOTAL AREAS FROM SEVERAL SOURCES

Source	Area (ha)
Brunt, 1959 (quoted by Forster, 1983)	66,000
Gigliogi and Thornton, 1965	45,000
Gambia Livestock Marketing Comm. 1971	65,644
Huygen, 1978	66,770
Johnson, 1978 and Abel, 1980	71,343
Saenger et al, 1983	60,000
Forster, 1983	66,900

According to Forster, 1983, the total mangrove area has not decreased since 1959 -- his figures are based on 1980 aerial photography -- but merely changed in composition from <u>Rhizophora</u> to <u>Avicennia</u> in the order of 15,000 ha. Forster, however, also states that mangroves are dying, especially along Bintang Bolon. From his figures (Table 10, page 46) one can surmise that there are some 1,650 ha of dead mangroves. Johnson, 1978 observed dead mangroves, although he gave no figures as to the extent. Chechi and Company, 1981, warned of a serious widespread mangrove disease in The Gambia, produced by a virulent strain of pathogen and suggested that by 1981 up to 95 percent of the high mangrove, more than 20 m height, had been killed. The same report stated that by 1986 most of the tall <u>Rhizophora</u> trees would be dead. Fortunately, this appears not to be true; our observations, supported by Snedaker (1984) and Twilley (1984) show that the problem is not as serious as originally thought. For one thing, the virulent pathogen has not been identified as the cause of death, and the diedback, although widely observed, is not as extensive as reported. We have examined 1/250,000 Landsat imagery (false color composites) of several dates and 1/50,000 color infrared aerial photography of January 1982 and have located affected areas in the GRB and north and south of it. These areas are in the Saloum river between Kaolack and Foundiougne, in the Memmeh Bolon near Memmeh, in the Jowara-Koular Bolon between Suarra Kunda and Baria, in the Bintang Bolon between Bintant Point and Mansabang, in the Allehein River, and in the Marigot de Baila. In all these areas the headwaters of the bolons or rivers appeared to be the most severely affected and the healthy mangrove vegetation increases as one moves down river towards the Atlantic or the mainstem Gambia River.

Our data, based on the analysis of 1979 and 1980 Landsat imagery for the stretch of Koular Bolon between Saboya and Baria, tend to confirm Johnson's (1978) conclusion that much mangrove dieoff occurred between 1972 and 1976, probably associated with the widespread Sahel drought. Rainfall data for many stations near the coast (Banjul Marina, Yundum, Kerewan, Jenoi, and Ziguinchor) show a significant decrease in 1968-1973, suggesting that one might look for effects as early as 1970 or 1971. Analysis of additional Landsat imagery would clarify this point.

Johnson (1978) estimated 8,700 ha of mangrove above the proposed Balingho site -- our estimate is 7,930 ha -- with a total volume of 1,150,000 m^3 of wood in that area, a mean of 132 m^3/ha. He gives a mean of 147 m^3/ha for mangroves (both <u>Avicennia</u> and <u>Rhizophora</u>) larger than or equal to 21 cm dbh (including underbark and stem and crown wood). Forster (1983) estimated 183 m^3/ha of total wood under bark (stem and crown wood presumably) for those mangroves defined as "High Mangroves" (more than 7 m in height). His definition of "high mangroves" may include some Avicennia, but they are "mainly Rhizophora".

Johnson's and Forster's figures are not readily comparable and but do indicate the high potential value of mangroves. The mean volume per ha is definitely larger than other forest classes within the GRB.

2.2.3. Agricultural Areas

These are areas used primarily for the production of agricultural crops on an annual, biennial or semipermanent basis. The class includes areas under actual cultivation at the time of the Landsat and fallow areas which may have been under cultivation in the last 3 to 4 years. Areas of this class also are sometimes used for grazing (immediately after crops have been harvested) and for some limited firewood collection (especially in the recently fallowed areas). This category covered 18 percent of the total area.

The agricultural production of the GRB is dependent on a rainy season that begins in May or June and ends in September or October. In the southern part of the basin (around 11°N) it begins around the second week of May and ends at the end of September early October. In the northern part (around 15°N) it begins at the end of May or early June and ends in mid-September. The hydrology report of the GRBS presents an updated version of the isohyetes of mean annual rainfall from 1928-1981 (Harza, 1984). The mean annual precipitation declines rather evenly from the north to the south, going from 600 mm in the north easternmost areas (between Goudiri and Bakel) to 1,600 mm in the south easternmost part, near Labe.

Each of the Basin's regions can be characterized in terms of relief, broad soil characteristics, and precipitation. The Fouta Djallon region is characterized by the highlands of the basin, a relatively steep topography, shallow soil on rocky pans, frequent and large rock outcrops and the highest precipitation, from about 1,200 to 1,600 mm. It is characterized by rainfed agriculture, the main crops being millet, rice, maize, sorghum, and yam.

The region between the Koulountou River valley and the Tambacounda-Naye road is characterized by a moderate to high slope, soils somewhat deeper than in the previous region, with higher clay content, many surface rocks and boulders, and a rainfall between about 1,000 mm and 1,200 mm. It includes the whole of Niokolo-Koba National Park. The agriculture is rain-fed with some small irrigated areas along the Gambia River and in the flatter areas. The main crops are rice, maize, millet, vegetables, cotton, and groundnuts.

The coastal plain region is flat, with sandy soils and a wide range of precipitation, from 600 mm in the northeast to about 1,200 mm in the southwest. Most of the area produces groundnuts and rice, together with vegetables, millet, sorghum, cotton, maize, and banan... This area contains almost all the irrigated and swamp agriculture in the Basin. Of the three areas, this is perhaps the most important in terms of production and extent.

The GRB is experiencing an extensive change in land cover and specific land use, from a forest vegetation cover to an agricultural land use. This change is most extensive in The Gambia and in the Senegal portion of the Basin to the north, northeast and southeast. The greatest amount of land use/cover change is due to the cultivation of groundnuts and to grazing. There are no reliable figures on the speed of these changes but we do know that the fallow period for agricultural lands steadily reduced and in some areas, due mainly to population pressure, has been all but eliminated. Agriculture development schemes all too often make recommendations for production increases based on making available more land rather than improving production of current agricultural lands. For example, the recent LRDC study (1984) draws 20 percent of the land suitable for rice cultivation from closed, open and riparian forest areas. The AHT/HHL (1983) feasibility study of possible irrigable lands for the Kekreti reservoir project, if carried out fully, would remove extensive areas of riparian forest, including some in Niokolo-Koba National Park.

The agricultural practices of the Basin are described in other GRBS report sections. It is appropriate to consider here some general principles which will be utilized in the discussion of impacts and mitigative suggestions.

2.2.3.1. Irrigated agriculture. This is agricultural land being irrigated by artificial means, mainly during the dry season, but on occasions also in the rainy season. The soil is covered with vegetation almost year round. Several crops are grown but preference is given to rice and bananas.

Irrigated agriculture in the GRB is almost exclusively restricted to areas close to the Gambia River. Two kinds of irrigation are seen in the field: one that uses a motor pump or gravity to bring the water to irrigation canals and another whereby water is manually brought to the fields in containers. The former is the more extensive, and the more efficient. The latter is much less common and only occurs near the river banks where the height difference between the river and the plot is not too great. The individual areas cultivated by the second method are too small to effectively plot on the 1:100,000 land use maps.

The two most common crops are rice, and bananas.

The total area for this class was estimated at 1,900 ha or 0.02 percent of the total GRB area. Of this 600 ha is in Senegal and 1,300 ha in The Gambia (Tables 2.4 and 2.5). The FAO, 1983 figure for The Gambia was 1,100 ha. For further discussions see Carney (1984).

2.2.3.2. Rainfed agriculture. Most agriculture in the Basin depends on seasonal rains for moisture. Planting generally occurs at the beginning of the rainy season and vegetation appears towards the middle of the season. Harvesting occurs towards the end of the rainy season and early in the dry season. The soil is devoid of natural vegetation most of the time. Several crops are grown, the most important being groundnuts, rice, maize, millet, and sorghum.

The products of this class are generally called upland crops, with two types are differentiated: one in the upland flat areas and another in the upland depression areas (Dunsmore, 1976; Carney, 1984). Rainfed agriculture is by far the most important agricultural activity in the GRB, covering 98 percent of all agriculture land. Our estimates showed 13,340 Km^2

of rainfed agriculture (17 percent of the GRB), of which Senegal has 9,390 Km^2, The Gambia, 3,590 Km^2 and Guinea 360 Km^2. Most of the areas in Senegal and The Gambia are planted with groundnuts. The crop has two varieties: one which spreads on the ground, has larger seeds and matures in four to five months, and an erect or upright variety which matures in three to three-and-one-half months and is easier to harvest. Groundnuts are planted as soon as the rains start and are harvested at the beginning of the dry season. The whole plant is collected and used: the groundnuts for human consumption and the leafy part for forrage.

Groundnut culture is concentrated in the third region described above, north of the Gambia River and north of isohyete 1,000 mm.

The other crops present in this class are rice; findo; maize, millet (a hardy crop that will grow in poor sandy or rocky soils), sorghum, and cotton. Millet and sorghum normally are intercropped or rotated with groundnuts. In Guinea, millet was observed in rocky, steep slope, poor soil terrain. (See also specialized GRBS reports, Dunsmore et al, 1976; and MacDonald and Low, 1984, a and b).

2.2.3.3. Swamp agriculture. There are crops grown in swamp areas subjected to periodic flooding by rain and/or rivers. In the GRB floodings occur during the rainy season (spring tides augmented by high flows) and daily along the Gambia River because of tidal influence (daily tides). The flooding by fresh or brackish water keeps the ground wet most of the year. Vegetation covers the ground almost year round. This class is almost exclusively cultivated in rice.

Three types are normally differentiated, although authors do not agree on the exact descriptions: (1) areas constantly flooded by fresh water; (2) areas under the influence of tidal flooding that are affected by brackish water, and (3) areas that have been cleared of mangrove vegetation and are, by definition, subjected to influence of brackish waters (Dunsmore et al, 1976; Carney, 1984). This class is the second most important agricultural activity in the GRB. It represents about two percent of all agricultural lands and it presents the opportunity for a dry season crop.

Swamp agriculture covers about 240 Km^2 (0.32 percent of the GRB), almost all of it in The Gambia (225 Km^2), with the rest in Senegal (19 Km^2). FAO (1983) put the Gambian figure at 168 Km^2.

2.2.4. Urban Areas

These are areas occupied by villages, towns or cities, ranging in population from a few dozen to tens of thousands. Their primary function is human habitation. This category covers about one percent of the Basin.

The Basin's population, its distribution and concentration, is discussed in other parts of the GRBS report. The classification used here will only show basinwide population concentrations and is intended as a guide to location and size. The working scale, 1:250,000, would only allow identification of communities of considerable area and those communities easily identifiable. Many small, rural communities are so concealed by their natural surroundings as to be difficult to identify at the working scale of 1:250,000 and the low resolution medium used, Landsat.

2.2.4.1. Large communities. Population centers more than 40 hectares in area are important centers of trade, services, communication, and production. A communication infrastructure is essential to their existence so they are located along major roads and usually near the Gambia River. They serve as poles of attraction to smaller rural communities.

2.2.4.2. Small communities. Most of the small, rural communities (less than 40 ha) are located in areas with minimal communication and transportation infrastructures, except those along main and secondary roads. Those further from the beaten track normally lack services and communications. They are difficult to identify on Landsat imagery and are almost always surrounded by agricultural fields.

2.2.5. Special Cover Classes

Certain categories that are not vegetative, agricultural or urban fall into this class. The designations here do not necessarily have anything in common except their exclusion from the previously defined classes. They occupy about four percent of the total area.

2.2.5.1. Water bodies. This includes all open bodies of water: rivers, streams, ponds, etc. The most important one is, of course, the Gambia River. Water is estimated at 1,060 Km^2, of just over one percent of the total area. By countries, The Gambia has most of this class, with over 820 Km^2, Senegal has about 80 Km^2, and Guinea has 160 Km^2.

2.2.5.2. Wetlands (swamp areas). These are areas flooded with standing water for much of the year, supporting a short vegetation, mostly of grasses, aquatic plants and palms. They are different from the mangroves and swamp agriculture areas defined earlier.

Swamps are located in brackish water along the Gambia river extending up-river to around Kuntaur-Baboon Island, and in fresh water throughout rest of the basin. Further, most of these areas present two stages: flooded during the rainy season and dry or semidry during the dry season. Each has particular plant associations.

Swamps cover 1,600 Km^2, or 2 percent, of the total GRB. Of this 495 Km^2 occurs in Senegal, and 1,100 Km^2 in The Gambia. There are some swamp areas in Guinea, but their sizes and numbers are too small to be detected on Landsat.

Swamps are important for agricultural development and for grazing especially in The Gambia. They also provide important wildlife habitat, especially for birds.

2.2.5.3. Barren flats ("tannes"). These are areas with little or no vegetation, on their highly leached, strongly acid, saline or saline-alkaline soils. They appear behind swamp areas or in the fringes of areas that have been drained for agriculture and then abandoned because of drought. The identified areas are almost exclusively located on the margins of the Gambia River from Gouloumbo to Banjul, but it is doubtful that this is an accurate picture of the distribution of this cover class, as there are many areas too small to show on Landsat. Areas identified as barren flats cover only 90 Km^2 or (0.12 percent) of the GRB; of this, 84 Km^2 is in The Gambia and 6 Km^2 in Senegal (Tables 2.4 and 2.5).

2.2.5.4. Bare lands and rock outcrops. These are in some parts of the Basin substantial areas with essentially no vegetative cover. Areas of bare rock and laterite flats. Most are in the mountains of Senegal and Guinea. The total area is 570 Km^2 (.73 percent of the Basin), three-quarters of which (380 Km^2) is in Guinea and the rest (190 Km^2) in Senegal.

3. WILDLIFE[1]

3.1. Introduction

The wildlife[2] of the Gambia River Basin is well known taxonomically, due to more than a century of work by British and French scientists. The species, therefore, have been named and their taxonomic positions much investigated. Ecologically, however, the basin's wildlife is known only generally and much work remains to be done on food habits, movements, habitat requirements and social behavior, all of which strongly affect the ways that species interact with man.

3.1.1. General Considerations

In view of the magnitude of the propcsed developments, not only in spatial and economic terms, but ecologically as well, there are two considerations which are important to this investigation: The regional perspective, and the concept of conservation with development.

3.1.1.1. The regional perspective. Many animals, especially birds and some of the larger mammals, are highly mobile. They have large home range areas, or exhibit seasonal migrations for a variety of reasons. Because of this, concentrated analyses limited to "development impact areas" are not ecologically sound approaches for wildlife assessment of major river basin developments. Animals do not recognize political or administrative boundaries. Since all but one (Kogou Foulbe) of the proposed developments are centrally located within the Basin, this report

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1/ This chapter has been condensed from working document No. 65, Treadwell B.D., and P.L. Ames.

2/ The term "wildlife," by generally accepted convention, and as used here, refers to all land vertebrates: mammals, birds, reptiles and amphibians, including the aquatic members of those classes such as whales, manatees and crocodiles. The term "fauna" includes all animals, regardless of life form, i.e., wildlife, plus fish, insects, crustaceans, worms, etc.

first considers the fauna in the basin-wide view then summarizes the status of the local wildlife within each of the development zones.

An even broader perspective is necessary for wildlife assessments. The contiguous distribution of many wildlife species has been disrupted by man, resulting in remnant populations of some species. There often is little interest in conserving species that are ubiquitous, but when a species becomes extremely restricted in distribution and numbers, as have elephants and eland, it becomes a focal point. The fact that the last of the Senegal River elephants was killed this year (1984), making the group in Niokolo-Koba National Park the last of the interior elephants west of the Senegal River, increases the importance of the species with the Basin.

3.1.1.2. Conservation with development. The fact that there are serious plans to construct a dam along the southern boundary of Nickolo-Koba National Park in Senegal-Oriental underscores the necessity for the concept of "conservation with development." By international accord the Park is set aside, to be permanently protected and supposedly sacrosanct. But national priorities for development, whether for water management or other actions towards self-sufficiency, take precedence over the conservation of natural resources. International agreements do not alter the course of development once it is set in motion. Nor is it necessarily in the national interest to do so. Reports such as this one can provide planners with a perspective that might otherwise be overlooked.

Wildlife invariably ends up low on the scale of development priorities. The burden is on the wildlife ecologist to demonstrate compatible alternatives or modifications to proposed development scenarios. Moreover, if it can be shown that the wildlife can "pay for itself" by providing a food supply, revenue from hunting and tourism, or a combination of these, new economic dimensions are perceived by the development planners.

Innovative mitigations, as well as viable compensatory measures, augmented protection, and research/monitoring designs must also be conceived and implemented if wildlife is to survive the development process. This might be construed by the more militant conservationists as a defeatist attitude, but it is simply realistic. One must be prepared for any eventualilty, because in wildlife conservation, second opportunities are rare.

3.1.2. Approach to the Study

Some of the topics of interest and key species were apparent from the beginning of our study. Rare and endangered animals are always a focal point for international concern and pest animals were important to consider because of the planned agricultural development. In other respects, howver, it is more prudent to begin with a general viewpoint, and let important faunal issues define themselves in due course.

Because the wildlife ecology of the Basin is not well known, an initial and continuing emphasis was placed on literature review, which, as expected, provided many useful pieces of information from sometimes obscure sources. Simultaneously, meetings with informed professionals were held to tap into the other source of extant information.

For the mammalian fauna, much of which is scarce and elusive outside of Niokolo-Koba National Park, a detailed and structured interview was developed for collecting information from local hunters. It included numerous repetitive questions posed in different ways in order to ascertain if responses were consistent. The questions were generalized at first, then progressed to the necessary details on such topics as which animals were used for food and how they were acquired, which ones posed problems for agricultural crops or livestock and how they were controlled, which animals formerly were found in the area, and so forth. Considerable effort was made not to let the informant know which species were of particular interest. For instance, the same emphasis was placed on jackals raiding groundnut fields as on leopards depredating livestock. The interviews always began with requesting the names of the animals in the local language, and later the correct scientific name was determined by matching the local name with pictures. As an additional control, the pictures included several species which do not occur in the area. If doubt still existed on any identifications, queries were made to test the informant's knowledge of unique habits of the animal in question.

Whenever and wherever possible, forays were made into the bush so that the informant could demonstrate his knowledge by showing us definitive sign of the animals (nests, tracks, etc.). It soon proved to be much more efficient always to work with a local guide. The Basin is quite large, and ground expeditions are very time consuming, so it rarely paid to mount random excursions. In total, about 20 percent of the 18 man-months expended evaluating the mammalian fauna of the Basin was spent in the field.

Livestock and rangeland conditions were assessed, as per the Work Plan, by general field observations of the distribution and condition of rangelands, and by discussions with personnel of the USAID Bakel Livestock Project in Senegal and the Mixed Farming Project in The Gambia. In Guinea, the GRBS Staff Veterinarian investigated additional aspects of the livestock industry. Socioeconomic parameters concerning livestock are presented in another volume of the GRBS report.

Additional information on the methodologies employed during this study is presented in Working Document No. 26 (Ames et al., 1984).

In this report, we adopt divisions of wildlife based on their importance to man. These divisions, which cut across the usual zoological classification, facilitate the identification and analysis of man-wildlife interactions:

- Species classified nationally or internationally as "rare, endangered or threatened" or considered of special scientific interest.
- Pest species: predators on livestock or crops, or representing a danger or nuisance to humans.
- Species valued for consumptive utilization, hunted for meat, hides, trophies or some commodity such as ivory.
- Species of touristic value.

Many species in the Basin occupy two or more of the above categories and will be treated as such in our text. Crocodiles, for example, are listed as "Endangered" or "Threatened" by the International Union for the Conservation of Nature and Natural Resources (IUCN) but continue to be hunted for their hides and to be treated as dangerous pests by many people.

Of the four categories listed above, the last is the most difficult to evaluate, because the tourist experience is such a composite one. Each tourist comes with individual expectations and leaves with impressions and experiences that may or may not coincide with expectations. The tourism agencies of The Gambia and Senegal, as well as the private companies, have gone to some trouble to meet the varied desires and needs of the visitor. These include hotel and transportation facilities, guide services, and a number of less tangible aspects such as recreational opportunities, exposure to local art and village life, and wildlife observation. The political stability of the area and the local use of English and French also attract tourists.

The majority of tourists of Senegambia come from Western Europe, although The Gambia is beginning to attract the attention of Americans, especially blacks interested in their cultural heritage. Tourists are lured to the region by brochures, magazine advertisements and the advice of travel agencies, and by accounts of other travelers. Although the income derived by Senegal and The Gambia is not great comparison with the major exports, it is nevertheless substantial.

The role of wildlife in the total tourist experience has not been quantified, nor can it be easily separated among the various types of wildlife. Certainly the 4,000-odd who visit the Niokolo-Koba National Park annually do so to see wildlife. Several hundred visitors come to The Gambia every winter solely to watch birds and many send accounts of their observations to the Gambia Ornithological Society.

For the purpose of evaluating the touristic importance of various types of wildlife, we will rely on our personal interviews with the staff of the Department of National Parks (Senegal), and the Department of Wildlife Conservation (The Gambia), the Gambia Ornithological Society (including archives), and numerous individual tourists. These sources have provided sufficient information to allow us to assign relative touristic values to some kinds of wildlife.

3.1.3. Major Limitations

3.1.3.1. Access to Niokolo-Koba National Park. It was anticipated at the start of this study that Niokolo-Koba National Park would play a major role in the investigations, because of the location of one of the major river projects, Kekreti Dam, at the edge of the Park, and because the Park contains the most important concentration of wildlife in Senegal. The Work Plan for the Wildlife/Vegetation studies reflected the importance of the Park, specifying methods of study that could only be accomplished within the Park. The draft of the Work Plan was submitted for comment to the administration of National Parks of Senegal and some suggestions were received from them.

Unfortunately, accomplishing the actual work in the Niokolo-Koba National Park proved more difficult than writing the program. The initial permit, issued by Park headquarters in Tambacounda, following our discussions with the administration in Dakar, was interpreted by the local warden ("chef-de-poste") as allowing only those activities permitted the ordinary tourist. Botanical sampling and close-up wildlife observations were forbidden.

We arranged a series of meetings with the National Parks administration in an effort to clarify the procedures for the issuance of the necessary permits and to overcome objections to the use of advanced telemetry and tracking techniques. Each time that the request for a general permit (excluding the handling of animals) was approved, new roadblocks appeared in the issuance of the actual permit. The urgency of obtaining the permit in time to work in the Park during the 1983-84 dry season never succeeded in overcoming the administrative delays. Communication vertically within the Ministry and between Dakar and Tambacounda broke down on several occasions, with the result that one administrator directed our wildlife specialist to obtain the Park permit in Tambacounda, where a subordinate directed him to the Dakar office. An exchange of telephone calls within the Parks department failed to release the permit; the conclusion was that it must be issued by the minister.

There ensued, beginning early in 1984, a series of meetings with the Administration of National Parks, USAID, and OMVG, attempting to overcome new objections to the approved Work Plan, most of which related to the proposed marking and telemetry program, scheduled for a narrow time window in April. Detailed written requests, copiously documented and supported by USAID and OMVG, failed to produce the required permits. The deadline for obtaining the telemetry equipment slipped by, as did the 1983-84 dry season, and the program was officially abandoned at a meeting with the Director of the Cabinet for the Ministry on 25 April 1984.

At one point in these discussions, Parks administration stated that the extent of their own data on animals in the Park was such that further studies would add little. We submitted written requests for access to this wealth of material and received quick approval. The actual documents never were provided, however, despite two following requests. The argument was offered that the field records were confidential material, intended for the use of Park staff only. GRBS researchers were told that all of the pertinent material was available in IFAN publications. A careful scrutiny of all the referenced publications, accomplished in the library of IFAN itself, revealed extensive gaps in this information especially for the largest mammals.

3.1.3.2. Socioeconomic wildlife data. Data on human interactions with wildlife (use of widlife products and depredations by animials on crops) were considered important to the GRBS in pre-project discussions among the study teams. At that time, late in 1982, it appeared that certain types of resource use information of interest to the Wildlife/ Vegetation Team would be forthcoming in the course of the Socio-Economic Studies. As those studies developed it became evident that little pertinent data would be developed, due largely to the fact that the areas selected for intensive investigations do not support dense populations of wildlife and several villages lacked hunters. The lack of data from that source did not prove a severe limitation, since much of the gap was filled through hunter interviews conducted by the Wildlife/Vegetation Team. The Socio-Economic

Team did provide an extensive printout on the control of pest animals by rural farmers.

3.1.3.3. Inability to handle large mammals. The refusal of the Senegalese government to permit the capture of large mammals for telemetry studies, and the general policy of The Gambia not to allow animal collecting, removed the possibility of studying several aspects of animal health such as ecto- and endoparasites. Although this was not a critical element in the study program, the availability of our veterinarian, combined with the interest of the GRB governments (especially that of The Gambia) in trypanosomiasis might have led to the acquisition of useful information.

3.2. The Historical Perspective

Much of the wildlife of the Basin is known to have declined substantially in the last century or so. This, especially, is precisely why there is interest among the OMVG Member States to determine what the impacts of the proposed develop ments will be, and what can be done to mitigrate the adverse impacts and enhance the positive benefits.

3.2.1. The Gambia Basin

3.2.1.1. The Gambia. There are four historical reports that illustrate well the wildlife population trends in The Gambia: Reeve (1969), Haywood (1933), Johnson (1937), and Parker (1973). The information in these reports is summarized in Table 3.1. Only one, the wild hunting dog, of seven species of small and medium- sized terrestrial carnivores, is considered extinct. Neither of the two large predators, the lion and the leopard, was ever reported as common, and both remain extant, although the lion is only a rare transient. Both of the large aquatic mammals reported, the hippopotamus and the manatee, are still extant, but only with considerably reduced population and more restricted ranges.

For the terrestrial ungulates, the picture is much less favorable. The elephant and the giraffe were extirpated by the 1930's. With the exception of the semi-aquatic sitatunga, all of the larger antelope and

Table 3.1

COMPARISON OF HISTORICAL RECORDS OF MAMMALS OF THE GAMBIA

Including Medium and Large Carnivora, Sirenia, Proboscidea, Artiodactyla & Selected Others

MAMMAL SPECIES	1912 (Reeve, 1969)	1293 (Haywood, 1933)	1937 (Johnson)	1972 (Parker, 1973)
wild hunting dog	occurs; seldom seen	extant[1]		"probably"
Jackal[2]	extant	extant[1]		extant
otter				extant
civet cat		extant[1]	"fairly common"	"abundant"
spotted hyena	extant	extant[1][4]		"common"
striped hyena	extant	[not differentiated][4]		[not mentioned][5]
cheetah				possible transient
golden cat				possible
serval	extant	extant[1]		"common"
caracal	not common	extant[1]		"widely known"
lion	"a few"	extant[1]		"occasional transient"
leopard	"common"	extant[1]		"widespread"
manatee	"visitor"		"rare"	"not abundant"
elephant	occasional transient[8]*	EXTINCT		"EXTINCT"
warthog	extant[10]	extant[1]		"abundant"
red river/forest hog	not present			"possibly extant"
hippopotamus	"plentiful enough"[11]*	"numerous"[12]	est. # <800[13]	"many fewer than before"[14]
giraffe	former transient[15]	extinct[16]	"some years ago"[17]	"EXTINCT"[18]
bubal hartebeest	"occasionally met"[19]	[not included][20]	est. # 50[21]	"EXTINCT"
blue/Maxwell duiker		extant[1]		extant
red-flanked duiker	"found everywhere"	extant[1]		extant
yellow-backed duiker			est. #200	"EXTINCT"
crowned duiker[22]	"fairly common"	extant[1]		unknown[22][34]
korrigum hartebeest	"still met"[23]			"EXTINCT"

Table 3.1 (Continued)

COMPARISON OF HISTORICAL RECORDS OF MAMMALS OF THE GAMBIA

Including Medium and Large Carnivora, Sirenia, Proboscidea, Artiodactyla & Selected Others

MAMMAL SPECIES	1912 (Reeve, 1969)	1293 (Haywood, 1933)	1937 (Johnson)	1972 (Parker, 1973)
roan antelope	"fairly common"	"numerous on North-bank;[24] very rare in Upper River	est. #400-500[25]	"verge of extinction, if not EXTINCT"[26] extant
waterbuck	"still found in certain areas	"numerous on North-bank;[24] few to none, Southbank"		"verge of extinction, if not EXTINCT"
Kob antelope	"common a 'few' years ago", now extant - 27	extant[1]		"EXTINCT" possible
oribi	"fairly common all over"	extant[1]	est. #1000	extant
reedbuck	extant	"numerous on North-bank;[24] scarce elsewhere		extant "occasional transient" "widespread"
Grimm's duiker				"common
buffalo	"scarce"*	EXTINCT[29]	rare transient	"EXTINCT"
western giant eland	"rare"*	EXTINCT[29]	est. #1000*	"EXTINCT"
bushbuck	"common throughout"	"numerous, exception on Southbank - 24		"common"
sitatunga	"extremely rare"[30]	[not mentioned[20]	est. #200	"relatively abundant"[31]
aardvark	"common"			"EXTINCT"
chimpanzee			"very rare"	"extant"[32]
western red colobus	"commonest of monkeys"	extant[1]		"EXTINCT"[33]

Note: Blank spaces denote "not mentioned".

Table 3-1 (Continued)

COMPARISON OF HISTORICAL RECORDS OF MAMMALS OF THE GAMBIA -- FOOTNOTES

\+ Order of animals presented according to Honacki et al (1982).

* denotes animal COMPLETELY PROTECTED at the time of publication.

o PROTECTED from 16 June to 31 December.

1/ Data based on questionaire replies and "is probably fairly correct as the Commissioners have each been a number of years in their respective Provinces and do a considerable amount of travelling." All animals listed as "extant" are reported as "rare or very scarce" in the text, but this statement can not be accurate as the list includes such animals as baboons and warthogs, which are noted later in the text as being crop pests.

2/ The two species of jackals (Canis adustus & C. aureus) are not differentiated.

3/ Spotted hyena is more common than the striped hyena.

4/ Species not differentiated.

5/ The striped hyena, the more xeric of the two species, probably does not occur in The Gambia.

6/a "Not recorded by Dorst and Dandelot (1969) or known by informants in The Gambia. However, Dupuy records it as occurring in Guinea savanna in Casamance Senegal and thus very likely to occur in The Gambia.

6/b "Although it is a rare animal, ... about a dozen are caught daily (in fishermen's nets) on a stretch of about 100 miles (of river).

7/ "...widespread in Gambian waterways, but nowhere abundant...may be rather sedentary and local."

8/ Only in the eastern most areas, and during the dry season.

9/ Last elephant in The Gambia killed in 1913.

10/ Not noted as being especially abundant.

11/ Formerly found in numbers down to the salt water areas; now only in the backwater areas and from Elephant Island upstream.

12/ "Altogether 18 are reported from the Upper River, 3 from Southbank, and from the Northbank they are said to be numerous." (Boundaries of thse Provinces are not provided).

13/ Found in creeks 30 miles from (Banjul) to the eastern frontier. The "Wild Animal Regulations of 1916 states it is lawful to kill 'hippo' in the Southbank Province..." but elsewhere there is a 15 fine.

14/ Still widespread; in some areas a hazard to small boat navigation; occasional calls for the Police Field Force to hunt them for crop (mostly rice) damage; future outlook is poor due to the expansion of rice cultivation.

Table 1 FOOTNOTES (Cont'd)

15/ Ca. 1900, carcass found in vicinity of MacCarthy Island; "At certain seasons of the year giraffes are to be found in very small numbers in the arid country to the northeast (of Gambia)."

16/ Recommends deleting giraffes from the Completely Protected List, because they no longer exist in The Gambia.

17/ A young animal caught "some years ago" near Kuntaur, but "we are still wondering how this animal got into The Gambia."

18/ "...the last specimen being recorded in 1903." Also extinct in Senegal.

19/ Plentiful in neighboring Senegal.

20/ "There seems doubt as to whether the western hartebeest ...exist, so I have not included them."

21/ "Inhabits the Upper Gambia River, especially southbank towards Casamance."

22/ The "crowned duiker" is listed in Reeve (and described) and Haywood, but is not referred to in Dorst and Dandelot, 1969.

23/ Still "...met with...during the height of the dry season", therefore are seasonal transient. In "1902, ...encountered a magnificent herd ...numbered well over a 100 beasts,..."

24/ Boundaries of these Provinces are not provided.

25/ Only found near Kuntaur (MID) and Koina (eastern frontier).

26/ "...no longer resident" but possibly "seasonal visitors from Casamance into Lower River..."

27/ "Not many years ago...common in many parts of the upper river,..." currently, due to cattle herds, herdsmen and dogs "...very few marshes ..." still support kob. Perhaps the commonest antelope in Senegal.

28/ "The habitat...is the almost continuous chain of marshes...which fringe the river..."

29/ "...seems agreed (these animals) do not now exist in The Gambia..."

30/ "Exceedingly shy" and prefers reedy forest swamps with plenty of cover; not found east of the Chamois river.

31/ All informants from Tendaba to Kuntaur indicated the sitatunga was present and could usually provide evidence (either skins, horns or tracks). One hunter claimed to have killed 36 during the last year and "there were no grounds...to doubt his veracity. Where the particular habitats required by the species exist, it is still relatively abundant."

32/ "Though I saw places where this species had dug (though no burrows normally associated with the species were observed), no locals recognized a picture of it."

33/ "...very probable that (the chimpanzee) once occurred in The Gambia. However, as no mention is made it in Reeve...it must be assumed that (its) disappearance...is not recent..."

34/ Author note: Based on the description of the crowned duiker, it is probably the Grimm's duiker.

buffalo are either extinct (bubal hartebeest, korrigum hartebeest, derby eland and the buffalo), or on the verge of extinction (roan antelope and waterbuck), with only an occasional transient found in the country. Two of the eight species of smaller antelope (kob antelope and yellow-back duiker) are extinct and most of the others can be considered uncommon.

Some species have either increased in numbers or at least maintained a level generally considered to be too high: the warthog (offically classed as vermin), baboon, patas and vervet monkeys. All of these species are considered agricultural pests. Of the other two primate species, the red colobus monkey is much reduced, due to destruction of the closed canopy forest; the chimpanzee was extinct, but currently a small population (27 individuals) is artifically maintained on Baboon Island.

Three of the larger and more interesting species that remain, the hippopotamus, manatee and sitatunga, are either aquatic or semi-aquatic and therefore vulnerable to river developments.

3.2.1.2 <u>Senegal</u>. In Senegal, with the creation of Niokolo-Koba National Park in 1962, the larger mammals have faired considerably better. Even there, however, the giraffe and korrigum harthebeest have been extirpated and the elephant is in extreme jeopardy. One attempt was made to reintroduce giraffes to Niokolo-Koba National Park (Dupuy, 1972), but the animals succumbed to trypanosomiasis. A second attempt is being considered (Plan Directeur Forestiere, La Faune et la Chasse, (1981).

3.2.1.3. <u>Guinea</u>. Northern Guinea has, in general, lost the majority of its large mammals. Exceptions include the agricultural pest species and livestock predators which benefit from man and his animals. Many of the smaller antelope and duikers are still extant, but not common. Chimpanzees are widely distributed, but not numerous. There are areas, due either to remoteness or to contact with neighboring Senegal, which still support modest numbers of such animals as buffalo, roan antelope and derby eland.

3.2.. Regional Setting

The Gambia River Basin cannot be considered in isolation if a realistic view of the overall impacts is to be achieved. If the mammalian fauna outside the Basin is decimated, or has a particularly bleak future, the fauna within the Basin has an augmented significance and value. This argument is supported by two examples:

- The Faleme Region: Implications of the Proposed Mining Developments. The Faleme River Basin in Senegal-Oriental lies to the east of the Gambia River Basin and drains into the Senegal River. This area still supports substantial herds of buffalo, roan and kob antelope, bubale hartebeest, waterbuck and derby eland (Dupuy, 1968). Under the administration of the Senegal Forestry and Wildlife Service, this is the only big game hunting area open in Senegal. The Faleme River lies approximately 100 km to the east of Niokolo-Koba National Park and, although there is faunal contact, there do not appear to be well defined seasonal migrations. The area is contiguous with portions of the north-east Gambia River Basin in Guinea, and this accounts for the occurrence of some of the larger ungulates there, notably the derby eland. There are plans for iron mining activities and a railroad extension into the area. The combination of land lost to the mining development, the improved access, and the increase in people will certainly decimate the large mammal fauna unless unusually successful measures are implemented to protect it.
- Extirpation of the Senegal River Elephants - 1984. It was reported that the last two elephants which lived in the Matam locality along the Senegal River were killed in January 1984 (Bakhoum, 1984). This was the last separate elephant herd in the regions immediately adjacent to the Gambia River Basin. Accordingly, the remaining few elephants in Niokolo-Koba National Park have a substantially increased importance.

3.3. Important Species Groups

3.3.1. Rare and Endangered Species

Species whose world populations have declined to a point of being in danger of extinction have been designated by the International Union for Conservation of Nature and Natural Resources (IUCN) as "endangered," "vulnerable," or "rare." The status of each species is under continual review, so species are periodically shifted from one category to another as new information is accumulated. The current status of every species is published in looseleaf form for inclusion in the "Red Data Books." Those compendia are maintained as separate volumes on reptiles and amphibians, birds (two volumes) and mammals. The designations of status employed by the IUCN are as follows:

- Endangered is a designation for species or subspecies whose survival is unlikely if the factors that have led to the present situation continue to operate. These factors may be direct, such as hunting, or indirect, such as habitat destruction. This category includes some taxa that may already be extinct, worldwide.
- Vulnerable refers to a species or subspecies "likely to move into the endangered category in the near future if the causal factors continue operating." These are species most or all of whose populations are decreasing, through overexploitation, habitat destruction, or other causes; species with severely depleted numbers, for which conservation measures now in operation have not yet effected recovery; or species still abundant but under threat from some "serious adverse factor throughout their range."
- Rare is applied to species not at present endangered or vulnerable, but at risk because of their small world populations. They often inhabit geographically restricted habitats (e.g., islands) or are thinly scattered over a wide geographical area.

3.3.1.1. Mammals. Seven species of mammals in the Basin are listed by the IUCN as endangered or threatened and listed under CITES-I or CITES-II.

- Chimpanzee, *Pan troglodytes*: endangered. This primate is widely distributed, in small groups, in Senegal Oriental (generally south of latitude 13°N) and northern Guinea. There is an isolated colony of introduced animals, mostly wild but not wholly independent, on Baboon Island in the Gambia River, about five kilometers upstream of Kuntaur. The species is fully protected by law in all three GRB countries.
- Wild Hunting Dog, *Lycaon pictus*: threatened. This predator is found in Senegal Oriental and northern Guinea. The population in Niokolo-Koba National Park was estimated at 100 animals in 1970 but is reported to be declining, apparently due to distemper. A few small packs are reported to be widely scattered in the extreme northwestern and northeastern portions of the Guinea GRB areas.
- Cheetah, *Acinonyx jubatus*: vulnerable. The status of this cat in the Basin is uncertain. It is believed to occur in the northernmost part of the Basin (Bakel) and is reported from the Faleme River valley, to the east of the GRB. It might occur as an extremely rare transient at the periphery of the Basin. The species is completely protected in Senegal and partially so in Guinea.
- Leopard, *Panthera pardus*: vulnerable. The leopard is distributed throughout the Basin, but is increasingly rare in The Gambia and unevenly distributed elsewhere. It might be considered common in favorable situations, such as Niokolo-Koba National Park, where the estimated 1975 population was 100. The species is fully protected in Senegal, but unprotected in Guinea. In The Gambia, it falls under the umbrealla wildlife protection law.

- Elephant, Loxodonta africana: vulnerable. The only known population of elephants in the GRB is the 60 animals in Niokolo-Koba National Park. The species is completely protected in Senegal and partially so in Guinea, but continues to fall victim to ivory poachers.
- African Manatee, Trichechus senegalensis: vulnerable. This gentle aquatic vegetarian once was distributed in rivers and coastal lagoons from northern Senegal to Angola. Its numbers have declined seriously throughout its range, due largely to uncontrolled hunting (IUCN, 1976). Reliable sightings and corollary information indicate that the manatee is uncommon in The Gambia River downstream of Georgetown and occurs, rarely, upstream, possibly as far as Simenti. It is fully protected in all three GRB countries, but is still subject to considerable hunting.
- Giant (Derby) Eland, Tragelaphus oryx: endangered. This large antelope, formerly called Taurotragus derbianus, exists as a sizable population in Niokolo-Koba National Park (about 500 individuals) and a smaller one in the Faleme basin (possibly 200). The Faleme herd ranges into northern Guinea, including parts of the GRB, around Balaki. The species is fully protected in Senegal, partially so in Guinea.

A few other species are protected under the CITES-I, -II, and -III agreements, but are not listed in the Red Data Book of the IUCN:

Certain other species are afforded special protection under Senegalese law and, in some cases, partial protection in Guinea. All wildlife, except for certain species designated "vermin," is protected under Gambian law.

- Lesser Galago or Bushbaby, Galago senegalensis. This small primate is abundantly distributed in closed and open forest habitats, and in forest islands in grassland. It is fully protected in Senegal. It also has been identified in two recent scientific papers (Stevens et al., 1982; Haines, 1982) as having merit for laboratory study.

- Vervet Monkey, _Cercopithecus aethiops_. Abundant throughout the Basin in a variety of habitats, ranging from mangrove to closed forest, this monkey also is a crop pest. It is completely protected under Senegalese law.
- Western Red Colobus Monkey, _Colobus badius_. This leaf-eating monkey usually is restricted to riverine or closed forest. It is abundant in The Gambia, but becomes increasingly rare upstream, in Senegal. It may now be absent from the Guinea portions of the Basin. It is completely protected in Senegal.
- Black-and-white Colobus Monkey, _Colobus polykomos_. This monkey is believed to be extinct in the GRB, but a remnant population recently was reported, well described but without specimens, near Pakeba, on the Sandougou River, in Senegal. The species is partially protected in Guinea, where it occurs only at a considerable distance from the GRB.
- Serval, _Felis serval_, and other small carnivores such as the civets, and henets, are partially protected in Senegal. Many of these are widespread and common.
- Lion, _Panthera leo_. Although offically only partially protected in Senegal, the lion is nearly fully protected, since only two hunting permits can be issued annually and these only with the president's approval. Lions are relatively common in Niokolo-Koba National Park (1975 estimate of 100 individuals) and perhaps more so in the Faleme Basin, southeast of the Park. They are rare in the Fouta Djallon of Guinea and even rarer (occurring only as an occasional vagrant) in The Gambia.
- Cape Clawless Otter, _Aonyx capensis_. This aquatic carnivore is partially protected in Senegal and is covered by The Gambia's general wildlife protection law. It is widely distributed in permanent rivers throughout the Basin, but generally uncommon. The local populations appear to be small and isolated from each other.

- Aardvark, Orycteropus afer. This innocuous mammal appears to be found uncommonly throughout the Basin, and may be locally common where termites infestations occur. It is fully protected by all three GRB countries.
- Pangolins, species of Manis and Smutsia. These insectivorous mammals, notable for their armor of overlapping bony plates, are widely distributed throughout the Basin, but uncommon to rare. They are fully protected in Senegal, and partially so in Guinea, but mounted specimens are offered in some tourist shops in Dakar.
- Red River hog. Potamochoerus porcus. This large pig is sparsely distributed in the upper Basin, from the national park through the Guinea Highlands. It apparently is extinct in The Gambia. The species is totally protected in Senegal.
- Hippopotamus, Hippopotamus amphibius. Like the lion, the hippo is afforded partial protection in Senegal, but, because the president's approval is required for permits to hunt hippo, the protection is nearly complete. The species is widespread in the GRB, with 100-200 in The Gambia, about 750 in Niokolo-Koba National Park (the 1979 count was 913, that of 1980, 500) and possibly another several hundred in the Gambia River and tributaries in Senegal; and a few hundred in the Guinea portion of the Basin.
- Yellow-flanked Duiker, Cephalophus sylvicultor. This diminutive antelope is reported from a few localities in Guinea and some in Senegal, but not reliably within the Senegalese part of the Basin. It is believed extinct in The Gambia. The species is partially protected in Guinea.
- Western Sitatunga, Tragelaphus spekei. This shy, marsh-loving antelope is widely distributed in central parts of The Gambia, from Jali Point to Georgetown, favoring islands and other floodplain areas. The total number is unlikely to exceed a few hundred. Not reported from Niokolo- Koba National Park, and

unlikely to occur there, due to the scarcity of suitable habitat. It is fully protected in The Gambia, and partially so in Senegal and Guinea.

A few species, mainly primates, are sought by laboratories around the world for use primarily in medical research.

- Chimpanzee, _Pan troglodytes_. As an endangered species, the chimpanzee cannot legally leave any GRB country, nor enter the majority of countries active in medical research, without special permits, which are not generally available. Enforcement of international endangered species agreements and pressure from conservation groups have substantially reduced the once flourishing market for young chimpanzees. An illicit trade still exists, but the number of animals involved is small.
- Monkeys are still in demand for biomedical research and may be legally exported from Senegal under appropriate permits. The number exported between 1976 and 1980 varied but seems not to have exceeded 250. Species records are not kept by the Forest and Wildlife Service, but the majority probably were Patas Monkeys (_Erythrocebus patas_).

3.3.1.2. _Birds_. The only and rare endangered bird species known to occur regularly in the Gambia River Basin is the Peregrine Falcon (_Falco peregrinus_), one of the most widely distributed birds in the world. Only certain northern hemisphere populations are listed as endangered. The listing resulted from a widespread decline of the Peregrine between 1945 and 1975, generally attributed to the use chlorinated hydrocarbon insecticides (Hickey, 1971). In recent years, due to vigorous conservation efforts and to decreased use of the insecticides, the endangered populations have recovered somewhat.

The Peregrines found in the Gambia River Basin include breeding birds of the West African populations _F. peregrinus perconfuscus_, which apparently breed in the Fouta Diallon of Guinea, and visiting _F. p. pelegrinoides_ (sometimes called Barbary Falcon), which breeds in North Africa; these populations are not designated "endangered." The Basin also is visited by

Peregrines of the endangered Western European population, F. p. peregrinus.

In addition to being Rare and Endangered, (or perhaps because of it), the Peregrine is a species of considerable tourist value in The Gambia, although only a few Peregrines are reported each year.

Several whole groups of birds are listed by Senegal under the CITES (Convention on International Trade in Endangered Species): parrots (Psittacidae), owls (Tytonidae, Strigidae), and falcons (genus Falco).

3.3.1.3. Reptiles. All three species of crocodiles occurring in the GRB are considered by the IUCN to be in need of conservation efforts. Individually, their plight is as follows:

- African Slender-snouted Crocodile, Crocodylus cataphractus: endangered. The range of this species extends from Senegal to Angola. It is rare throughout this vast range, apparently because it is intensively hunted for its meat and hide (and, in some areas, for eggs). We have found no records of the species for the GRB, but it may occur occasionally.
- Nile Crocodile, Crocodylus niloticus: vulnerable. Even more widespread than the preceding species, the Nile crocodile occurs virtually throughout Africa and is under pressure from skin hunters everywhere it occurs. In addition, it is considered a dangerous pest in many countries. It occurs throughout the GRB, even to the estuary, but sparsely. Large individuals, such as those six meters or more in length that may be seen in East Africa, are rare in the Basin. Two animals about three meters in length lived in the Abuko Reserve, near Banjul, but appear to have moved into the tidal creeks during the severe drought of 1984.
- Dwarf Crocodile, Ostralaemus tetrapis: endangered. The dwarf crocodile occurs throughout west and central Africa, inhabiting freshwater rivers and lakes, especially those in deep forest. It is sparsely distributed throughout the GRB. E. Edberg (pers. comm.) has photographs of this species in the Abuko Reserve, near

Banjul. Being smaller than the Nile crocodile, this species is less sought after for its hide, but it doubtless is killed for meat when encountered.

3.3.2. Pest Species

An animal perceived as conflicting with human interests (rightly or wrongly) is generally considered to be a pest species. This includes the animals which ravage agricultural crops, or kill livestock, as well as animals of which man is afraid through real danger or human ignorance. If a species occupies several ecological positions, some of which are beneficial to human interests while others are detrimental (for example: a predators that feeds largely on rodents but takes an occasional chicken) it is usually the negative trait that results in the human viewpoint.

3.3.2.1. Mammals. Some information on pests is found in government reports and other published literature, but the majority was collected first-hand during field studies and interviews with local residents conducted throughout the Basin.

Crop pests can be divided into small mammals (rodents) and large mammals such as monkeys, warthog and hippopotamus. Rodents generally cause more damage and have been the focus of numerous investigations, which are briefly summarized in this report. Large mammals and the damage they cause have not been systematically studied, but are reported as a serious problem throughout the Basin. Original field studies were conducted during the GBRS project to better assess these depredations by large mammals.

In addition to mammals that eat and damage crops, there is a group of predominantly large species that achieve pest status through preying on livestock. The best known of these are the spotted hyaena, lion, leopard, and wild hunting dog. A number of the smaller carnivores (mongooses, genets, civet, and the smaller cats) are predators on chickens and possibly goats.

Crop pests: rodents. Rodents are an integral component of the terrestrial environment throughout the Basin, and are chronic agricultural pests. Except during sporadic outbreaks i.e., when exceptional densities occur, they do not generally command national attention and are relegated as a problem of the subsistence farmer or recurrent loss to communal irrigation projects.

Table 3.2 presents a classification of rodent pests for Senegal, the target crops and the type or extent of damage. The main rodent pests in Senegal are Arvicanthis niloticus, Taterillus pygargus, and two species of Mastomys. Arvicanthis is the most widely distributed of these species, and is the most important rodent pest in humid agricultural areas. Taterillus may be the more significant pest in groundnut growing areas, especially after the harvest. One species omitted from Table 3.2, but mentioned by most villagers interviewed as an important crop pest, is the cane rat, Thryonomys swinderianus. Another animal which can be included as a regular, if not a major pest, is the porcupine, Hystrix cristata. These two species are also preferred food animals.

In Senegal, Arvicanthus was identified by Fall (1976) as the main species devastating rice fields both by consuming rice plants and by using them to construct their above ground nests. An 85 percent reduction in the harvest from an infested irrigated seed farm was documented.

Damage occurs to wheat and maize both by the consumption of newly planted seeds, and by rodents climbing the stalks to eat the developing heads.

In many areas, substantial damage to local and commercial garden crops (tomatos, potatos, beans, cabbage, and carrots) was reported by farmers, but no figures are available. Damage occurs to both vegetative parts and fruit. Where substantial areas of bare ground exist between the plants (.e.g., tomatoes), damage tends to be concentrated around the perimeter of the field. For crops such as melons, where the vegetation covers most of the soil area, damage is generally dispersed throughout the field.

Rodent damage in dwellings and granaries often is extensive. Commensal rodents including the house mouse (Mus musculus), black rat (Rattus rattus), and multimammate rat (species of Mastomys), have been reported to consume or destroy 65 kg/year/dwelling. The behavior of Arvicanthus in enlarging cracked ground and the burrowing habits of Taterillus and

Table 3.2

PRINCIPAL RODENT PESTS IN SENEGAL

Type of Agriculture	Crop	Extent of Damage by Species Group					
		Mastomys	Arvicanthus	Taterillus	Cricetomys	Xerus	Rattus
Traditional farming (humid soils)	Potatoes		important		important		unk.
	Cauliflower	noticeable	important		important		unk.
	Beans	important	important		noticeable		unk.
	Manoic		disastrous				
	Tomatoes	important	important				
Irrigated farming	Rice	important	disastrous				
	Sugarcane	noticeable	noticeable				unk.
	B/E (dry season)	important	disastrous				
	Tomatoes (dry season)	important	disastrous				
Grains	Maize, Millet, Sorghum	noticeable	disastrous				
Commercial farming	Peppers	disastrous					unk.
	Tomatoes	disastrous	disastrous	noticeable			
	Beans	important	noticeable				
Rainfed Agr. (dry soils)	Groundnuts	unk.	noticeable	important	noticeable	noticeable	
	Millet	unk.	noticeable	noticeable			
Sylviculture	Acacia		disastrous				

Source: ORSTOM (1976)

Mastomys can be damaging to irrigation dikes, especially in loose and sandy soil types. The plastic pipes often used for irrigation and sprinkler systems sometimes are gnawed through by rodents, possibly attracted to accumulations of salt. Plantations also suffer rodent damage. In one reforestation area, the loss of 10,000 seedlings on a 25 ha. plot was reported.

Rodents also compete with domestic livestock for wild vegetation, sometimes reaching unusually high populations in non-agricultural areas. A study of *Taterillus gracilis* and *Mastomys erythroleucus* in a sudano-sahelian habitat revealed that, depending on the year, 1-15 percent of the annual herbaceous seed production was consumed (Moro and Hubert, 1983). It can be expected that the higher consumption levels would lead to a reduction in forage available for both domestic and wild herbivores.

Heliosciurus gambianus, *Xerus erythropus*, and *Grammomys buntingi* were rodent species associated with oilpalm damage in Guinea. *Rattus simus* and *Cricetomys emini*, respectively, were listed as pest species on cacao and cola in Guinea (Univ. of Arizona 1983).

Although many of the pest species cited above demonstrate a preference for specific crops, depredations change drastically during major outbreaks as the dense populations move from one area (or field) to another in search of food. During normal population periods, it is possible that cropping sequences and/or double cropping (i.e , multiple cr s developing in the same field simultaneously) might serve as an additional attractant, or deterrent to depredations.

Crop pests: large mammals. Certain species of large mammals have a rather long history as agricultural crop pests in the Basin. By 1950, crop depredations had reached a level in The Gambia where a bounty was paid for every tail of a baboon, warthog, or monkey. The two primary target monkey species were probably the red patas and the green vervet monkeys. A third species in The Gambia, the western red colobus, is predominantly arboreal, and was not typically considered an agricultural pest by villagers interviewed during GRBS surveys. It is not known what distinctions were made between these three species during the bounty campaign, nor if substantial numbers of the red colobus were taken.

It is also not known how successful the program was, although the total numbers taken, especially the diminishing returns, indicate that depredations from these species must have been substantially curtailed. At the present time, however, these species are abundant in most areas of the Basin. In recent years, the warthog was regularly discussed as a major pest species in the Gambia Crop Protection Service (CPS) bulletins. The main reasons for the overpopulation and resultant crop depredation are (a) the main species involved are well adapted to the culturally modified landscape and habitats, and benefit greatly from the supplementary agricultural food supply; (b) the species are prolific; (c) natural prey species such as the lion and leopard have been drastically reduced and even eliminated from some areas; and (4) these pest animals are not utilized as food by the predominantly Muslim population.

In addition to the warthog and monkeys, the hippotamus is also considered a crop depredating animal. Unlike the others, the hippo is consumed for food, but it has been at least partially protected by law for decades in all three of the member states.

In spite of the apparent magnitude of this problem, including the economic ramifications, there are virtually no quantitative studes or scientific evaluations available. The densities of these populations have not been determined; little is known of their supplemental feeding habits and behavior (except for the vervet monkey); control methods are mostly traditional and primitive (although sometimes effective); and no effort been made to determine the actual amount of damage done.

Considerable effort was made during the GRB Study to improve the state of knowledge on this problem and the statements in this report are based on original field data. They represent the only systematic, numerical assessment of large mammal crop depredations which could be located, either in the literature or from such international organizations as FAO or UNEP. Due to the magnitude and variability of this problem, however, even these data (presented in Table 3.3) should be considered preliminary.

Although there are apparent patterns in the data, there are often major exceptions. Such exceptions clearly reveal the variations in animal distributions, village protection methods, and probably an ever present "chance" factor. When reports from all fields and villages are considered, it is clear that in both pure groundnut and groundnut crop associations, the warthog is the primary pest, followed by monkeys, with birds being only minor pests, in less than five percent of the fields.

Domestic stock are often responsible for damage to agricultural crops. Perhaps the frequency of livestock trespass is a good indicator of the effectiveness of the protection methods used. Certainly, if crop protection is pursued with any amount of diligence, this damage can be avoided. Indeed, in most instances, livestock account for less than five percent, and usually less than two percent of the trespass frequency.

In groundnuts warthog was the predominant pest species reported, ranging from 13 to 55 percent (n=49) trespass frequency and generally accounting for over 20 percent. Monkeys were the next most frequent invader (2-27 percent), but averaging around 10 percent. Livestock trespass was variable, but did reach 10 to 15 percent of the fields in some villages. Invasions by birds typically occurred in less than 5 percent of the groundnut fields surveyed. There does not appear to be any readily apparent difference in damage between pure groundnut fields and groundnuts planted in association with other crops.

Among the primate depredators, there was a tendency for baboon to invade groundnut fields regularly throughout the year (with the exception of the semi- arid region in the north portion of the Basin, where they were not even mentioned as a crop pest species). Vervet monkey, however, were only reported during, or just after the rainy season. Reports of patas monkey were variable. In areas settled by Basssari and Konagui people, monkey populations were usually substantially reduced, but were still reported as crop pest species. Warthog did not seem to display a strong seasonal preference. They were reported in fields during the rainy season, the dry season, all year long, and only when the crop was ripe.

Others of the large and medium-sized mammals were reported as crop pests. The jackal and civet exhibit a definite taste for groundnuts. Jackals, in particular, seem only to dig up the newly planted seeds, or wait until the crop is ripe. The single report of hares damaging groundnuts also specified this preference for the ripe crop. Porcupine were regularly listed as a minor pest, and in areas where antelope were still present in any numbers, they were also included in the list.

Patas monkey, baboon and warthog apparently depredate maize fields throughout the year in the Gambia and Senegal, while vervet monkey continue to exhibit their preference for only rainy season feeding. In Guinea, all three primates were reported only to enter fields when the maize is ripe.

Civets definitely lead all other of the larger mammal species in reports of maize depredations. Jackal, porcupine and small antelope were indicated as minor pests.

Other large mammals cited as pests in millet from other interviews were hippo, porcupine, hare and antelope.

A clear pattern of large mammal pests in sorghum fields was not apparent. Birds seemed to dominate early sorghum field damage (although the sample size was small), but not late sorghum, which again suggests the possibility of a migratory species.

For irrigated rice, birds are the predominant pest species, damaging an average of 26 percent of all fields surveyed. Monkeys were a consistent second with 12 percent of all fields. Warthog were a major pest at Allunhare (40 percent, n=5); a minor pest at Tuba (3 percent n=30); and not reported from Nema. Hippo were a consistent, but minor pest at Nema for both dry and wet season irrigated rice, 2-3 percent of the fields respectively.

Hunter interviews in Guinea indicated that warthog, patas and vervet monkey and baboon were the major depredators of fonio. No quantitative estimates were obtained.

Other crops, such as potato, casava, and beans, also were reported eaten by pests. Both species of monkey and baboon were identified as raiding the fields of these crops, especially in Guinea. Surprizingly, warthog were only mentioned for potato. Porcupine were also identified as minor pests of all of these crops. Table 3.3 summarizes crop depredations by large mammal and other pest animals.

<u>Pests of livestock: large mammals</u>. The four major large predatory species in the Basin are the spotted hyaena, leopard, lion and wild hunting dog. These species have been documented to kill cattle, sheep, goats, horses and donkeys. Several medium and small predators are also reported as killing sheep and goats, and chickens.

Hyaena are found throughout the Basin, except possibly the westernmost end of The Gambia and the southern portions of the Basin in Guinea. The Guinea Livestock Service has distributed strychnine since the 1950s and as a result of this control program most villages visited in the southern half of the Basin reported the hyanea to be rare or even locally extinct. In most parts of their range, hyaena are uncommon, but they are common in the vicinity of Niokolo-Koba National Park and in the major livestock areas.

Where they occur, hyaena are essentially sedentary (with well established territories) and active all year. Lower River Division (LRD), The Gambia, reports an increase in predation towards the end of the dry season and early in the rainy season. This coincides with the concentration of cattle at the Gambia River for water during this period.

Regularly identified prey includes sheep, goats, calves, and usually cattle. In the LRD and some Middle Island division (MID) localities, donkeys, and horses are added to this list. There may be a tendency for cows to be taken during parturition, when they are isolated and helpless. There were unconfirmed reports of a human being killed in 1984 near Bansan. In fact, during the President's "Meet the Farmers Tour", a major issue raized by the people was the need for increased government assistance with hyaena control. In northern Senegal, near Bakel, where most hunting by locals is precluded by permit regulations, farmer/herders said they would be content to be able to shoot three species--hyaena, jackal, and ground squirrel--which they consider to be the main depredating animals.

The amount of damage caused by hyaena was usually combined in interviews with that of the other large predators. One Senegal village on the

Table 3.3

PERCENT FREQUENCY OF CROP DEPREDATIONS BY LARGE MAMMALS AND OTHER ANIMAL PESTS. (BASED ON DATA COLLECTED DURING GRBS SURVEYS)

CROP	VILLAGE	NO. OF FIELDS	CROP DEPREDATORS - In Order of % Frequency of Occurrence - % Frequency (Mean Size of Fields)
Groundnut	Nema	16	Monkey 27% (6270) - Bird 20% (7220) - Goat 7% (5800)
	Tuba	39	Warthog 28% (11210) - Goat 15% (4310) - Monkey 10% (8450) - Bird 5% (4510)
	Pakeba	102	Warthog 26% (8530) - Monkey 2% (510) - Bird 1% (9550)
	Adiaf	68	Warthog 28% (3610) - Monkey 6% (1730) - Bird 2% (2340)
Groundnut Associations	Allunhare	87	Warthog 23% (3490) - Cattle 10% (2900) - Monkey 7% (6170) - Bird 5% (4590)
	Nema	8	Warthog 13% (2180)
	Tuba	5	Goat 60% (10090) - Warthog 20% (4060)
	Pakeba	49	Warthog 55% (12550) - Monkey 10% (13070) - Bird 2% (8640) - Cattle 2% (6900)
	Adiaf	15	Warthog 20% (2900) - Monkey 13% (8070)
Maize	Nema	5	Bird 20% (720)
	Tuba	8	Bird 38% (2300) - Goat 38% (1450)
	Pakeba	30	Monkey 20% (2410) - Bird 17% (4990) - Warthog 10% (2310)
	Adiaf	31	Bird 3% (1990)
Maize Associations	Allunhare	12	Warthog 33% (11840) - Goat 25% (3520) - Bird 17% (1010)
	Nema	5	Bird 20% (716)
	Tuba	22	Bird 48% (3080) - Goat 24% (1680) - Warthog 5% (2420) - Cattle 5% (4460)
	Pakeba	4	Bird 25% (4461) - Monkey 25%
	Adiaf	7	- No Damage -
Millet (Early)	Nema	15	Insect 27% (2470) - Bird 13% (4290)
	Pakeba	8	Bird 63% (2760) - Monkey 13% (No Info.) - Cattle 13% (13100)
Millet (Late)	Allunhare	17	Bird 24% (6160) - Insect 18% (58210) - Warthog 12% (3250) - Cattle 6%
	Pakeba	13	Monkey 15% (4130)
Sorghum (Early)	Allunhare	2	Bird 50% (5400) - Goat 50% (5430)
	Adiaf	6	Bird 33% (165)
Sorghum (Late)	Allunhare	2	Warthog 50% (8680) - Goat 50% (370)
	Nema	19	Monkey 16% (3630) - Goat 5% (13550) - Bird 5% (5460)
	Pakeba	11	Monkey 40% (17630) - Warthog 10% (3900)
	Adiaf	21	Bird 14% (2560) - Warthog 10% (3120)
Rice (Swamp)	Tuba	150	Bird 70% (590) - Warthog 1% (1450) - Cattle 1% (950)
Rice (Rainfed)	Nema	123	Bird 8% (1670) - Monkey 6% (2080) - Warthog 2% (1690) - Cattle 2% (1080)
	Tuba	243	Bird 34% (1450) - Monkey 10% (1330) - Warthog 9% (1240) - Cattle 2% (1110)
Rice (Irrig. Dry Season)	Nema	94	Bird 29% (870) - Monkey 16% (720) - Cattle 5% (1550) - Hippo 2% (720)
Rice (Irrig. Wet Season)	Allunhare	5	Warthog 10% (13750)
	Nema	20	Bird 10% - Monkey 5% - Hippo 3%
	Tuba	30	Bird 23% - Monkey 3% - Warthog 3%

north bank, Gambia Upper River Division (URD) area claimed forty domestic animals were killed by hyaena during the previous year. It is likely that some of the depredations attributed to hyaena were actually scavenging of animals which had died from other causes.

One northbank village in the MID Gambia indicated that there were two types of hyaena in the area. It is possible that the second species was the striped hyaena. Although this species is typically found only in the semiarid and arid areas of northern Senegal, it might be a rare transient in the Basin.

The leopard ranges from common to uncommon in the Basin. The most commonly reported domestic prey animals are sheep, goats and calves, and an occasional cow, animals consistent with the leopard's typical size range of wild prey. They are reported to be active year round, both day and night. They do not seem to habitually work the same small area - herders report that one village will lose an animal one day, and two or three days later another village. Leopards are probably locally sedentary, but their home range can be fairly large. Usually damage reports given by local villagers are combined for leopard, lion and hyaena, but one village, Pakeba, on the northside of the Gambia River near the Upper River Division, attributed three goats and one sheep to leopard depredations in 1984.

The lion was regularly reported as a livestock predator that generally takes cows or steers. The Atlas National du Senegal (1979) indicates that the western limit of lion distribution is a north-south line passing through Kuntaur and Georgetown in the Gambia Middle Island Division. Only a single, questionable lion depredation was reported for The Gambia during this study. Pakeba (north bank Gambia URD/Senegal) reported no lions for the last seven years. At this time, it is surmised that lions are only rare transients in The Gambia, and only in the eastern part of the country. In the northeast semiarid region of the Basin (near Bakel) lions are reported to be rare and only present during the rainy season when water is available. This seasonal distribution coincides with Forest and Wildlife Service reports of their presence in the Ferlo District to the northwest of the Basin. In and around Niokolo-Koba National Park, lions are common and frequently cited as livestock depredating species. The estimated population in the Park in 1975 was 100 lions (Verschuren, 1982b). All villages south of the Park report regular losses to lions. Residents of villages in Guinea except those in the southern portion of the Basin (Nianou, Pilimini) claimed that lions are present and take livestock. Interestingly, at Kounsi, immediately to the north of the Liti-Gambia River confluence, villagers reported that lions are common on the west side of the Gambia, but village cattle are lost only during the dry season when lions can swim across the river.

Because of the year-round and wide distribution of lion depredations, it can be assumed that lions are resident in most areas within the Senegal and Guinea portions of the Basin, especially southern Senegal and northern Guinea. In addition to seasonal movements into the drier regions to the north, there appear to be other seasonal movement patterns. Of particular importance, there seems to be an exodus from the Park to the east and south (north of Kedougou) towards the Faleme region. Although difficult to verify from the piecemeal reports, this partial exodus begins with the rains and coincides with the general dispersal of much of the larger Park fauna.

In spite of seasonal changes in local abundance, there is a tendency for depredations to be most prevalent during the dry season. This is generally when cattle are allowed to range freely, because there is no need for herders to protect the agricultural fields from livestock trespass and damage.

In addition to livestock depredations, there are also numerous reports (some from reliable sources) of people being attacked and even killed by lions. During the course of this study, three substantiated attacks occurred in the area between Kedougou and Mako, along the apparent migration route. Another occurred in Guinea at Simbaya, east of Madina Salambande and within the proposed Kouya reservoir.

Responses to general inquiries concerning the amount of damage frequently combined the numbers of livestock lost to all three of the major predators: hyaena, leopard, and lion. Considering that the questions asked required a recall for the entire last year and the fact that total losses by all livestock owners or herders in the village were requested, the replies were rather consistent and reasonable. The question would be comparable to asking somebody how many cats were hit by cars in their neighborhood last year.

Even assuming a number from the lower end of estimates made by villagers, ten animals killed per year per village (not an unreasonable number in terms of normal large predator carrying capacity), livestock depredations evidently constitute a significant problem and an economic loss to the village. It is more difficult to put an economic value on the losses since cows, calves, sheep and goats all are included. However, assuming a loss of four cows (some which may have been calves) and six sheep and goats, at a value of 50,000 fcfa and 8,000 fcfa respectively, the total loss approximates 248,000 cfs (US$620) per village per year.

The only other major large animal predator found in the Basin is the wild hunting dog. This animal, an endangered species, occurs in the Niokolo-Koba Nationa Park and vicinity. Although recognized by many hunters throughout the Basin, its only reported depredations were in villages immediately to the south of the Park, and in the proposed reservoir locality. One village claimed the loss of a single cow; another reported 20 goats were killed in 1984. It is conceivable that a pack of these animals, if temporarily residing in a certain portion of its large home range say, during whelping season, could kill that many animals.

A wide variety of other carnivores were reported to kill domestic animals. The following animals were reported to kill sheep and goats: the civet cat, ratel, serval, and caracal. No real indication concerning the extent of damage caused by these animals could be obtained. The mongooses may be regular predators of chickens but their status is not central to this study. In general, there was widespread agreement on the feeding habits of most small carnivores. The one species for which there was strong disagreement was the civet cat. This animal, whose name in Pulaar means "goat-panther", was variously reported as killing goats and sheep, killing only small goats, never killing goats, and being a regular pest in groundnut and maize fields (the last certainly being true). There was also a nomenclature problem among the civet, genets, and serval (and even the cheetah), all of these animals being variously spotted and stiped. People rarely observe these noctural species and therefore tend to confuse their names.

The following animals were indicated as predators of chickens: mongoose (several species), genet (several species), the african wildcat and the serval. Mongoose and genets are very common throughout the Basin, and the wildcat can also be considered common. Serval are common to uncommon, and are taken when possible for their skins, even though they are not especially valuable. Chicken losses were reported from occasional to "everyday". In one village where chickens were penned up at night, it was reported that predators (especially the wildcat) would lie concealed in the fields and when the chickens were turned loose during the day to forage for insects in the fields they would be killed.

3.3.2.2. Birds. Bird pests fall into two categories, depending on what they consume.

- Crop pests: consumers of grain and fruit.
- Poultry pests: predators on chickens, ducks and domestic guinea-fowl.

By far the most important avian crop pest in the Gambia River Basin is the village weaver (*Ploceus cucullatus*). This ubiquitous granivore is found by the thousands wherever rice, sorghum, millet, and other grains are grown. There are no data available on the total losses to this or any other species, but P.L. Ames, in Harza's 1982 study of weaver damage in the Casamance of Senegal, estimated that about 6,000 village weavers were feeding in the rice fields of Niabina, consuming about 3 gm per bird per day, a total for the flock of nearly 200 tons of grain during the 30-day rice harvest period. In addition to actually eating grain, village weavers cause additional losses by breaking down the rice plant, and by dropping kernels. The local figure of 200 tons is consistent with the figure given by Bruggers (1976) of 100,000-200,000 tons of grain consumed annually in Senegal by birds. Brugger's estimate is intended to include the extensive losses to the two species of Quelea, dominant pests in the north of Senegal, and to a dozen or more other species. The figure certainly is conservative, for the total Senegal population of Quelea alone is estimated in millions. Certainly the Gambian population of village weaver runs into hundreds of thousands, and even allowing for substantial consumption of wild foods (fruits, flowers, and seeds of a variety of plants), an adult weaver with a body weight of 30 gm, consuming five grams of grain per day is likely to take at least 500 gm of domestic grain per year, perhaps twice that. An annual loss of 1,000 to 2,000 tons of rice to weaver in The Gambia seems likely.

In addition to the depredations of village weavers on rice, farmers in the Basin suffer losses of sorghum, millet and corn consumed by weavers, starlings, parrots and doves. We have seen no estimates of losses of other grains or losses to birds other than weavers. On the basis of available data, we can only state with confidence that granivorous birds constitute an important source of crop losses in many parts of the basin.

Birds were the major pest identified with both pure maize and maize associations. With the exception of Adiaf, which reported that only 3 percent of pure maize fields (n=31) had bird damage, and had no damage from any pest species in maize crop associations (n=7), birds accounted for at least 17 percent of the trespasses reported but often had much higher frequencies.

In millet, insects were identified as damaging 27 percent of the early fields at Nema (n=15) and 18 percent of the late fields at Allunhare (n=17), but were not reported from Pakeba. Birds were the next most frequent predator, damaging 21 percent of all millet fields surveyed (n=53).

Compared with granivorous birds, the predatory birds represent a rather minor pest category. The group includes about fifteen species of hawks and eagles and three species of owls. The total number of domestic fowl taken is not large, but a single farmer or village may suffer repeated losses to one or two individual raptors.

3.3.2.3. Reptiles. A species of reptile may become a pest to man for one or both of two reasons: 1) it presents a personal danger from venom (some snakes) or physical attack (crocodiles and pythons) or 2) it threatens his livelihood through the consumption of livestock or poultry.

Of the species of snakes found in the Gambia River Basin, only eight or ten represent much hazard to man. These may be categorized as follows:

- Cobras, two species, dangerously venomous and attaining sufficient size that an untreated bite frequently causes death.
- The green mamba, widespread and agressive; the bite of a large specimen usually is fatal if untreated.
- The boomslang, a rearfanged member of the family Colubridae, others of which are harmless; the bite of a large specimen often is fatal.
- Vipers, five species, of which one, the puff adder, accounts for the majority of viper bites, although it does not attain the length reached by some of the other venomous snakes of the region (maximum about 1.6 m). It has large fangs and a large quantity of powerful venom. The other species, the night adder, the carpet viper, the green tree viper, and the burrowing viper, are smaller and less frequently encountered. The carpet viper, however, although small, is reported by Cansdale (1961) to be the source of many serious snakebites in Nigeria, due to its nocturnal habits, readiness to bite, and strong venom.
- Pythons. Only one of the two Senegambian species, the African rock python, attains sufficient size to be dangerous to man. Pythons large enough to attack and kill even a child are rare in most of the inhabited parts of the Basin, but occasional deaths are reported.

Most authorities on West African snakes believe that venomous snakes and pythons represent a rather minor hazard to man when compared with numerous other risks faced by rural people (Cansdale, 1961; Villiers, 1975). Their opinion probably is justified, but it is not shared by the majority of rural folk, who kill any large snake on sight. Accurate snakebike statistics do not exist for any part of the Basin. Certainly, a number of bites occur and some of these cause death. We have encountered a few hunters who have been partially incapacitated by snakebite (probably by the larger vipers, whose venom has a more localized effect than that of cobras and mambas).

Snakes also consume occasional chickens or even small livestock, but such depredations are infrequent, due in large measure to the persistence with which snakes are exterminated around villages. On balance, the consumption of rodents by snakes represents a benefit that far out weights the slight losses of poultry and livestock.

3.3.2.4. Crop protection against vertebrate pests. Because agriculture is the basis for subsistence throughout the Basin, a substantial effort is directed towards protecting the various crops from depredating animals. Methods currently used within the Basin range from traditional practices such as shooting trespassing animals, organizing village drives, and constructing fences, to more modernized uses of poisons or chemical deterents. All of the methods employed are designed to serve at least one of three purposes: direct reduction of the target species population by killing; prevention of access to the field; and/or scaring the animals from the immediate locality. While there is some overlap in the application of these methods, for convenience they will be presented separately for small mammals (principly rodents) and the large mammals (warthog, monkeys and baboon, and hippopotamus).

3.3.2.4.1. Rodent control methods. Following the massive rodent outbreaks in the mid-1970's, the Government of Senegal, with the technical assistance of several foreign governments, instigated both immediate remedial and long term rodent control programs. Background information and recommendations for these programs are described in greater detail in several reports (M.W. Fall and USAID-ADO, Dakar, 1976; Rep. of Senegal, Ministry of Rural Development and Hydraulics, Jan. 1976; Rep. of Senegal, Delegation Generale a la Recherche Scientifique et Technique, Jan. 1976; Weis 1981) and are only highlighted here. While the major devastations and subsequent action programs were primarily experienced by Senegal, later cooperation between the USAID Crop Protection Services in Gambia and

Senegal have resulted in similar levels of awareness and capabilities for these two countries. The situation in Guinea, especially in the more remote areas within the GRB, is decidedly less advanced.

The objectives of the control program in Senegal were sixfold:

- Protect the current crops
- Permit the growth of wet season crops
- Preserve the irrigation dikes and canals
- Clear the agricultural areas of rats
- Prevent expansion of the rodent populations to the interior (groundnut) areas
- Organize the infrastructure of continuing crop protection

Fall (1976:3) emphasizes in his report of this program, however, that the overall objective is the protection of crops and/or the control of damage - not simply killing rodents. The primary methods for control are described below.

Organized drive-hunts or "battues"

In this "physical" control method, individuals or groups of people systematically work fields and adjacent areas, using clubs to dispatch the rodents. As originally proposed, this program included bounty payments to provide additional incentive. This total cost proposed for the initial control period during the outbreak was calculated at $5.5 million dollars. Fall (1976) comments that bounties paid per numbers of rats killed was not a proven way to reduce the amount of crop damage. He recommended that if bounties were to be paid, they should be based on work-time invested rather than a per-head basis.

Sulphur wicks

Burning sulphur wick fumigants placed into burrows during hunts was suggested to increase their efficiency because the animals were driven from their holes where they could be clubbed by the hunters.

Flame-throwers

Flame-throwers were recommended for clearing borrows (presumably by directing the nozzle into the hole thereby killing the inhabitants either by high temperatures and burning, or depletion of oxygen), and for incinerating large piles of carcasses.

Other physical preventative and protective measures

These methods are especially recommended for small garden plots which could not economically justify the expense of chemical control methods.

- Clear debris and weeds from fields and clear brush from surrounding areas for 25-50 meters.
- Remove thorn-brush fences around fields because these collect blowing sand, leaves and other debris which provide cover and burrowing locations for rodents. (Fall does note that this would require additional surveillance to keep stock out of the gardens).
- Excavate existing burrows, kill resident rodents, and fill in the holes; continue this activity as required.
- Clean village yard areas, piling materials off the ground to reduce harborage for rodents.
- Store grain, food and other materials on racks or tables away from walls to reduce rodent access.
- Pile grains and groundnuts being dried in the field on racks or platforms off the ground to reduce rodent access. For large storage piles which can not be elevated off the ground, dig trenches around these.

Anticoagulant poison baits

The recommended rodenticide is an "anticoagulant" type. These poisons act relatively slow by requiring several days of continuous ingestion, and ultimately kills the animal by arresting blood clotting actions which results in internal hemorraghing. Such poisons are used because the social and intelligent nature of rats tends to prevent the population as a whole from eating a new food source found within their environs after the dominant individuals are seen to die from consuming it. Thus, the slower action of the anticoagulant type allows a large portion of the population to be poisoned before symptoms develop. Anticoagulants are safer than most poisons because they do not act on non-rodents.

For the initial program in Senegal, it was recommended to use commercially prepared baits formulated on a grain carrier. The estimated cost of the bait required was $5.3 million dollars. The expense of the commercial baits was justified because of its proven success with some of the larger agricultural enterprises in Senegal, and because the average Senegal farmer was not trained to use the concentrate form to prepare baits with local grains. This necessary extension training was to be incorporated into the infrastructure development phase of the program.

Fall (1976:14-17) further discusses the pros and cons of single versus multiple treatments; sustained baiting; bait stations; paraffin blocks; acute (fast-acting) toxins; poison tracking powders (substances spread across access trails which adhere to the rat's feet, later being ingested during grooming); and appropriate methods for dry or wet season applications.

Phostoxin

This insecticide can be placed into burrows as a toxic fumigant. The product sumlimates upon exposure to the air, releasing a toxic gas. One or two lozenges placed into holes, which are then filled in, can be quite effective, but the method requires trained applicators.

Biological control methods

No biological method (sterilants, diseases, parasites, predators, deletorious genes, etc.) have been found to be effective for rodent control.

Human safety during any major rodent control program is a major consideration. First, rodents and their ectoparasites (fleas, mites, ticks or lice) can transmit a variety of diseases to humans, and this possibility is augmented with contacts between people and rodents. Handling dead animals also poses a definite threat because of the tendancy for the parasites to seek new hosts. Such diseases as plague, leptospirosis, murine typhus, salmonellosis and rat bite fever are known to be transmitted, but Fall (1976:20) states that it is not proven if any or all of these diseases are endemic to the major West African rodent species. He recommended that this matter be investigated, and it is possible that additional information is now available from public health authorities. As a precaution, he recommends that neither live nor dead rats should handled by people without using gloves or grasping implements, and that all carcasses be burned or buried away from human inhabitation areas. A second aspect of safety is the use of pesticides. It was recommended that appropriate training programs be conducted concerning some general precautions:

- Only authorized persons should handle the baits.
- Children in particular should be warned not to touch the poisons.
- Containers should clearly be marked as poison and used for no other purpose.
- Baits should be stored in clearly marked and locked places, and great care should be taken lest the treated grain be consumed as food by unknowing humans.
- All domestic animals should be kept away from treatment areas.
- Rural doctors should be briefed on the symptoms and treatments of anticoagulant intoxication and supplies of vitamin K (a natural antidote) should be available). Information was not available in the reports concerning the possibilities of general environmental contamination from the use of the recommended rodenticides (chlorophacinone, coumatetralyl, coumachlor, GEIGY 23123, coumafene, and crimidine). Further inquiries should be made if major use of these chemicals becomes part of the overall basin development program.

The Fall report (1976) concludes with various recommendations for further studies, evaluations and training programs he considers will be necessary for a long term successful campaign. The current status of specific programs in progress can be ascertained from the Crop Protection

Services of The Gambia and Senegal. A rather succinct summary of rodent control programs in rice fields is provided in "The Philipine Recommends for Rice - 1976" (cited only as from The Rodent Research Center; photocopy on file at USAID-Dakar). The general measures include the cutting of weeds along dikes and canal banks and adjacent waste areas, particularly several weeks before transplanting and during the early stages of rice growth. This practice removes the necessary cover which the rodents need to survive. The report cautions that fields planted to mature much earlier or much later than the surrounding fields often have very heavy rat damage, and even emergency control measures employed at this stage are not usually successful. Finally, for the farmer who really wants to protect his crop, there is no substitute for continuous rodent control throughout the crop period. The German (GTZ) publication "Rodent Pests and their Control" (Weis, 1981) also emphasizes that for cereal crops, a continuous, well-planned and monitored control program is the key to success.

There is one additional method, and two variations of crop protection methods which are used by some local farmers for rodent control. An additional method, not included in the Government program is the popular use of dogs for hunting the grasscutter. According to some of the farmer/hunters interviewed, this method is rather effective. This particular rodent is also considered as a prized food animal, which certainly increases the incentive to hunt it. We did not ascertain if whether hunting with dogs or consumpton as food extends to other rodent species. The community drive/hunt organized primarily to combat one or more of the larger pest mammals, and has the corollary affect of also reducing rodent populations, which are often encountered during the exercise. This probably qualifies as one of the "continuous control" practices recommended by the Philipineand German reports cited previously. Lastly, around one of the irrigated perimeters visited (and probably others as well), a steep sided ditch was dug in an attempt to prevent access by warthog. Although this "moat" was not successful for its intended purpose, the steep sides, especially if cement, might aid in controlling rodent access.

3.3.2.4.2. <u>Control of large mammals</u>. The vast majority of control methods employed against the large crop depredating species are traditional methods which have been used for decades: hunting, community drives, scaring tactics. While there is some Government assistance in the form of sanctioned hunts, or the distribution of low-cost ammunition, the average farmer must rely on his own resources. The Gambian Crop Protection Bulletin regularly carries articles decrying the warthog problem, which has led to the purported abandonment of several agricultural areas (CPS Bulletins No. 7, 1980; No. 8, 1981; No. 21, 1982).

Hunting

Hunting is the preferred method for dealing with all of the large crop pest animals. Typical weapons include the 12 ga shotgun, blackpowder rifles (illegal in Senegal), and in Guinea, an occasional rifle (Ca 30 calibre) and even bow and arrow. The use of predator urine as a repellent does not hold much promise according to a study conducted in South Africa (Novellie et al, 1982). For the warthog and hippo, hunting is probably the only currently reliable method, with fences and other barriers running a distant second (see below). Most farmers in Senegal Oriental now face the dilemma of substantially restricted firearms and the vigilant patrols of the National Park Service. They claim that their harvests are substantially reduced. In Guinea, the situation is somewhat better because guns are widely owned and in most areas warthog populations are not as plentiful, but the availability and cost of shells and/or powder is cited as a limiting control factor. In the Gambia, warthog are classified as vermin and can be freely hunted by indigenous people, but the high population densities of the warthog and the limited availability of affordable shells have resulted in major crop losses. Even though the Ministry of Local Governments supposedly distributes low cost shells, the program does not seem to be adequate to handle the problem, according to the CPS Bulletins. In Senegal, the Government sanctions hunts on the basis of complaints received from local farmers. Such hunts, however, must be authorized by the President, and only after a field evaluation by the Forest and Wildlife Service. Tables 3.4 and 3.5 present the official numbers of animals killed during these administrative hunts, also the respective numbers taken by sport hunting. Reports of up to a hundred wart hogs observed around major agricultural perimeters (L. Merli, pers. comm., 1984), suggest that the effective control realized by these sanctioned hunts is minimal, except, perhaps, in the local area hunted. Although this method could be considereably more effective, the logistic capabilities of the Forest Service (communications, man-power, fuel, etc.) seem to preclude success. Another indication of the effectiveness of the Gambia program, is the periodic authorization for the Police Field Force to participate in sanctioned hunts in particularly chronic problem areas. The level of this program is probably comparable to the Administrative hunts in Senegal.

A common practice throughout the GRB is the organization of community hunts, often including several villages. When firearms are used, these activities are apparently quite effective both in driving animals away from the locality and in reducing the population levels. In The Gambia, these community hunts are reported to minimize the problem for up to a month. Along the river, where wildlife has congregated for water, once the rains begin and the animals are driven to the upland areas, the effects are even longer lasting because of the improved water distribution. The Gambia has numerous hunter associations, whose primary purpose is to organize local hunters, who are then dispatched on a quasirotating basis whereever needed.

Table: 3.4

RESULTS OF SANCTIONED HUNTS AGAINST DEPREDATING MAMMALS
IN SENEGAL-ORIENTAL (LES BATTUES ADMINISTRATIVE)

Sector	Animal	1975	1978	1979	1980
Tambacounda	Warthog	167	695	1175	477
	Monkeys*	9	97	55	13
Kedougou	Warthog	81	199	325	42
	Monkeys*	163	300	306	11
TOTALS	Warthog	248	894	1500	519
	Monkeys*	172	397	361	24

*Monkeys include Baboons, Patas and Vervet monkeys.
Source: Republique de Senegal, Direction Des Eaux, Foret Et Chasse. Annual Reports.

Table: 3.5

TOTAL NUMBER WARTHOGS KILLED UNDER SPORT HUNTING PERMITS

Area	1975	1978	1979	1980	81-82	82-83
Senegal-Oriental	(No Data)	535	1	0	(No Data)	
All Senegal		927	533	300	693	593

Source: Republique de Senegal, Direction Des Eaux, Foret Et Chasse. Annual Reports.

Non-hunting methods

Numerous methods have been devised either to supplement hunting, or to attempt to replace it in areas where hunting is illegal or sufficient shells/powder can not be procured.

Day or night time vigils and various scaring methods are the most commonly employed. Often, platforms will be constructed in the fields to provide an elevated observation point. Yelling, beating on drums and other vocal techniques are typical. Tin can rattles, strung on wire around the perimeter of fields frequently are tried, but in general the poor quality cord breaks too easy. Possibly the use of stronger monofilament line would improve this method. For monkeys and baboons, the yelling is often reinforced by throwing rocks with slings. At night, fires placed, either centrally or at intervals around the perimeter of a field are reported to be somewhat effective. Young boys and even girls do the scaring during the day, and men usually patrol during the night. In either case, constant vigil is required.

Fences are often constructed around the fields. These range from light weight thorny branches to virtual heavy pole stockades. Tremendous manpower goes into the construction of these fences (again attesting to the seriousness of the problem) and these must be regularly replaced due to destruction by termites. In some areas, the amount of wood used must certainly contribute to deforestation. Unfortunately, it only requires a few breaches in these fences to allow a warthog to force its way into the field. Nonetheless, these fences are reported to reduce the amount of damage. Many types of fences have been tried to prevent access by hippos. There are mixed reports on their effectiveness, but it seems that properly constructed and placed structures can reduce depredations. It has also been reported that occasionally, surprisingly feeble structures (small trenches; light weight fences painted white, etc.) are effective. If hippos are to survive in The Gambia, some basic experimentation on the most appropriate structure will be required.

Dogs are used to chase and even hunt monkeys, baboon and warthog. Many hunter/farmers have one or two dogs which definitely contribute to protection of the fields. Around Pakeba, packs of up to 20 dogs were routinely used to hunt and kill warthogs. One hunter in Guinea used his two dogs to tree monkeys, which he shot with arrows to conserve his ammunition.

Specialized methods employed by commercial agricultural enterprises

The commercial agricultural operations have attempted some more elaborate control measures. SODIFITEX near Pakeba tried a chemical repellent to keep warthog from their fields, but local farmers claimed it was not very effective. The use of carbide cannons, which discharge every 5-10 minutes during the night, has also been tried. Some reports attest to the effectiveness of these devices, but one GRB field worker reports seeing warthog sleeping near the cannons (F. Casey, pers. comm., 1984).

Improving control. The foregoing discussion indicates that most methods for controlling crop depredating mammals currently in use are not particularly effective. It is impossible to subject an existing or potential control method to cost/benefit analysis, while the extent of current losses remains unknown. Existing pest control represents levels of effort that the individual farmer or the village heads believe is commensurate with the problem and with time and manpower resources available to combat it. More sophisticated means of pest control are available, but most are expensive and substantially more complex. By their higher cost they may exceed the value of damage done by the pest and they are likely to require outside funding. By their complexity such methods often require equipment and supplies, trained personnel and local education programs, without the absence of any of which may render the pest control effort ineffective and even hazardous. Little can be done to salvage crops once an unexpected population explosion of rodents is in progress.

All in all, the actual impact on the target rodent species is likely to be negligible due to the ecological principle of density-dependent natural controls. Even though tens of thousands might be killed during an intensive control campaign, these are abnormally high population levels which would eventually succumb to other innate population control mechanisms. Furthermore, even the most intense efforts will never succeed in the total eradication of these species, and the very act of reducing the peak population increases the odds for the survivors. Either locally surviving individuals, or certainly new immigrant animals will always begin the repopulation process.

As Fall emphasizes in his 1976 recommendations, continued evaluations must be made to determine the most appropriate control methods, including such variables as types of poisons, timing and amounts of baits deployed, better coordination of the physical control methods, and the increased training of local farmers to deal with these problems. One other possible way to focus additional attention on this matter, and perhaps even derive certain economical and/or nutritional benefits, would be to encourage the increased use of at least two of these rodent species (Thryonomys swinderianus and Cricetomys gambianus) as human food. Both of these species are commercially hunted and even farmed in Nigeria as a food source.

The recommended programs of continuous control, however, with both habitat manipulation and the use of anticoagulant baits, will not only provide partial control of rodent pests in the short run, but will establish a cadre of trained staff, local stocks of poisons, and the logistic infrastructure so that when climatic variables or other conditions cause rapid increases in rodent pest populations controls can be implemented more effectively. Village-based methods such as continued improvements in grain storage and locally manufactured snap-traps would not only reduce post-harvest losses but would involve the local people more directly in the problem.

For the large mammals, it must also be said that control efforts are only partially successful. The evidence for this statement is the continued high population levels of warthog, monkeys, and baboon in many areas. Further evidence is the low numbers of individuals actually killed during the sporadic sanctioned control operations. This is not to say that the particular locality of the operation might not experience a substantial reduction, but if one considers the total area of the Basin, these numbers are indeed minimal. The amount of time spent trying to protect fields, invested either as fence building or as guard duty, also suggests that the depredation problem is real, and not merely an exaggerated fabrication to get more government support. In summary, it can be stated that monkeys, baboon and warthog are ideally adapted to their combined natural and agricultural habitat; they have little population control except for being shot as crop pests (neither hunting for meat, hides, trophies, nor natural predators is intensive enought to moderate their numbers); and the species do damage agricultural crops.

Hippos are the exception. In The Gambia, population levels are low, and are probably declining with the number killed in the fields each year.

The fact that this animal is used for food adds additional incentive to control efforts. Since most barrier methods presently in use are eventually circumvented by persistent hippos in the major rice areas, the animals end up in the fields sooner or later. Since they do not scare away readily, they are shot. Thus, the control methods are having a long-term dertrimental effect on The Gambia, where numbers are fewer (outside of the Park) and legal protection is more effective.

A few suggestions can be made for the possible improvement of control methods. There is a need for additional research and evaluation for better methods to control the large mammals. Unlike rodents, virtually no systematic damage assessment or studies of new methods has been made. Considering that this is a pan-African problem, the lack of research is surprising. We believe that a quantitative assessment of the actual damage caused by large mammals would succinctly indicate the need for such research. Backed by the numerical reality of the problem, assistance funds would probably be provided from international agencies interested in improving agricultural yields.

Within the Basin, one recommendation for improving existing methods would be to conduct a comparative study of the methods used at Adiaf, Senegal, and the practices at Tuba, The Gambia. Adiaf reported a consistently low amount of damage, while Tuba damage estimates were much higher. Many of the traditional methods are relatively effective if applied properly and some substantial benefits might be realized from this simple comparison. Another suggestion, based on the fact that each of the traditional methods is effective but only for a brief time, is to consider a carefully choreographed rotation application of the common methods: shooting; yelling; rattles; dogs, then perhaps return to shooting. Such an approach might keep the depredators disoriented enough to increase the overall protection. Such an experiment could be implemented within the organization of the hunter associations in The Gambia.

Two "new" methods can also be suggested. One is the use of solar powered electric fences. Evaluations of this relatively new technology are currently being conducted for livestock control by the Veterinary Services in The Gambia. The other suggestion is directed towards control of warthog in The Gambia. This would entail the establishment of a small commercial enterprise which would sell properly processed and inspected warthog meat to the expatriate and hotel communities in Banjul.

3.3.3. Species for Consumptive Utilization

3.3.3.1. Mammals. Consumptive utilization consists of killing an animal for its meat, hide, horns or other products. There are four purposes for which mammalian species in the Basin are consumptively exploited: a) food; b) other traditional uses; c) sport hunting; and d) commercialized poaching.

3.3.3.1.1. Food (bush meat). A large variety of mammal species are taken for food in the Basin. The selections are dependent on the availability of the animal, and are influenced by ethnic and religious practices. Data gathered by the GRBS Wildlife Team are presented separately for the three GRB countries in Tables 3.6a, 3.6b, and 3.6c. The divisions reflect in varying degrees the availability (distribution and density) of the fauna (most of the larger ungulates are no longer resident in The Gambia) the completeness of the data acquired and the regional pressures on many of the species. The division by country also facilitates analysis of the proposed development impacts.

The majority of our information was collected during interviews with local hunters. In addition to food animals, the same interview also inquired into other mammals present in the area, recent extinctions, crop and livestock pest species, hunting practices, and other uses of wildlife. Especially in Senegal, where laws prohibiting subsistance hunting are apparently harshly enforced periodically, hunters were very hesitant to discuss this subject. Nonetheless, the data presented in Table 3.6 provide a good profile of the mammal species used for food in the Basin.

Virtually all of the larger mammals are used for food. In fact, the only animals consistently excluded as food are the galagos and the chimpanzee. The hyaena may also be in this category, since it was never mentioned. One Mandinka hunter in Senegal claimed that any animal killed was eaten (formerly). A Sarehuli hunter in The Gambia stated that all

Table 3.6a

WILD MAMMALS USED FOR FOOD IN THE GAMBIA

baboon	Not eaten by Muslim people, but reported as food animal in one Peuhl village.
fox, jackal	(Mandinka; Peuhl; Wollof; not Serahuli)
otter	(Mandinka; Peuhl)
gorilla	Reported eaten in one Peuhl village, but never has been present in The Gambia. (Peuhl)
ratel	(Mankinka; Peuhl; Serahuli; Wollof)
civet cat	(Peuhl)
genet	(Peuhl)
mongoose	(Mandinka; Peuhl)
serval	(Mandinka; Peuhl)
leopard	Formerly hunted for food; (Peuhl; others?) now rarely eaten but probably preferred because of quantity of meat.
manatee	(Serahuli; probably other ethnic groups, too)
aardvark	Not eaten by Muslim people, but reported as a food animal in one Peuhl and one Mandinka-Wollof village.
warthog	Favored (because of large quantity of meat) but not often eaten. Illegal to hunt for food; but regularly killed while depredating fields (see Pest Species). (Mandinka; Peuhl: Serahuli; Wollof)
hippopotamus	Preferred animal; taken occasionally. (Mandinka; Peuhl; Serahuli; Wollof)
red flanked duiker	Preferred, but probably only an occasional transient in The Gambia. One reported killed two years ago in a Peuhl village. (Mandinka; Peuhl; Serahuli)
roan antelope	Preferred but not commonly taken. (Mandinka; Peuhl; Wollof)
oribi	Preferred but not widely distributed or common. (Mandinka; Peuhl; Wollof))
reedbuck	Preferred but not often taken. (Mandinka; Peuhl; Serahuli; Wollof)
bushbuck	A preferred and apparently regularly taken animal. (Mandinka; Peuhl; Serahuli; Wollof)
sitatunga	Preferred and frequently eaten. (Mandinka; Peuhl; Wollof)
porcupine	Probably common food species. (Mandinka; Peuhl)
ground squirrel	Commonly eaten; preferred in most areas. (Mandinka; Peuhl)
cane rat	

Source: Data collected during GRBS Wildlife Team hunter interviews, 1983-84.

Table 3.6b

WILD MAMMALS USED FOR FOOD IN SENEGAL

vervet monkey	Common food species for Bassari.
red colobus monkey	Probably eaten by Bassari, but rare in their region.
black & white colobus monkey	Very restricted and uncommon species, tentatively identified in only one locality. Reported as a food species in one Mandinka village.
red patas monkey	Common food species for Bassari, reported as eaten in one Mandinka village.
baboon	Probably common food species for Bassari.
fox, jackal	(Bassari)
otter	Uncommon, restricted distribution. (Malinke)
ratel	(Peuhl)
civet cat	(Bassari; Malinke; Peuhl)
mongoose	(Peuhl)
serval	(Peuhl)
wild cat	(Peuhl)
caracal	(Peuhl)
lion	(Bassari)
leopard	(Bassari; Peuhl)
elephant	(Bassari)
aardvark	Preferred but not commonly taken. (Bassari; Malinke; Peuhl)
warthog	Common food species for the species.
bubal	(Bassari; Malinke)
red-flanked duiker	Along with the bushbuck, the most frequently taken ungulate. (Bassari; Malinke; Peuhl)
red-fronted gazelle	Occasionally taken in sahelian areas. (Peuhl)
roan antelope	Occasionally taken (Bassari; Malinke; Peuhl)
waterbuck	Rarely taken (Bassari)
gribl	Occasionally taken (Bassari; Malinke)
reedbuck	Rarely taken (Bassari; Malinke)
buffalo	Occasionally taken (Bassari; Malinke)
eland	Rarely taken (Bassari)
bushbuck	Preferred, and along with red-flanked duiker, the most frequently taken ungulate. (Bassari; Malinke; Peuhl)
pangolin	Rarely taken. (Malinke)
porcupine	Preferred, commonly taken. (Bassari)
ground squirrel	Commonly eaten. (Peuhl)
hare	Commonly eaten but some Malinke do not eat due totem restrictions. (Bassari; Malinke; Peuhl)

Table 3.6c

WILD MAMMALS USED FOR FOOD IN GUINEA

vervet monkey	Common food animal. (Kognagui; Bassari)
red patas	Common food animal. (Kognagui; Bassari)
civet cat	(Peuhl, but not eaten in all villages)
lion	(Peuhl)
aardvark	(Bassari; Dialonke; Peuhl)
rock dassie	(Peuhl)
warthog	Preferred and commonly eaten. (Kognagui)
red river hog	Uncommon, but eaten. (Diakhanke; Peuhl)
red-flanked duiker	(Dialonke; Peuhl)
kob antelope	Reported from only one area; uncommonly taken. (Dialonke)
roan antelope	Uncommon species in Guinea, but a preferred food animal. (Kognagui; Peuhl)
oribi	Occasionally taken in some areas. (Dialonke; Peuhl)
eland	Reported from only one area; 3 killed in 1984. (Peuhl)
bushbuck	Preferred and regularly taken. (Dialonke; Peuhl)
pangolin	Rarely taken. (Bassari; Diakhanke; Peuhl)
porcupine	Preferred and often taken species; someplaces considered a delicacy; can be locally hunted out. (Bassari; Diakhanke; Dialonke; Kognagui; Peuhl)
ground squirrel	Occasional food species. (Dialonke; Peuhl)
hare	Probably the most commonly taken mammal. (Dialonke; Kognagui; Peuhl)

Source: Data collected during GRBS Wildlife Team hunter interviews, 1983-84.

animals except warthogs, baboons and monkeys are eaten. The Basari and Kognagui appear to have the largest repertoire of wild food animals.

The preferred species throughout the Basin are the antelope (including the bushbuck, duikers, oribi, roan, eland and sitatunga) porcupine, aardvark and cane rat. Monkeys and warthogs are preferred by the Basari and Kognagui, as well as by some non-practicing Muslims from other ethnic groups. The commonly acquired animals are the hare, cane rat, ground squirrel, porcupine and warthog. Among the antelope, bushbuck and red-flanked duiker are the most frequently taken.

The large antelope are only occasionally killed. Of these, the roan is probably killed most often, because currently it is the most wide-ranging of the large ungulates. Waterbuck are not common in most areas outside of Niokolo-Koba National Park, but are reported to be inquistive and easy to hunt. Kob antelope were only reliably reported in one locality outside the Park, about 10 km north of the confluence of the Gambia and Liti. Eland were only reported by hunters in the Balaki locality, Guinea, and to the south of Niokolo-Koba National Park.

Some of the non-mammalian food species encountered during the survey were the monitor lizard, python, crocodile, fish and various "bushfowl" (guineafowl and francolins).

The importance of bush meat varies throughout the Basin, depending on the numbers of animals available and the ease of their acquisition. Three-fourths of the hunters interviewed in The Gambia considered bush meat to be important. Those dissenting explained that there were not many animals in their areas. In Senegal, the majority of hunters (and village chiefs participating in the discussion) stated that bush meat used to be very important, but no longer was, because there were no game animals in some localities, they are not allowed to hunt, or both. In spite of these replies, the Plan Directeur de Forestiere (la Faune et la Chasse, 1981) states that subsistence hunting is still widespread. Bush meat in Guinea appears to be significant in the northeast region, especially along the frontier, between Medina Gada-Oundou and Balaki, and in the northwest, from Kifaya to Sambailo.

While hunting is generally practiced throughout the year, there tends to be an increase in activity during the dry season. Many villages reported that bush meat was particularly important towards the end of the dry season because their harvests from the previous growing season were exhausted. Most people claim bush meat is important, even though it is not often actually eaten, and rarely in large quantities, as a condiment to be added to their sauces.

Furthermore, families with hunters exploit this resource much more than non-hunter families. Small game animals and bushfowl are the most commonly taken forms of bush meat, and these are generally consumed by the hunter family. It is only when the occasional larger animal is killed that there is enough surplus meat to be divided and sold to other villagers.

Data from the Wildlife Team field survey in Guinea on the frequency of bush meat meals shown an average of 4.5 meals per month for families with hunters, but Hamer (1984) found only 0.9 meals per month a village-wide basis. Although the samples were not large and the methods were somewhat different, the magnitude of the difference is reasonable. Table 3.7 compares the frequency of bush meat to domestic meat in 6 villages, 10 compounds per village (A. Hamer, ibid.) The overall ratio is 1:4 (0.6 times per month for bush meat; 2.5 times per month for domestic) if Kognagui village, which exploited the abundant warthogs and monkeys, is excluded. Including this minority ethnic group reduces the ratio to 1:3. In either case, the ratio substantially favors domestic meat in all but Kognagui village where, as expected, bush meat is as frequently consumed as domestic meat, if not more often.

Table 3.7

FREQUENCY AND QUANTITIES OF MEAT CONSUMED IN GUINEA[a]

Village Number Designation	Bush Meat Frequency Meals per month	Domestic Meat	
		Frequency Meals per Month	Quantity kg/fam/mo
1[b]	2.5	2.0	--
2	>0.5	2.8	--
3	0.13	2.5	3.0
4	0.25	3.0	3.2
5	1.75	4.75	3.0
6	0.4	1.4	2.4
avg. 2-6	0.6	2.44	
avg. 1-6	0.92	2.9	
avg. 3-6			2.9

NOTE: (a) Source: A. Hamer, GRBS Nutritional Survey, 1984.
(b) Kognagui Village (includes monkeys and warthogs).

Table 3.7 also indicates that the average amount of domestic meat consumed per family per month is only 2.9 kg. Even though this quantity is low, and bush meat consumption is even lower, their importance should not be ignored. Ajayi (1979) states that for people with such minimal amounts of protein in their diets, every gram counts.

Frequency data for The Gambia tended to be a little higher, but the sample was not large and was biased towards hunter families. An average of one bush meat meal per week for hunter families, and considerably less for others, would be reasonable estimate. During the rainy season the majority of time is spent working in the fields and hunting is sporadic.

In Senegal, frequency data could not be obtained, but the consumption rate should be similar to that in The Gambia and Guinea. The minimum consumption rate reported in Sale (1981) for Senegal of about 0.2 kg per person per day ("373,631 metric tons of wild mammals and birds per annum for the country's 1981 human population of about 5,000,000") is impossibly high.

3.3.3.1.2. Other traditional uses. Wild mammals are used for a variety of other traditional purposes. Some examples include 1) the hides of the red-flanked duiker, bushbuck and other antelope for sitting mats, 2) aardvark feet, otter and ratel skins for good fortune or protection charms, and 3) hyaena and red-river hog for medicinal purposes.

3.3.3.1.3. Sport and recreational hunting. Sport hunting is a form of consumptive utilization, but in the Basin it is not very significant in terms of numbers killed of most mammal species.

In The Gambia, no mammal species is authorized for sport hunting. The warthog, Gambian rat, and "house and warehouse rodents"1/ are listed in as vermin, and can be hunted by anyone with a valid gun permit but since 1980 gun permits have been difficult to obtain.

The only authorized hunting area for medium and big game in the Basin (excluding the warthog, which can be hunted in many areas) is the Kayanga locality, south of Medina Gounas, west of Niokolo-Koba Park and north of the Guinea frontier (A. DeGeorges, pers. com., 1984). Possible species include the roan and kob antelope, buffalo, waterbuck, and duikers. The facts that this area is heavily poached, making animals scare and secretive, and that the slaughter tax must be paid in advance, make the area of little attraction for sport hunting. No further information was available in the Forest and Wildlife Service Annual Reports through 1980.

Warthog and hares are numerous and are major sport hunting targets in Senegal. However, according to the 1982-83 Bilan de la Saison Cynegetique (Forest and Wildlife Service), only 593 warthogs and 490 hares (45 and 30 in Senegal-Oriental respectively) were killed. Undoubtedly, many go unreported.

Mammals available for sport hunting in Guinea are difficult to ascertain from the documents provided to the GRBS. According to information on

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1/ Supplement A, Schedule IV, Wildlife Conservation Act, Gambia Gazette No. 58, 1979:79.

the Small Game Hunting Permit printed for the 1980's it is possible to hunt (with a special permit, presumably for mid-sized and big game) male buffalo, cheetah, eland, roan antelope, yellow-backed duiker, sitatunga, pangolin and even elephants (having tusks heaver than 5 kg). This seems to still be in accordance with the new "Code de la Chasse" apparently recently printed (K. Oulare, pers. com., 1984). Apparently, leopard, lion, waterbuck, bubal, and the smaller antelope are not designated as protected.

3.3.3.1.4. Commercial poaching. Mammal species of interest to commercial hunters can be divided into two main groups: those for meat and those for trophies.

The species selected for meat are generally larger forms yielding a salable surplus. The most commonly killed are probably the warthog, bushbuck, and duikers. The preferred species would include the roan antelope, bubal hartebeest, buffalo and waterbuck (in Senegal-Oriental and restricted localities around Balaki, Guinea) and the sitatunga and manatee (in The Gambia only). In earlier years, Senegalese hunters reportedly entered The Gambia annually to hunt manatees, but this has been stopped (E. Brewer, pers. comm., 1984). Based on information gathered by Powell at least two manatee have been killed by local hunters in The Gambia in each of the last five years.

Trophy species can also be divided into two groups: those for skins and horns, and those for ivory. The primary target for the commercial skin trade is the leopard, which occurs throughout the Basin. One skin was confiscated in Banjul in 1984 (E. Brewer, pers. com., 1984) but the exact source is uncertain. Apparently, the lion also is sought for its skin; five skins were confiscated by Niokolo-Koba National Park guards (National Parks, Annual Report, 1983-84). The two other mammals hunted primarily for their hides are the otter and giraffe (the latter now extinct in the Basin).

Mammals poached for horn (and possibly hide) trophies include the roan antelope, bubal hartebeest, waterbuck, buffalo, reedbuck and eland. Most of this activity is apparently done by expatriates for personal trophies and centers in Senegal-Oriental. This area can be stated with some certainty because, for all practical purposes, only the reedbuck occurs in The Gambia and all of these species can be legally hunted in Guinea.

Three species are hunted in the Basin for ivory: elephant, hippopotamus, and warthog. The elephant is the primary target and poaching threatens the animals' continued existance even in Niokolo-Koba National Park, its last refuge in the Basin and Senegal. Table 3.8 illustrates the downward population trend since 1975.

Table 3.8

NIOKOLO-KOBA ELEPHANT POPULATION TREND 1969-1984[a]

Year:	1969	1970	1971	1972	73-4	1975	1976	1978	81-2	83-4
Count	129	141	142	124		98	122	90		46
Est. Total	150	200	200+		350				100	56-60

a/ Source: Administration of National Parks, Aerial Surveys.

Although there is natural mortality, rarely mentioned in the Senegal literature, poaching is the primary reason for the decline. In 1983-84, 23 tusks were confiscated at a Park guard post (National Parks, Annual Report, Annex 1). Despite the efforts of the Park, the future looks exceedingly bleak for the few remaining elephants. The reason for this decimation is, of course, the value of ivory. The situation is discussed in detail in Working Document No. 65 (Treadwell & Ames, 1985).

The Gambia has completely outlawed trafficking in wild animal products, and this is reasonably well enforced on certain fronts. During 1984, when one hotel attempted to open a ivory shop, it was soon closed down by the authorities. Ivory can be purchased illicitly in The Gambia (B.D. Treadwell, pers. obs.) but the amounts are relatively small.

The situation of the elephants in the Basin (i.e., Niokolo-Koba National Park) is critical. Even a single elephant with small tusks will continue to interest poachers. The other danger that elephants face is loss of habitat. Although Niokolo-Koba currently provides more than ample space and habitat, when elephant numbers decline to a certain point, forces opposing conservation begin to ask why so much land is set aside for so few animals, when people need it for farming. Although there is an abundance of other wild animals in the Park the elephant issue should be of concern. A similar situation confronting Tsavo Park in Kenya (Douglas-Hamilton, 1979) is setting a new and dangerous precedent for parks in developing countries.

The other two species sought for ivory are of minor consequence. Warthog tusks are sold (carved and uncarved) to tourists, but it is unlikely that the animal is hunted solely for this market. Hippopotamus ivory also is sold in Dakar. In The Gambia, where the animal is much preferred for its meat, and can be legally shot if in the act of depredating fields, the ivory is only a byproduct. In Senegal, however, the National Parks Annual Reports for 1981-82 and 1983-84 state that as elephants decline, there is an increase the killing of hippos for their ivory.

3.3.4. Species of Touristic Value

A complete analysis of the tourist industry, with regards to wildlife in the Basin, is beyond the scope of this study. Even if the comprehensive study of tourism were within our purview, the necessary data are totally lacking. It is impossible to determine just what part of the SeneGambian tourist industry operates within the Basin, because, for example, most of the major hotels in The Gambia are technically not in the Basin but on beach ridges draining directly into the Atlantic Ocean. Furthermore, few tourists come to West Africa strictly to partake of the widlife opportunities. Even those who come to watch birds strictly within The Gambia usually partake of other activities, such as sunbathing and visiting native villages. The same can be said for the Tambacounda area hotels in eastern Senegal. Niokolo-Koba National Park might be the prime attraction, but there also are local cultural attractions, such as the Bassari ceremonies, which add to the total package. An analysis would be further complicated by two other facts. The first is that there are innumerable support services such as car rentals and taxis, vehicle repair facilities and gasoline, souvenir manufacturers and salesmen and others which benefit from tourism, for which wildlife per se is only one of the attactions and for only some of the people. The second is that a substantial portion of tourist revenue does not even stay within the host countries, but is returned to the European bank of the tourist or hotel agency. For these reasons, this report only notes which animals provide tourist attractions, and the approximate number of tourists directly partaking of the overall opportunity. This section presents the principle species of interest, and certain potential opportunities discovered in the course of this study.

Senegal and Gambia have well developed tourist industries in which wildlife plays a role. Guinea has essentially no tourist industry within the Basin, but has certain plans.

3.3.4.1. <u>The Gambia</u>. The Gambia is small country with a dense population. Conflicts between man and wild animals have left little valuable wildlife legacy for tourism. The remaining opportunties are threefold: roadside observations up-country; viewing opportunities from the river boat; and visits to the Abuko Nature Reserve.

3.3.4.1.1. <u>Up-country observation possibilities</u>. The Gambia has an excellent road network along the south bank of the river, and many tourists take the opportunity to visit indigenous villages and historical landmarks. During these "bush trips" one invariably sees groups of primates: baboon, patas, vervet, and occasionally red colobus monkeys. It is not uncommon to see warthogs, especially near the river. Although these species are considered pests in The Gambia, they still contribute to the overall tourist experience. Until late 1984 many tourists traveled this road by tourist bus as part of a package one-way trip on the river steamer "Lady Chillel Jawara".

3.3.4.1.2. <u>Riverine observation possibilities from "The Lady Chillel Jawara"</u>. The three-day river boat excursion was until late 1984 a favorite activity of many of the more adventuresome tourists. Unfortunately, the Lady Chillel capsized and sank near Kerewan and a year later had not been raised. It appears that this part of the tourist experience will be lacking for several years, at least. Wildlife observations definitely contributed to this experience. Participants spent many hours on-deck looking for hippo, and usually were rewarded. The other species readily seen were the primates. Both the red colobus monkey and the baboon can sometimes be seen in large numbers along the river; troops of baboons in particular can include hundreds of individuals. Along the route is Baboon Island National Park, the home of the chimpanzee rehabilitation project. On occasion, a few of the 30- odd chimps can be seen, and even when they are not, there is the anticipation factor adding to the experience. Wart-hogs can often be seen along the bank. On very rare occasions, the West African manatee, a treat for the well-informed tourist, has been sighted.

3.3.4.1.3. Abuko nature reserve. This small nature reserve is situated near the Yundum International Airport, within easy access of the major tourist hotels. It is a remnant block of relatively unspoiled riverine forest, fenced to keep out livestock and provided with some amenities to enhance the visitor's experience. A series of large "hides" allows the visitor to watch animals without them seeing him. The overall experience is enhanced by the dense forest and by series of ponds which promote a natural setting and tend to draw in animals. Under these conditions, once can view or photograph at close hand colobus, patas and vervet monkeys, bushbuck, and the extremely elusive sitatunga.

There is also a small "zoo" area, which contains several species of mammals and is a great favorite of the tourists. Here they can see chimpanzees, spotted hyaenas, lions and several species of the small antelopes. At present (1984), there is a young lowland gorilla, a species not native to The Gambia.

3.3.4.2 Senegal. A definite portion of the Senegal tourist industry is directed towards non-consumptive utilization of wildlife (primarily observation and photography). Within the Basin, this activity appears to be the primary purpose for Niokolo-Koba National Park. The Park has a diversified mammal fauna, with many species of interest to tourists (Dupuy, 1971). In fact, with a few specific exceptions, the variety of species is itself the major attraction. The Park has an excellent road network, numerous observation points (including shaded stands) and a good tourist support facility. At present, tourists have the option of driving through the Park unattended, employing a guide to travel with them, participating in guided tours in "safari vehicles", or some combination of these. Most species are well habituated to vehicles. Species are listed below in groups of likely observation without guide service.

- <u>Most Desired Animals</u>
  - Elephants are probably the most often requested species. In fact, local guides state that even if a tourist sees "everything else" except the elephant, some degree of dissatisfaction is expressed. Elephant observations in the Park without the services of a guide are unlikely at present.
  - Lions are another tourist favorite. Verschuren (1982) estimated 100 lions for the Park in 1975 and Dupuy (1974) claims about 120. Lions are common in the Park and frequently seen, although there is no guarantee even with a guide.
  - Buffalo are magnificent animals when seen in large herds or at close quarters. Opportunities are quite good, especially with a guide.

- <u>Commonly Observed Mammals</u>

  Four terrestrial ungulates almost invariably observed are warthog, kob antelope, bushbuck, and waterbuck. Baboons, patas and vervet monkeys are also regularly encountered. Hippopotamus can be regularly seen at certain localities along the Gambia River. Sylla (1984, personal communication) reports that their numbers are slowly declining.

  Four other terrestrial ungulates can usually be seen. The roan antelope and bubal hartebeest are often seen in small herds. Single red-flanked duikers and generally pairs of oribi frequently are encountered during a day's drive.

Least often observed of the large antelope is the giant eland. Sylla (1984 pers. comm.) said the 1983 number was about 300, but increasing.

Population estimates for the various other antelopes are not provided to species. Dupuy (1974, cited by Meyers 1976) reports total of 25,000, and in order of abundance the species are: kob antelope, waterbuck, bushbuck and bubal (roan antelope are not mentioned).

- <u>Rarely Observed Animals</u>

Three of the large predators are presented in Niokolo-Koba, but rarely seen. Leopard and spotted hyaena are primarily nocturnal hunters and the wild hunting dog is diurnal but not very numerous. Published population estimates for these species are, incredibly, the same as the the lion: 100 of each species (Verschuren, 1982). A more complete analysis of wildlife population trends reported for the Park is presented in Working Document No. 65.

The red river hog, or potamochere, is another interesting but uncommon resident. Finally, chimpanzees are found in the Mount Asserik locality, but probably are not often seen by tourists. This species is represented in the Park by a single community, numbering about 128 individuals (Tutin, McGrew and Baldwin, 1983).

The Administration of National Parks' Annual Report for 1981 indicates that 3,263 tourists visited Niokolo-Koba National Park during 1980. Attendance by country of orgin is summarized in Table 3.9.

Table 3.9

NIOKOLO-KOBA NATIONAL PARK ATTENDANCE
BY COUNTRY FOR 1980-1981 SEASON
OF ORIGIN

Country	Number	Percent
France	2,269	69.5
Belgium	306	9.4
United States	141	4.3
Senegal	117	3.6
Germany	45	1.4
Canada	44	1.4
Switzerland	38	1.2
25 Countries <1 Percent	148	4.5
Tourist Groupt (Unspecified)	155	4.7
	3,263	100.0 Percent

Sylla (personal commmunication, 1984) estimated the 1983 Park attendance at approximately 4,000. Of this number, he believes that only about 200 came primarily for bird-watching. Thus, the importance of the large mammalian fauna of Niokolo-Koba National Park to the tourist industry in the Senegal portion of the Basin is Apparent.

Outside the Park, there are only a few species of larger mammals which can be readily observed by the tourist or traveler. Principally, these are the primates: the baboon, patas and vervet monkeys. In addition, hippos can usually be seen near Kedougou.

3.3.4.3. Guinea. Guinea has essentially no tourism within the Basin, although there is some developing interest. The primary attractions are the beautiful mountains of the Fouta Djallon and the extraordinarily hospitable people. Unfortunately, the road system is not good, but considerable progress is being made and improvements in certain roads could be seen even during the brief period of this study. The current tourist potential fits in the "bush adventure" category, in which wildlife plays a role.

There is talk of a National Park in the administrative unit of Youkounkoun (Kaba Oulare, 1984 pers. comm.) No specific location has been provided. Since Niokolo-Koba National Park in Senegal is contiguous with the frontier, and there are movements of certain animal species between these two locations, there is potential for a park, although it is unlikely ever to compete with Niokolo-Koba. Currently, the only locally abundant animals which would be likely to be observed are patas and vervet monkeys, baboons (in sizable troops), and warthogs. At Kogou Foulbe, hippos are present. Even these species, however, normally considered pest animals, are of interest to tourists.

There is one other aspect of Guinea wildlife which could be developed for tourism. The use of powerful lights during the night was a method often employed to see animals during this study. It was not only productive in verifying the presence of numerous nocturnal animals, but was genuinely entertaining as well. Our experience on this project suggest that the tourist entrepreneur with a "night-light" would have a satisfied clientel. Species commonly seen at night include the galago (common and very entertaining), mongoose, jackals, civet, genets, porcupine and hares.

3.3.4.4. Birds. Birds form an important component of the tourist experience in the tropics. Each tourist perceives the local bird life in his or her own way, but most tourists fall into one of two broad categories:

- Passive Observers. These people do not come to Senegambia primarily to watch birds; they come for the general tropical African experience (art, music, village life, wildlife, etc) or for some part of it. Birds are a part of the tropical mystique, especially species that are conspicuous, brightly colored or noisy.
- Active Observers. These visitors come to Senegambia primarily to see birds. They are equipped with guide books, binoculars and often cameras, and usually seek a large variety of birds. Bright colors give them pleasure, but rarity gives greater pleasure.

These tourists will avail themselves of other amenities, but only so as not to interfere with birdwatching.

The bird fauna of the Gambia River Basin has been much studied, especially in The Gambia, where a small but vigorous ornithological society keeps records of sightings and provides assistance to birdwatchers. Despite a tradition of record keeping going back nearly a century, the list of Gambian birds acquires several new species every year. The lability, due to intensive field observation and to ecological change, enhances the attractiveness of The Gambia for the serious birdwatcher.

About 550 birds species have been recorded in The Gambia and another 50 or so are known from the Senegal and Guinea parts of the Basin, but absent from The Gambia. Of the total, perhaps 20-25 percent are sufficiently conspicuous and abundant to contribute significantly to the tropical impressions of the passive observer. These may be grouped as follows:

- Conspicuous and abundant: rollers, kingfishers, bee-eaters, barbets, sunbirds, some weavers, some shrikes; some species that are less brightly colored but very active, such as hornbills, drongos and the crow.
- Loud vocalists or musicians: gonolek, bulbuls, plantain eaters.
- Birds of prey, especially the large scavengers, palm nut vulture, and fishing eagle.
- Wading birds, such as egrets, spoonbills, flamingos, herons, crowned crane, and lily-trotter.

Ecologically, birds in the above groups are highly varied, but those most likely to impress the casual tourist are species tolerant of habitat disturbance. Within the Basin, particularly in The Gambia, habitat disturbance is the rule, rather than the exception. Fortunately for the tourist, some of the most colorful birds may be seen in gardens, hotel grounds, roadsides and agricultural areas.

3.4. Factors Affecting Wildlife

3.4.1. Hunting

Wildlife in the GRB is hunted for three principal reasons: subsistence, in which the hunter uses virtually all of the meat and other products for himself and his family; commercial hunting, in which the primary objective is the sale of meat, hides or other products from the animals taken; and sport hunting, or trophy hunting, in which the hunter derives pleasure from the challenge of the hunt itself, and from the acquisition of the horns, mounted head, or other remembrance (e.g., photographs) of the hunt; and protective hunting in which the primary objective is to protect crops or livestock from predators.

These distinctions are made because for these types of hunting, the objectives, practices, and impacts are different and the types of government control required also are different. As in most classifications, there are overlaps. A hunter might go to guard his field from monkeys, and find a food species such as a porcupine. Besides the fact that this is not a common event (judging from the infrequency of bush meat consumption), the hunter would then spend the planned time guarding his field, so the primary objectives is still protection. In spite of this occasional overlap, the overall impact of the activity on the wildlife and the need for government controls, the classification remains useful. All hunting is opportunistic.

3.4.1.1. Subsistence hunting. This is defined as the killing of selected species (see Table 3.4) by indigenous people living within the locality, using personal or village guns, with consumption of meat as the primary objective. In the Basin, average distances traveled from the village are probably less than 10 km. The hunter normally sells portions of larger animals to other village families (or at a market if the day and place coincide with the availability of this meat), in order to purchase additional powder or cartridges, various subsistence items, and occasionally trade goods. The present monetized economy uses cash as the medium of exchange, but this does not imply a commmercialized venture. Prior to the cash economy, these local products were bartered from one specialist (e.g., a hunter) to another (e.g., farmer). The low cash values of bush meat preclude anything beyond a subsistence vocation. Nonetheless, the laws of all three countries (though considerably less so in Guinea) consider much of subsistence hunting to be poaching (i.e., illegal hunting) because it is practiced out-of-season or without approved permits.

3.4.1.1.1. Hunting methods. Table 3.10 lists the hunting methods used in the Basin. By far, the most common method is the gun. Although no accurate data are available, field interviews suggest that virtually every village has one or two guns, often many more. In eastern Senegal, where control of hunting and gun possession is especially stringent, weapons are often hidden in the bush. Locally made muzzle-loading guns are predominant. This type of gun is illegal in Senegal, ostensibly because it is dangerous, but not in the Gambia or Guinea. Twelve-guage, single-barrel shot guns are the preferred weapons and are also widely distributed. Rifles, generally in the .30 caliber range, are occasionally encountered. Many of these are old and unusual models, and cartridges are difficult to obtain. In all cases, however, the limited availability of either powder or cartridges functions as a controlling factor. Several villagers visited said they had no powder at all this year. It was rare to see a hunter with more than a half dozen shotgun shells.

Hunting is often done at night, and a flashlight attached to the head so as to be aligned with the gunsight is used to spot animal eyes and/or to temporarily blind the animal. Dogs also are used for hunting, but are especially important in field protection. In hunting, they are used to catch grasscutter rats, and to flush and track other animals. All dogs observed were of the African bushdog variety, a medium-sized lean, short-haired type. Most of the other hunting methods encountered, such as snares, steel traps, bow-and-arrow, seemed to be individual preferences. They were not commonly practiced, and cannot really be assigned to particular areas or ethnic groups.

Table 3.10

HUNTING METHODS

1. Guns - Local Flintlock - Muzzle Loading,
   - 12 gage,country single shot
   - Rifles, .302
   - Automatic - illegal, usually only for poaching

   Minimum 1 or 2/village; occasionally many more

2. Hooks, baited for monitor lizards

3. Snares, monkeys, hares, antelopes

4. Manatees taken by harpoon and traps

5. Night-lighting with flashlight, for shooting

6. Steel jaw, traps, local manufacture

7. Stone drop doortrap-leopards, hyenas (see IFAN publications)

8. Dogs for Trailing, driving, hunting grasscutter rats, monkeys, baboons, bush pigs.

9. Cooperative village drives/hunts

10. Clubs

11. Bow and arrow, rarely used now; used to shoot monkeys treed by dogs

12. Export sport hunting

13. Poaching

Source: Personal field observations and inquiries.

3.4.1.1.2. Frequency and seasonality. Several full-time hunters were encountered, but this is not a common sole-profession. Most hunters are regularly active (every day or every other day) during the dry seasons, but work their family fields during the rainy season and hunt only once or twice a week then. In areas where animals are scarce, the frequency may be as low as once or twice a month.

The dry season seems to be the preferred hunting time, even though most people say that there are more animals around in the rainy season. In addition to the necessity of field work, other reasons given for hunting in the dry season include 1) that the lack of vegetative cover, especially tall grass, in the dry season makes it easier to see the animals; 2) that wildlife is more localized near the water sources; 3) that it is safer to hunt when the grass is not tall because there is less chance of being surprised by a lion; 4) that there is less danger of shooting another person in the all grass (mentioned by one hunter); and 5) that the hunting season is closed during the rainy season (the gestation period) according to several hunters in Guinea. One commandant said the closed season was from 15 August to 15 November, but the regulations indicate 16 August to 15 December.

In addition to hunting expeditions, many animals are taken by opportunistic encounters, by individuals, not necessarily even hunters, who carry a gun to the fields or while traveling. Most hunters readily admit that they are not always successful. Many of the smaller animals (hares, game birds) appear to be taken as a result of an "itchy trigger finger." The cost of a shotgun shell (180- 220 sylis in Guinea) precludes the economical shooting of small animals. Several hunters confirmed, however, that after a long and fruitless day hunting, they just want to have something to show for their effort, and the shell they carefully saved all day might well be spend on a small animal.

3.4.1.1.3. Areal extent of hunting activities. Hunters differ considerably in the distance traveled from the villages and the amount of area exploited. Most hunt within 10-15 km of the village, some radiate out 25-30 km, and a few travel 50 or more kilometers and spend several weeks afield. Effectively, all areas of the Basin are hunted, with the notable exception (or near exception) of Niokolo-Koba National Park and environs.

3.4.1.1.4. Impact of subsistence hunting. Virtually all areas of Guinea within the Basin can be considered heavily hunted. While the larger animals have been hunted out in most areas (although not only by subsistence hunting) the remaining fauna, including such animals as red-flanked duiker and bushbuck, seems to be holding its own. In eastern Senegal, the effect of subsistence hunting is much more difficult to determine, since it is mostly secretive, but due to emigration from Niokolo-Koba National Park, there is modest large-animal fauna still extant. Even in The Gambia, which must be considered heavily hunted because of its small size and dense population, hunters continue to take such animals as the bushbuck, so apparently some equilibrium has been established, at least temporarily.

3.4.1.2. Sport and recreational hunting. Sport and recreational hunting is defined as killing wild animals for other than subsistence or livelihood reasons. In essence, this type of hunting constitutes an activity engaged in for adventure and/or relaxation. Although it may contribute to table meat, the expense of permits, equipment, travel and other requisites normally precludes subsistence as the primary objective. Trophies, photographs, stories and the activity itself are the usual benefits. In most countries, properly licensed sport and recreational hunting is the only form of legal hunting and most other wild animal killing is considered poaching.

Of the three countries, only Senegal has an appreciable amount of sport hunting. In the Gambia, sport hunting is virtually nonexistant. In Guinea, the legal framework and licensing are included in the hunting code, but this type of hunting is not extensively practiced in the Basin, except by occasional expatriates and by nationals of some wealth and position. Most hunting within the Basin, permitted and otherwise, would come under the heading of subsistence hunting. No hunting statistics were found and it is very unlikely that any accurate data exist for the Fouta Djallon region. In Senegal, sport hunting is well organized and profitable. It is under the jurisdiction of the Forest and Wildlife Service. Table 3.11 shows that 2,425 hunting permits (of all classes) yielded a gross revenue of 45,275,500 Francs (West African) in 1983. At 1984 exchange rates, this is worth approximately US $113,000.

3.4.1.2.1. Senegal hunting areas. There are four hunting areas (Zones d'interet Cynegetique, or ZIC) in or adjacent to the Basin. Two are in the western most portion of the country (north of The Gambia's Lower River Division and south of Kaolack) and are restricted to small game. The other two, ZIC Faleme and ZIC Kayanga, provide the only big game hunting in Senegal.

ZIC Faleme includes 1,336,000 ha in southeast Senegal, a small part of which lies within the Basin. At present, it is the only "open" big game hunting area. The Faleme is important to the large mammal fauna of the Basin for several reasons. It is contiguous with the northeast portions of the Basin in Guinea and contributes to the large mammal fauna still extant there, including buffalo and eland. It is not contingous with Niokolo-Koba National Park. Most persons knowledgeable of the regional wildlife, however, concur that there are faunal movements between the two areas. These movements are not regular migrations nor are they well described. The species involved include the roan antelope and buffalo, and it is possible that eland, which suddenly increased in the Park during the early 1970's, came from the Faleme. The Faleme region has been surveyed for mining development, including a railroad. The impacts of these plans were not evaluated within the scope of the GRB Study, but the general opinion is that they will be devastating to the large mammals. Thus, it seems advisable to consider the Faleme as well as the Gambia river developments in a regional context if the integrity of the fauna is to be continued.

The ZIC Kayanga includes 126,000 ha of the upper Casamance Region, but lies primarily within the Basin. It is situated north of the Guinea frontier and west of the Koulountou River. Although contiguous with Niokolo-Koba National Park, this area is heavily poached and the fauna is not at levels which can sustain an annual sport harvest as well. An open

Table 3.11

HUNTING & OTHER WILD ANIMAL PERMITS, AND ANNUAL REVENUE IN SENEGAL

Category of Permit	No. Permits 1976[1]	No. Permits 1978[1]	No. Permits 1979[1]	No. Permits 1980[1]	No. Permits 1983[2]
Big Game	61				
Tourist		12	9	45	106
Resident		47	67	52	68
"Moyenne"	1102				
Tourist		403	792	920	1098
Resident		589	629	581	489
Small Game	747				
Tourist		101	130	223	76
Resident		335	325	248	174
Waterfowl	647				
Tourist		162	295	207	195
Resident		292	299	263	219
Commercial Capture	14	22	17	–	
Scientific	3	–	–	–	
All Others	154	243	312	–	
Total No. Permits	2728	2206	2875	2539	2425
Total Income	23.485.550	32.474.500	40.580.50	40.224.000	45.275.500
% Tourist Permits*		39%	54%	60%	68%

*Larger Mammals = Big Game and "Moyenne" Hunting Permits.

Sources (1) Rep. de Senegal, Direction Des Eaux, Forets et Chasses. Annual Rapports.
(2) Rep. de Senegal, Direction Des Eaux, Bilan de La Saison Cynegetique 1982-1983.

season and quotas, if it resulted in more intensive attendant patrols, might well hasten the repopulation of the fauna.

3.4.1.2.2. Categories of hunting (Senegal). The sport hunting of mammals in Senegal is divided into three permit categories:

- Small Game. Includes hares and ground squirrels.
- Mid-sized Game. Permits hunting of small game animals; one warthog per week; and one per year of the following species: kob antelope, waterbuck, bushbuck, oribi, duiker and red-fronted gazelle.
- Big Game. Permits hunting of one each per year of buffalo, roan antelope, bubal hartebeest and reedbuck, and Mid-size Game; one warthog per week; two each of the other ungulates listed under one; as well as the small game animals. In addition, one lion and one hippo can be taken, with presidential authorization.

Other regulations pertaining to hunting in Senegal are summarized in Working Document No. 65 (Treadwell and Ames, 1984). The hunting permit summary data provided in the Forest and Wildlife Services Annual Reports does not allow analysis of regional hunting activities because the record is kept where the permit is purchased, which is not necessarily where the hunting takes place. The one exception to this is, of course, the big game permits, because the Faleme is the only open ZIC.

Small game permits for both residents and tourists apparently have reached a saturation level, and have been declining since 1979, with the exception of a surge in tourist permits during 1980. Two possible explanations for this trend are a) that the availability of small game animals is declining and the quality of the hunt decreasing and/or b) that there is an increasing preference for the mid-sized game permit, which does not cost appreciably more (especially for tourists) includes not only small game animals, but also the abundant warthog. Apparently the second alternative holds for tourist mid-sized game permits, which increased about eight percent in 1979 and 1980 and somewhat less from 1980 to 1983. During these periods, resident permits decreased by the same amounts.

Big game permits for residents appear to have remained essentially constant since 1978. Tourists permit numbers have consistently increased from nine (1979), to 45 (1980), to 106 (1983). This generally upward trend of tourist hunting interest for both mid-sized and big game is clearly reflected by the percentage of tourist among total permit holders in these two categories: 39 percent in 1978; 54 percent in 1979; 60 percent in 1980; and 68 percent in 1983.

Table 3.12 presents the annual quota and animals killed for 1975, 1978, 1979, 1980 and 1983 in the Faleme. The percent of the quota attained has steadily increased from 16 percent in 1978 to 65 percent in 1983. Since the quota remained the same from 1978 to 1980, this substantial improvement can be explained by better facilities and access (hunter camps and guides), increased hunter interest (number of hunting days per year), and possibly an increase in the target species's populations. The overall hunter success for the big game species can be determined by comparing Tables 3.9 and 3.10. A success rate of 26 percent in 1980 dropped to only 13 percent in 1983, in spite of a quota increase (which was met) in the two preferred species, buffalo and roan antelope. This suggests that the maximum level for quality hunts might be reached under the current quota allotment. Data from the 1979 Annual Report indicate that both hunter utilization and harvest are fairly well distributed throughout the four-month season, from January through April.

3.4.1.3. Organized commercial hunting. Organized commercial hunting is defined as the killing of selected species because they have a substantial monetary value. It is illegal in all three GRB countries, so is a form of poaching. Only in Senegal is it a major commercial activity. Examples of commercial hunting include the taking of elephant for its ivory, and leopard for its skin.

Commercial hunting is organized in many respects. The hunter generally knows that he can sell his product (either directly at a regular market, or to traveling merchants), or he is specifically requested to participate in an expedition. According to Senegal National Park Annual Reports, these expeditions can involve from 10 to 40 individuals. They are

Table 3.12

FALEME HUNTING ZONE - ANNUAL SUMMARY OF ANIMALS KILLED, HUNTING DAYS, AND INCOME RECEIVED

SPECIES	1975 QUOTA	1975 KILLED	1975 INCOME	1978 QUOTA	1978 KILLED	1978 INCOME	1979 QUOTA	1979 KILLED	1979 INCOME
Lion[a]	1	0		2	0		2	0	
Roan Antelope[a]	5	4		6	4	300,000	6	4	300,000
Buffalo[a]	5	1		5	2	150,000	5	3	225,000
Waterbuck	5	0		3	0		3	1	40,000
Bubal[a]	5	2		5	0		5	3	120,000
Kob Antelope	10	1		4	0		4	1	40,000
Bushbuck	5	2		5	0		5	3	90,000
Oribi	5	2		3	1	20,000	3	0	
Grimm's Duiker	10	2		10	0		10	4	60,000
Warthog									1,000
Sub-totals	51	14		43	7	470,000	43	19	876,000
% of Quota	27%			16%			44%		
Hunting Days				153			143		
Other Income						105,500			115,000
Total Income			316,500			575,500			991,000

Sources:

Rep. of Senegal, Forest and Wildlife Service. Annuel Rapports.

Rep. of Senegal, Forest and Wildlife Service. Bilan de la Saison Cynegetique 1982-1983.

Note: (a) Denotes 'Big Game' Animals

Table 3.12 (Cont'd)

FALEME HUNTING ZONE - ANNUAL SUMMARY OF ANIMALS KILLED, HUNTING DAYS, AND INCOME RECEIVED

SPECIES	1980[a] QUOTA	1980[a] KILLED	1980[a] INCOME	1982[a] QUOTA	1982[a] KILLED	1982[a] INCOME
Lion[a]	2	0		2	0	(Per
Roan Antelope[a]	6	7	525,000	12	12	Species
Buffalo[a]	5	6	450,000	10	9	Data not
Waterbuck	3	1	40,000	6	2	Provided)
Bubal[a]	5	3	120,000	6	6	
Kob Antelope	4	0		4	1	
Bushbuck	5	4	120,000	5	5	
Oribi	3	1	20,000	5	3	
Grimm's Duiker	10	3	45,000	10	1	
Warthog						
Sub-totals	43	25	1,320,000	60	39	2,160,000
% of Quota	58%			65%		
Hunting Days	273			495		
Other Income			188,000			1,344,000
Total Income			1,508,000			3,504,000

Sources:

(a) Rep. de Senegal, Forest and Wildlife Service. Annuel Rapports.

(b) Rep. de Senegal, Forest and Wildlife Service, Bilan de la Saison Cynegetique 1982-1983.

Note: (a) Denotes 'Big Game' Animals.

often provided with sophisicated weapons, and are undoubtedly organized for the secret transport of the contraband. Further organization of the business includes the necessary transfer agents, urban dealers, international transporters and known wholesale buyers.

3.4.1.3.1. Mammal species targeted. Trophy species can be subdivided in to those having skins or horns of interest, and those hunted for ivory. Because these species have been discussed above, a simple listing will suffice.

- Meat Animals. These include the larger antelope such as the eland, roan, bubal hartebeest, kob; also the buffalo, warthog and manatee.
- Skin and Horn Trophies. Eland, waterbuck, roan antelope, bubal hartebeest, buffalo, leopard, lion, warthog and formerly giraffe. It should be noted that all of these animals, except the eland and leopard, can be legally hunted in Senegal.
- Ivory and Teeth. Most notably the elephant, but in recent years hippos have been killed and only the teeth taken. Warthog tusks have a small commercial value.

3.4.1.3.2. Benefits and risks. Values of mammalian wildlife species and their products are discussed in Section 3.3. Risks in illegal hunting range from confiscation of products and equipment, to fines, imprisonment and occasionally death. Tables 3.13 and 3.14 indicate the number of poachers shot and/or killed each year in Niokolo-Koba. Since 1980, five percent of poachers apprehended were in this category, reportedly because they fired at the Park wardens. At least two poachers have been killed each year since 1980 and in 1984 a Park guard also was killed. Fines and prison sentences for illegal hunting can also be severe, especially for repeat offenders. There is a mandatory prison sentence ranging from one to 60 months and maximum penalty of 240,000 Francs (cfa) with five years in prison for hunting within National Parks.

3.4.1.3.3. Commercial hunting methods. Hunting methods used in the Basin are summarized in Table 3.10. The most important variation employed for commercial hunting is the often sizable groups of people

Table 3.13

ANNUAL SUMMARY OF ILLEGAL HUNTING ACTIVITIES IN NIOKOLO-KOBA NATIONAL PARK, SENEGAL, INCLUDING NUMBER AND TYPE OF WEAPONS CONFISCATED

	74-75	76-77	77-78	78-79	80-81[a]	81-82	82-83	83-84
Number of Hunters:								
Observed					79(107)	46	79	93
Apprehended	22	32	17	22	43 (58)	13	66	56
Shot					5 (5)	3	1	1
Total	22	32	17	22	43	13	66	56
Other Violations[b]	8	16	0	5	No Data	No Data	No Data	No Data
Total Infractions	30	48	17	27				
% Hunting Violations	73%	67%	100%	82%				
Weapons Confiscated:								
Muzzle-Loading	14		10	17	16 (30)	14	6	18
12 Gauge Guns	5		3	5	15 (19)	5	20	13
Other Rifles				1		4		
Semi-Automatic					3 (3)	6	9	8
Pistols								
Total	19	10	13	25	33	29	35	39

(a) Different numbers presented in itemized listing and summary table in report.
(b) Includes fishing, bird capture, harvest of forest products, traffice violations, etc.

Table 3.14

SEASONAL ANALYSIS OF ILLEGAL HUNTING IN NIOKOLO-KOBA NATIONAL PARK, SENEGAL[a]

Seasonal[b]	74-75	76-77	77-78	78-79	80-81	81-82
October - December	5	1	9	11	18	11
January - March	11	0	3	5	31	19
April - May	6	28	2	5	21	11
June - September	0	3	3	1	9	5
Total	22	32	17	22	79	46

(a) Based on number of violators seen or apprehended.

(b) Seasonal Periods:

October - December: Post rainy season; interior guard posts re-opened; road repair activities.
January - March: Early dry season; tourism.
April - May: End of dry season.
June - September: Rainy season, park closed, most interior posts abandoned.

involved, and the increasing use of semi- and fully automatic rifles. The use of these sophisticated weapons was first reported in the 1978 Senegal National Parks Annual Report. As indicated in Table 3.12, which details only the number of arms confiscated. The use of semiautomatic rifles has risen alarmingly during the last four years.

Perhaps the only method especially useful to the commercial hunter is the use of traps for leopards. Dupuy (1974b) states that during May 1973, 57 leopard cage-traps (photo in his text) were discovered in less than 10 km along the Niokolo-Koba River.

3.4.1.3.4. Origins of commercial hunters. Definitive data concerning nationalities or origins of poachers do not appear to be available. The 1978 Annual Report National Parks 1978 states that the automatic rifles come through Guinea, and that Europeans, Lebanese and Syrians have been known to hunt illegally for trophies of warthog, eland, roan antelope, waterbuck, elephant, lion and leopard. The report suggests that groups of 10-20 Guineans, Gambians and particularly Mauritanians tend to hunt in the Park between March and May for quantities of meat (and presumably other trophies as well). One other nationality, Nigerian, has been mentioned during discussions on organized poaching but no definitive information source can be cited. Similarly, the Senegal village of Medina Gounas (immediately west of the Park) seems to have an infamous reputation for poaching, but no citation is available.

3.4.1.3.5. Control of commercial hunting (Senegal). Both commercial poaching and illegal subsistence hunting are major decimating factors of the mammal fauna of Senegal. Both of these activities are regularly practiced in and around Niokolo-Koba National Park. Commercial hunting for elephant ivory centers in the Park because it is the last refuge of the species in Senegal. Lion skins and other trophies also are sought due to the numbers of animals readily approached by humans. Illegal hunting for food is also faciltitated by the large numbers of hoofed mammals, for which the Park serves as a reservoir.

Senegal law does not provide for any hunting without permits and for the larger animals it includes a corresponding slaughter tax. The high cost of sport hunting permits incites indigenes to illegal hunting and makes sport hunting by the more affluent nationals and expatriates locally unpopular (Rep. du 1981 and La Faune et la Chasse 1981). Commercial poaching and illegal subsistence hunting are combined in the Laws of Senegal (although penalties are variable) and control measures and record keeping do not distinguish between these activities.

Illegal hunting is of such concern to the Government of Senegal that a national committee has been established to control poaching. This committee has representation from the Forest and Wildlife Service, National Parks, Police (Gendarmerie), National Army, and Customs. Only the Forest and Wildlife Service and National Parks are specifially charged with the protection of nature and wildlife; the other organizations are included to help control the transport of contraband, including illegal weapons, and to assist with certain military enforcement operations. The rate of deaths of poachers and wardens show that poaching is a deadly business in Senegal.

All aspects of hunting and hunting control are well legislated. The effectivenes of these laws is uneven between the two agencies charged with the protection of wildlife.

- Forest and Wildlife Service ("Eaux et Foret"). This service is charged with the management of all hunting activities in the country, and the enforcement of hunting and wildlife protection regulations outside of national parks. Information provided in their Annual Reports indicates that the effectiveness of their enforcement is minimal (Table 3.15). The reason for this ineffectiveness is well summarized in the 1980 Annual Report. The numbers of guard posts and game wardens are not sufficient to control the large areas under their jurisdiction, and they do not have adequate vehicles, fuel, and radio facilities. The Plan Directeur Forestier (Resume of Synthesis, 1981) further points out that, unlike forest development, hunting development receives no external funding.

Table 3.15

CITATIONS FOR HUNTING VIOLATIONS ISSUED BY THE FOREST AND WILDLIFE SERVICE[a]

Year/Page	Citations	Comments
1975: 166	Roadblock statistics	Of 2,052 hunting permits issued in Ca. Vert (where there is virtually no hunting) only 39% were accounted at roadblocks controlling this peninsula
1978: 168	34	2 in Senegal oriental - 1 hunting without permit; 1 hunting during closed season.
1979: 156	49	None in Senegal Oriental.
1980: 174	35	None in Senegal Oriental.

a/ Source: Annual Reports, Senegal Forest and Wildlife Service

- Administration of National Parks. We are unable to analyze in depth the impact of poaching on the mammal fauna of Niokolo-Koba National Park, due to the meager nature of data provided by the Park authorities. Their refusal to provide information on specific localities of poaching, animal species killed, parts of animals used, and origins of hunters forced us to rely on the Annual Reports (Table 3.13) which concentrate on the number of poachers encountered and the types of weapons used.

  Table 3.14 shows the seasonal distribution of illegal hunting in the Park, based on data from the Annual Reports. It is assumed that the dates from the citations ("process verbal") reflect the actual date of each infraction. The data do not show the late dry season peak in poaching reported by the agency (National Parks Annual Report, 1980) and expected by us on the basis of villagers' claims that depletion of previous year's harvest forces them to turn to the bush for sustenance. Whether the Park data accurately relfect the actual activity level (a consistenent degree of vigilance, with corresponding arrests, between October and June) is not known.

Even regarding the steady decline in elephant numbers (Table 3.8), it is difficult to ascertain exactly what percentage is due to poaching. In the 1974-75 Annual Report (National Parks), the only year which presents data on numbers of different species and causes of mortality, only one elephant death was attributed to poaching, but three were listed as natural causes. A single year's data can not be used to define a ratio between these types of mortality, but it does illustrate that other factors besides poaching are involved.

The Administration of National Parks continually emphasizes that the decimation of certain wildlife species is due to poaching, and that this has been actively involved in combatting this problem for years. The situation, from the National Park perspective, can best be presented by summarizing statements in their annual reports:

- 1976-77. Efforts to deter poaching are emphasized. Actions include the establishment of additonal guard posts around the Park (in neighboring villages), increased foot patrols and the use of bicycles to promote guard mobility.
- 1977-78. First reported appearance of semiautomatic rifles among poachers, reported to be entering the country from Guinea. There was apparently a combined National Park/ Forest and Wildlife Service antipoaching operation in Senegal Oriental.
- 1978-79. Confiscation of seven elephant tusks in Banjul, one definitely recognized as a Niokolo-Koba elephant. Subsistence hunting by people around the Park reported to be negligable. Large groups of immigrant poachers (from Guinea, Gambia and Mauritania) using semiautomatic weapons

are reported in the Park during March through May. Target animals are listed as elephants, leopards, lions and giraffes (yet no giraffe has been seen in more than a decade). In an effort to save the elephants, a decree is passed forbidding the sale of ivory in any form in Senegal.

- 1980-81. It is noted that there are certain public offices and State Societies still involved in ivory trafficking.
- 1981-82. Elephants are now the primary target species, due to the high value of ivory. But as the elephants decline, killing of hippo for their ivory is increasing. All permanent poaching camps have been closed down around the park.
- 1982-83. In Dakar, Park agents are actively pursuing ivory traffickers because the decree banning the sale of ivory has not deterred the poachers. Some violators being released with only light fines. Public awareness ("sensibilization") programs are emphasized at Dakar conferences and tourist clubs, as well as in villages adjacent to the Park. Large bands of poachers continue to enter the Park and the increase in automatic weapons is alarming. A National Park/Forest and Wildlife Service/National Army joint operation is undertaken. Illegal subsistence hunting is virtually nonexistent, but the commercial sale of bush meat in Tambacounda is becoming more and more profitable.
- 1983-84. Poaching of elephants, lions and leopards continues, and a resurgence in hippo poaching is noted. Twenty-three elephant tusks and five lion skins are confiscated. A Park guard is killed during a poaching control operation this year.

- Although not mentioned in the Annual Reports, another method used to control poaching is to enlist the cooperation of villages surrounding the Park. In return for this assistance, the Park provides rice, canned milk, and cooking oil (quantities unspecified). At least eight villages are involved in this program, and two others have secret informers on the Park payroll (anonymous, 1984, pers. comm.).

- Unfortunately, in most villages surrounding the Park, visited during this study, there seems to be a definite fear of and animosity toward the Park guards. This seems to stem from the periodic "show-of-force" by Park agents, who are reported to arrive in villages well beyond their jurisdiction limits and search houses without warrants (this act is in violation of Senegal law 67-28, Title II, Article L.7). Most of these actions seem directed at subsistence hunting violations, which are reported in the National Parks Annual Reports to be minimal. Although it must be frustrating for Park guards to see continued poaching activities of any kind within the Park, this does not justify any illegal act on their part. More important, the ultimate control of poaching activities will have to rely on the cooperation of neighboring villages, and such overzealous actions on the part of agents only hinders this necessary mutal understanding.
- Solutions Proposed by Senegal Agencies. The Plan Directeur Forstiere (Resume et Synthesis, 1981) offers several suggestions directed at the solution of illegal hunting in Senegal.
  1. Village Hunting Permits. According to the Forest and Wildlife Service, subsistence hunting is widely practiced in Senegal Oriental, and the larger ungulates are included. This activity would possibly be best controlled by the issue of a special "village hunting permit" since local hunters can not afford the sport hunting permits. According to A. DeGeorges (1984, personnal communication) the new revision of the hunting code for Senegal will have a special, inexpensive permit for "Traditional Hunting".
  2. Agency-Local Resident Agreements. Establish mutually beneficial agreements beteween the agencies in charge of illegal

hunting control, and those groups having a vested interest in local wildlife (e.g., hunting societies, "amodiataires, des ZIC", rural communities and leaders)

3. Increase the Effectiveness of "Hunting Lieutenants". Increase budget allocations, especially for vehicles and fuel to improved mobility. Initiate new methods, including aircraft surveillance, radio systems for improved coordination of patrols, horseback patrol units. These can cover any terrain, but would require prophylactic treatment against trypanosomiasis.

The only long-term solution to problem of illegal hunting in the Basin was succinctly stated by S.I. Sylla, the former Conservator of Niokolo-Koba National Park: "sensibilization" or public awarness (1984, per. com.). In other words, more guns and guards will only result in more people killed, and poaching activities will continue as they have for the last decade. If the effort were made to develop a sense of propriety and understanding in the local people, and they could realize some benefits from the Park and wildlife which they currently perceive as taken from them for the benefit of expatriates, they might eventually assist the conservation agencies in protecting and managing Senegal wildlife heritage. The suggestions made in the Plan Directeur Forestiere seem well in line with this strategy and should be supported.

3.4.1.3.6. Commercial hunting in The Gambia. There is minimal commercial hunting in The Gambia because (1) there are few large mammals of interest to commercial hunters, (2) no new gun permits have been issued since the attempted coup in 1980, and (3) hunting in the Gambia is for subsistence.

There are a few exceptions. A small commercial outlet for warthog meat exists in Basse, utilizing meat supplied by hunters near enough to Basse to be able to transport fresh kills. At least a few hunters seem to make their living in this manner. The meat is consumed mostly by certain Basse residents. Otters are hunted in several areas for their skins, but these skins are apparently only sold in local markets (as opposed to export) and used for traditional purposes. It is probable that leopards are occasionally taken for their skins. One leopard skin was confiscated in Banjul in 1984 (E. Brewer, per. com.), but it is not known whether it actually came from The Gambia. Manatee hunters can still be found in The Gambia (J. Powell, 1984 pers. com.). However, judging from the numbers taken -- a total of ten in six years was considered good in 1972, according to Parker (1973) -- it cannot be considered a truly commercial enterprize even though a rare windfall profit might be realized. Although hippopotamus are frequently killed in The Gambia, it is generally under the rubric of pest control, when they are found in the rice fields. This, too, cannot be construed as a truly commercial venture.

Even though commercial hunting does not appear to be a significant activity in The Gambia, the port capital of Banjul does tend to to attract illicit wild animal products for the market potential. This attraction is further enhanced by the substantial number of tourists. This fact is demonstrated by the confiscation of the leopard skin in 1984 and of several elephant tusks poached from Niokolo-Koba in 1979, (DPN, Annual Report). The confiscations also demonstrate that the Government of The Gambia does enforce its legal ban on the trade of all wild animal products in the country. Data on total confiscations per year could not be obtained, but they were reported to be few by E. Brewer (1984, pers. comm.). Whether this indicates that the traffic is indeed small, or that a quantity of illicit products are moved undetected cannot be stated with conviction, but the actual situation probably lies between the two extremes.

3.4.1.3.7. Commercial hunting in Guinea. There is probably no appreciable commercial hunting for the larger mammals in Guinea. Although this may seem paradoxical in a country where the larger fauna has been virtually eliminated within the Basin, it results from the fact that hunting for many of the commercial target species is legal, at least insofar as can be determined from the hunting regulation information provided.

PART TWO

IMPACTS OF DEVELOPMENT PROJECTS

4. APPROACH TO IMPACT ASSESSMENT

Many books and articles have been written about environmental impact assessment. Each author presents his own method of identifying and evaluating project impacts, but in reality all approaches contain the same basic elements:

- Baseline Conditions. One must understand the intricacies of the environment being impacted. For the ecologist, this means detailed knowledge of the natural resources and their interactions.
- Proposed Project. One must understand in detail the proposed development, not only its structures but also its construction and mode of operation. This requirement poses problems for the environmental planner, for the objective of environmental assessment is to affect some aspects of project planning. Thus, the environmental analyst may have to deal with a number of project alternatives or with project components not yet fully planned.
- Experience from Other Projects. An astute ecologist can predict with some confidence how natural systems will react to human interventions. His predictions gain more credence, however, substantiated by examples of other projects in similar ecosystems.

Given these similarities, the various methods of impact analysis diverge slightly. Some authors have devised numerical matrices and others prefer network analyses. Even here the methods have one fundamental similarity: the environment and the project are broken down into components whose interactions are considered, sometimes on a one-to-one basis, sometimes in combination.

The ecologist knows that most ecosystems are inherently unstable; a natural irregularity, such as a drought or volcanic eruption, sends a wave of change through the system. Manmade interventions cause similar oscillations, so the environmental planner must consider the impacts of impacts, the direction of each impact, and its timing.

4.1 Types of Impacts, Direct-Indirect

Because of the complexity of the interactions between a project and its environment, it is convenient to treat effects in various categories, while bearing in mind the interrelationships of categories. The first division of impacts often is into **direct** (or **primary**) impacts and indirect (**secondary**, **tertiary**, etc.) ones. A direct impact is one resulting from the interaction of a project component or function with its immediate environment. An indirect impact is the result of a direct impact or of another indirect one.

4.2 Timing of Impacts

Time influences the analysis of project impacts in several ways, all of which must be taken into account when predicting environmental effects.

4.2.1 Stages of Project Development

Each project moves through a series of stages, from conceptualization to operation, that seldom spans less than ten years and often last decades. The most important stages are construction and operation, but in remote areas the exploration (usually undertaken during feasibility studies) may strongly affect the environment. Many project effects are limited to the construction or the operation phase of the project, while others are felt throughout.

4.2.2. Seasonality

The river projects and their environments are strongly influenced by the cycle of wet and dry seasons. For the project, influence of climate is felt largely through river flow rates, for the ecosystem, rainfall itself is more important. Most aspects of dam construction will be timed to allow river diversions to be accomplished during a period of low flow. The relationship thus established between the project and river flow carries

ries through the entire life of the project and forms an important element in our impact analyses.

Many aspects of the environment are seasonally controlled: vegetation growth and flowering, wildlife movements and reproduction, crop production, tourism, and disease patterns, to mention only a few.

4.2.3. Importance of Projecting Resource Conditions

Accurate impact prediction demands that present conditions be projected forward to the actual time of impact. Here the crystal ball may be clouded. It is one thing to identify existing trends in resource condition but another entirely to predict whether these trends will continue. In many instances, e.g., population growth, one may be quite certain that an existing trend will continue but uncertain of its future rate. Nevertheless, some trends are recognizable and we have tried to allow for them.

- Population growth and increased pressure on resources
- Regional development: roads, communication, agriculture, health services, etc.
- Ecological succession
- Natural fluctuations and trends such as rainfall, temperature and animal populations
- Cropping cycles

4.3. Beneficial vs. Adverse Impacts

The term "environmental impact" gained worldwide usage during the 1970's when undesirable and often unforeseen side effects of certain major development projects loomed so large in the public eye as to seem to outweigh the project benefits. Unforeseen beneficial side effects sometimes were observed -- but most benefits had already been foreseen and heralded by the developer -- but often were swamped by the negative aspects of the project. Thus, the term "impact" became endowed with a connotation of undesirability which persists today. Because of its wide usage, we will employ "impact freely in this report, but without indending to imply a beneficial or adverse direction. A more neutral term, one which we will use when we wish to emphasize that a particular environment-project interaction is neutral or of unknown value, is "effect".

An environmental impact can be descibed in terms of cause, action, target, magnitude, and direction. Change one component and you probably will change several others, especially magnitude (severity, in the case of adverse impacts) and direction.

4.4. Potential vs. Residual Impacts

In devising an environmental management plan, one must first attempt to identify all effects that a project might have on its surroundings, beneficial and adverse, without any action taken to reduce the severity of undesirable effects or enhance beneficial ones.

Once the complete spectrum of potential impacts has been identified and evaluated, we are in a position to propose actions or programs to eliminate or diminish the adverse effects and augment the benefit of desirable ones. What remains is a set of "unavoidable adverse impacts," in the words of the U.S. Council on Environmental Quality guidelines for the preparation of environmental impact statements.

It is usual in hydroelectric or other reservoir projects to assume that the most severe potential adverse impact, the inundation of homes and families by the reservoir, will be mitigated through a complete resettlement program. The impact that would result from failure to develop a resettlement program is generally considered unthinkable, so most environmental assessments treat resettlement, which really is a program to mitigate a potentially severe adverse impact, as a component of the overall project. As such, of course, the resettlement program has the potential for both adverse and beneficial impacts of its own.

In predicting the impacts of the Kekreti Project, we have made the assumption that intrusions into the Niokolo-Koba National Park will be minimized by the project planners. We do not, therefore, describe the potential impacts of placing major project support features, such as vehicle storage areas and borrow pits, in the park. We believe that to postulate such actions would be setting up a "straw man" of potential impacts that cannot be reasonably expected to occur.

4.5. Importance Coefficients

The evaluation of the importance of a given impact has posed a major problem in the environmental assessment of development projects. The specialists tend to evaluate an impact in terms of the values of his or her own country rather than in local terms. This tendency has led the designers of some numerical evaluation systems to separate the magnitude of the impact from its importance. The Water Resources Assessment Methodology (WRAM), developed by the U.S. Army Corps of Engineers, employs a numerical matrix in which each of several project alternatives is given a score which is a composite of impact evaluations. Each impact evaluation is the product of a severity score and a Relative Importance Coefficient which is intended to incorporate an indication of how much the impacted resource means to local people.

Although we are not using a numerical matrix to evaluate impacts, we do attempt to evaluate each potential impact in terms of local and national objectives, as we perceive these. This perception is based on contact with local rsidents, reports from others, and discussions with representatives of national and inernational agencies.

4.6. Methods of Predicting Impacts

There really is only one basic method of identifying and evaluating environmental impacts, that of applying the experience gained from other studies to the one at hand. When the project comprises a large number of components that will react separately with various components of the environment, a matrix system provides a useful means of ensuring that no possible interaction is forgotten. When the components of such a matrix become excessively numerous -- matrices have been designed with up to 8,000 or more intersects -- some consolidation is necessary. Obviously, one cannot evaluate and mitigate separately the impacts of the project on 300 species of trees or 500 species of birds. In fact, when ten or a dozen different components of a project are considered and the construction and operation phases are treated separately, the interactions of the project with 35 species of mammals become exceedingly complex with nearly a thousand potential impacts.

In order to bring this array of potential impacts into a manageable form, various forms of consolidation have been performed.

4.6.1. Vegetation.

We treat the impacts of each project on vegetation and land use in terms of project components (dam, work area, access roads, borrow pits, etc., sometimes consolidated), and separate vegetative communitites. We felt it important to separate unavoidable destruction (clearing and inundating) from degradation, since the available migitation actions for these types of impacts differ.

4.6.2. Mammals

Due to the variety of species, their different status at each of the proposed developments and their varying sensitivities to habitat change and human presence a matrix analysis was used to identify the impacts of each activity associated with the development on each species (or in some instances species assemblages). The number of major species reviewed for each development facility was imposing simply because there were many important species. For example, within the basin, there are 9 species listed as "endangered" or in need of protection by international organizations or treaties. Adding other species singled out for protection by the GRB member states increases the total number to 20. To this number can be added some of the common species recognized as pest animals, a topic central to a development program designed to increase agricultural production.

A detailed list of specific potential impacts was prepared to determine which would actually affect a given species, and whether the effect would be positive or negative, large or small, and whether it would be short-term or long-term. The effects of an access road is illustrative. In this analysis, the road itself is not an impact, rather it is merely one activity involved in the construction of the dam. The actual impacts include displacement of animals during construction, direct mortality from animal-vehicle collisions, and increased deaths from incidental roadside hunting in any area previously difficult to enter.

This is the type of information identified in the matrix. This data set is then summarized in text for each of the impacts appearing to be important from the matrix analysis. Where necessary in the text, a phrase is added to explain why the impact is expected. In the case where the impact is perceived to have neither positive nor negative effect, or only affect one or two species, it is usually omitted from the matrix and presented in the text only. The matrix is included in Chapters 5 and 6.

Where appropriate, both in the matrix and in the text, species are grouped into final assemblages reacting in a similar manner to a particular impact.

4.6.3. Birds

With more than 500 species of birds in the Gambia River Basin and several hundred possible within the impact zone of a given project, about the only way that impacts can be evaluated is in terms of ecological groupings. Birds are the most mobile of animals, but are rather habitat specific. Moreover, reduction in habitat usually means reduction in bird populations, depending to some degree on the extent that the species present are dependent on the particular features of habitat being destroyed. Many animal species or species groups utilize separate habitats in different parts of the annual or daily cycle, for example breeding and nonbreeding or feeding and resting. We have attempted to take these differences into account, while also clustering bird species into ecological groupings. Kestrels, thickness and larks, for example, are taxonomically unrelated, but share a dependence on grassland habitat. Despite wide differences in their other ecological requirements, all these groups will decline when grassland is removed from the area.

In terms of importance, the vast majority of birds are neutral, from man's point of view, or slightly beneficial, contributing to his overall appreciation of the natural world. It is essentially impossible to evaluate any one species as paramount in importance, since the contribution of birds to tourism and to local residents is a general one.

5. POTENTIAL IMPACTS OF BALINGO DAM

5.1. Characteristics of the Project

The Balingho Antisalt Barrage will be located on the Gambia River approximately 128 km from the mouth of the river. It will be a low embankment dam whose primary purpose will be to maintain, on its upstream side, a pool of fresh water for irrigation. Its secondary objective will be to provide a crossing for vehicles on the Trans-Gambia Highway, which now cross the river by ferry at Yelitenda, four kilometers upstream of the dam site.

5.1.1 Primary Structures

The project for which we have analyzed impacts will consist of the following main structures:

- A rockfill embankment dam, the "enclosure dam," approximately 1600 m long from its abutment on the left (south) bank of the river its junction with the gated section.
- A gated spillway structure along the dam axis, consisting of a rockfill and concrete foundation and 36 vertical double gates. The design of the gates will permit the release of water from the surface of the reservoir or from deeper layers.
- A conventional double-gate lock to allow the passage of sea-going vessels through the barrage. It will be 18 m wide and 180 m long and will be located close to the right bank of the river.
- A ship gate to pass vessels through the barrage when upstream and downstream water levels are nearly equal.
- A two-lane, hard-surface roadway on the top of the embankment dam and bridging the gate structure and the navigation lock.

The height of the embankment dam above the river bed will vary with the bottom elevation, up to a maximum height of about 14 meters. The top of the embankment will be 80 m thick and the base, at the deepest point, about 130 m.

The freshwater pool behind the barrage will have a surface elevation varying seasonally between 1.3 and 1.7 m GMD and a surface area of about 700 km^2. It will extend 120 km up river, to about Kuntaur.

5.1.1.1. Work area. Much of the work area will be cofferdammed river bottom, but some offices, workshops, a concrete plant, and an aggregate plant will have to be placed on firm ground. The total area probably will be about 100 ha.

5.1.1.2. Access roads. The primary access road to each end of the barrage probably will follow the route of the relocated main highway. This road will be 17 km long, with a right-of-way about 30 m wide. Other access roads will be required to connect the components of the project; these probably will be all- weather gravel roads. A temporary docking facility will be constructed, to aid in bringing in supplies by ship.

5.1.1.3. Workers village. A large and complex project such as this one requires a considerable work force. We estimate that skilled workers and higher professionals (management, clerks, engineers, geologists, etc) will number about 250 and laborers and semi-skilled workers another 1,000. Aside from the workers, one must expect some 200-500 job seekers, as well as people offering services. Which of the workers will be provided housing is a matter for speculation, but certainly the professional staff will be housed close enough to the site to avoid expensive travel time. Housing and support facilities for that group, including families, will require about 25 ha. If housing is provided for the laborers and semi- and skilled workers, it will take about 50 ha. Recreational facilities (football field, tennis courts, etc) would require another few hectares.

5.1.1.4. Borrow areas. The embankment dam will have a volume of about one million cubic meters, consisting of rock of carefully graded sizes and several types of soil. Other structures, such as the spillway structures, locks, cofferdams and the stilling basin below the spillway, also will require sound rock, crushed to specified dimensions, or soil. The volumes involved are only a few tens of thousands of cubic meters.

The Rhein-Ruhr (1983) report (Vol. III, Geotechnical Report) indicates that bottom sediments, consisting of water saturated silts, are 25 m thick at the northwest end of the embankment dam, and 8-10 m at the left abutment, in the rice fields. This will dictate a much larger amount of fill than would be required if the dam were to sit on firm foundation rock closer to the surface.

Rhein-Ruhr also concludes that designated borrow areas, consisting of a hill near Balingho, a line of hills extending toward Farafenni, and the area around Jenoi (where the new highway intersects the old one) are insufficient to produce the rock and earth required for the enclosure dam.

5.1.1.5. Operation. The barrage will be operated so as to maintain the fresh water pool upstream year-round. The water level will vary from 1.3 to 1.7 m GMD (Gambia Mean Datum). The control gates will be opened as necessary to control the reservoir level but during the dry season the only water passing through the barrage will be that necessary for lock operation.

5.2. Construction Phase Impacts

The ecological effects of constructing the barrage will be divided, for purposes of discussion, into several categories:

- Direct Effects
    1. Loss or alteration of vegetation due to land clearing for primary struclures, offices and workshops, borrow areas, workers' village, access roads, etc.
    2. Actions of the work force, or others less directly connected with the project, on vegetation or wildlife: fuelwood cutting, grazing, land clearing for agriculture, hunting, etc.
    3. Project noise (vehicles, cranes, blasting, etc) and dust effects on wildlife.
    4. Crushing of manatees by lock gates and spillway gates.
- Indirect Effects
    1. Decline in certain wildlife populations due to habitat loss or alteration.

2. Aesthetic degradation due to losses of mangroves within reservoir area.

5.2.1. Vegetation

5.2.1.1. Construction zone. As pointed out in Table 5.1, about 240 ha will be affected. Of this, only 15 percent corresponds to natural vegetation areas. The open forest that will be lost to construction was estimated at 22 ha, with a total wood volume of 1,200 m^3, of which 240 m^3 are considered commercial timber and the rest firewood. The mangrove area was estimated at 15 ha with a total wood volume of about 2,400 m^3, of which about 70 percent can be considered timber and 30 percent firewood.

TABLE 5.1

AREA AND PRODUCTION IMPACTS OF PROJECT INFRASTRUCTURE CONSTRUCTION (Production per Year)

Class Affected	Area (ha)	Timber (m^3)	Firewood (m^3)	Other Products
1.3 Open Forest	22	242	968	
1.6 Mangrove	15	1648	707	
2.2 Rainfed Agriculture	170			190t ground-nuts or 7t rice
2.3 Swamp Agriculture	30			36-45t rice
TOTAL	239	1890	1675	190t ground-nuts 43-52t rice

The loss of open forest area will mean the loss of some wild fruit sources for the population (from Parkia biglobosa, Ficus spp. and Borassus belliter especially) and a denial of habitat to bushpigs, monkeys and birds, which will move to adjacent rainfed agriculture and open forest areas. The firewood loss is not significant, mainly because of the small area involved. The impact of the sudden availability of firewood will be a positive one because of greater supply and possibly lower prices in the two main consumption centers, Farafeni and Soma-Mansa Konko, although it will be for a short time. We are not certain, however, whether the local fuel-wood dealers will be able to take advantage of the added firewood source. If they do not, wood will be left to rot or scavenged by local people.

The loss of mangrove area will mean the loss of wildlife habitat, especially to monkeys, crocodiles, manatee and birds. Most of the vegetation loss is from Rhizophora which provides ample leafy matter to the aquatic environment. The loss of the mangrove vegetation will cause river bank instability especially in the south (left) bank. The firewood merchants interviewed in the area consider mangrove too difficult to collect and argue that there is too much wood in the uplands to bother with mangrove. Thus, because of the same lack of infrastructure to take advantage of this wood, the mangrove will be left standing.

The combined loss of timber is significant because of the high timber volume assigned to mangrove. The possibility exists that this timber will be utilized by transporting it to Nyambai sawmill or the planned Kafuta sawmill (Schindele, 1983). Both sawmills are rather distant from the construction area (over 120 km), so transportation will be costly.

The Banjul and the Mansa-Konko markets sell a bundle of firewood known as "wuare" or "mata" containing approximately 0.0121 and 0.0127 m^3 respectively. The prices are D1.00 and D1.50 for the "wuare" and "mata", which works out to a price per cubic meter of between D83.00 to D118.00. These prices are for the end product (firewood cut, bundled and put in the market), and are valid for different kinds of wood, including mangrove. As it has been noted previously, mangrove is not a good sawnwood and its utilization, other than for small dwelling interior beams (larger houses use palm wood for these purposes), is not common and does not represent a ready market for which a price could be established. Therefore, the only outlet for the mangrove at present seems to be firewood, where it competes with other woods which are easier to collect, according to people interviewed in the field. It has been previously suggested that the mangrove be exported to Senegal where it can be converted into charcoal since charcoal production is prohibited by law in The Gambia. This option represents one possible outlet for the wood since the Senegalese market is much bigger and could possibly absorb the total volume which will be lost to the construction of Balingho. Alternatively, the government of The Gambia could pass a special law or issue a decree allowing the cutting and charcoaling of mangrove and other trees within the strict limits of the Balingho pool area. This would require some extension education of fuelwood suppliers and some additional enforcement personnel. Another option suggested previously in our report, that of chips, is more complicated and would require a careful cost/benefit analysis since a chip plant would have to be set up.

Further, the value of mangrove should be divided into a stumpage price (in situ) and a market price. The latter has been explored above and the former will be set at 50% of the market price. Tables 5.1 and 5.2 put the total mangrove wood loss at 1'247,365 m^3. The stumpage price will be between D51'765,647 an D73'594,535 and the put in the market price twice as much.

Table 5.1 also points out that 85 percent of the 240 ha affected by construction corresponds to agricultural areas. The impacts of this loss will be dealt with in detail by the Socioeconomic Team. We will simply point out here that this area also is a food source for birds and bushpigs as well as monkeys, and its loss will mean a further loss of habitat to this wildlife. Also, assuming that the areas two main crops are rainfed ground-nuts and rice, and that the area ratio between ground-nuts and rice is 20 to 1, then about 160 ha are ground-nuts and 10 are rice. Using the yields of AHT/HHL, 1983 about 190 tons of ground-nuts and 7 tons of rice will be lost.

The swamp agriculture area mentioned in Table 5.1 produces almost exclusively rice. Using Carney, 1984 and AHT/HHL, 1983 figures, between 36 to 45 tons of rice will be lost. The loss of this swamp agriculture area will increase riverbank instability, especially on the south (left) bank where all this area is concentrated. Stability on this bank will be fur-

TABLE 5.2

AREA AND PRODUCTION LOSSES OF THE BALINGHO INUNDATION AREA

Class Affected	Area (ha)	Percent of Area	Timber (m^3)	Firewood (m^3)	Other Products
1.4 Riparian Forest	170	0.3	1700	7480	wild fruit and construction wood
1.6 Mangrove	7930	11.0	872,300	372,710	construction wood
2.3 Swamp Agriculture	11,000	15.3			13,200 - 16,500t of rice
4.1 Water Bodies	9,420	13.2			
4.2 Wetlands (Swamp)	40,550	56.7			grazing area thatch & fence material
4.3 Bare Lands	2,530	3.5			
TOTAL	71,600	100	874,000	380,190	13,200 - 16,500t of rice

ther endangered by the amplification of tidal amplitude at the dam site, expected to reach 1.5.

5.2.1.2. Work force effects. Housing for skilled worker's will be largely concrete, with wood used for interior finishings and furniture. Some lumber may be obtained locally. Construction wood will be mainly rough sawnwood and roof beams. Interior finishings include doors, windows and frames. Furniture wood will be utilized for cabinets, closets, chairs, tables, beds, etc.

The semi-skilled workers and laborers, if not provided with project housing, will have basically the same needs plus thatch roofing material and firewood. The same needs will be felt by the job seekers and purveyors of services.

Construction wood is obtained from Borassus aethiopum, Bombax costatum, small diameter trees of Terminalia sp., Combretum sp.; rough sawnwood from Afzelia africana and Khaya senegalensis. For interior finishings the following species are used: Khaya senegalensis, Afzelia africana, Parkia biglobosa and Erythrophleum guineensis. These same species are used for furniture as well as Borassus aethiopum and Raphia gracilis for the local palm furniture.

The thatch roofing material comes from the two palms above and the grass Paspalum sp. Also, the local people use Rhizophora spp. for interior beams as well as Borassus aethiopum. Firewood comes mainly from Pterocarpus erinaceus, Combretum spp., Terminalia sp., Bauhinia thonninguii, etc. Mangrove is also utilized but to a much lesser extent than Pterocarpus erinaceus.

The incoming population will place a further requirement on the vegetation by consumption of wild fruits from Borassus aethiopum, Raphia gracilis, Parkia biglobosa, Adansonia digitata, Cola cordifolia, Parinari excelsa, Annonna senegalensis, Spondias mombin and assorted introduced fruit trees now growing in the wild. The Department of Agriculture of The Gambia published, in 1950, a "List of Food Plants Available Throughout the Year" which is summarized in Working Document No. 64, Appendix 8, "List of Plants Available Throughout the Year."

5.2.1.3. Resettlement and immigration to reservoir margins. Prior to inundation of the Balingho reservoir area, it will be necessary to evacuate and resettle the population presently living in the area. Although we assume no urban area will be flooded, this does not mean that some villages would not be affected, because of their proximity to the reservoir.

Whatever resettlement and immigration takes place in the Balingho Project Area, it will affect the rainfed agriculture and open forest areas which, together, cover more than 90 percent of the area of inundation (See Table 5.2). This will mean further decrease of open and closed forest areas, since whatever amount of agricultural area is used for resettlement will be made up by opening forest lands.

5.2.1.4. Inundation areas. AHT/HHL (1983) and RRI (1984) calculate that 70,000 ha will be flooded when the reservoir is completed; our calculations put the figure at 71,600 ha. The riparian forest that will be flooded comes to 170 ha with a total volume of about 9,200 m^3, of which 1700 m^3 are considered timber volume and the rest firewood. The mangrove that will be flooded represents 12 percent of the total mangrove area of the GRB, with a total volume of 1,245,000 m^3, of which 872,300 m^3 are considered timber and the rest firewood. (See Table 5.2).

The agricultural land that will be flooded is swamp agriculture and produces almost exclusively rice. The total area expected to be flooded is 11,000 ha or 49 percent of the total swamp agricultural area of The Gambia. The estimated loss of production is between 13,200 to 16,500 tons of rice. The labor force that will be displaced is expected to move to new irrigated rice fields and ground-nut fields. Carney (1984) observed a shortage of ground-nut fields in the area, which would become more serious if lowland crop areas are lost.

The water body, mostly from the Gambia river, is estimated at 9,420 ha. This is brackish water which supports a specialized habitat. It will eventually be replaced by a body of fresh water. The change from a brackish, tidal water to a fresh, stationary water body will eliminate the mangrove vegetation and all of the vegetation that may be submerged.

The swamp area lost will be 40,550 ha or 37 percent of the total swamp of The Gambia. The immediate impact will be the loss of dry season grazing area that will cause a greater concentration of cattle in the Upper River Division. This area is also the source of thatch grass and fence material for the local population. The loss of it, and the influx of project personnel, will mean a further strain in the *Borassus belliter* and *Raphia gracilis* stands. Further, the bird population will be displaced to adjacent areas, as will the small mammals that make the swamps their habitat.

The barren flats that will be inundated cover 2,530 ha. These areas are former swamp or agricultural areas that have become heavily salted. Their loss to inundation could be considered as a potential loss to agriculture (but probably not a serous one), since it is theoretically possible to rehabilitate them if irrigation were available.

The inundation of forested areas (riparian and mangrove) will mean a heavy loss of animal habitat. The loss of the riparian forest will mean a loss of some wild fruits but this is not too important because of its difficult accessibility (most of it is located on Passari island). The major concern is the loss of timber. In the case of the riparian forest the timber volume may warrant some selective cutting of most commercially desirable species, especially *Khaya senegalensis*, but also *Parkia biglobosa*, *Pterocarpus erinaceus*, *Erythrophleum guineensis* and *Afzelia africana*. However, the difficulties in access preclude a major commercial effort and this forest most likely will stay in place after inundation.

The potential loss of mangrove is significant both because of the total area and wood volume involved and also because of the profound ecological implications in the area. The timber volume is substantial, estimated at 872,300 m^3, (based on Forster, 1983 data) but mangrove has not proven to be good sawnwood and its utilization as commercial timber is rather limited. Its major use is as chips for particle board and pulp and paper (Johnson, 1978; Saenger et al, 1983). There is no chip plant in The Gambia and no chip consumption. Therefore, to use the mangrove would be necessary to set up a plant and to export the product. This particular decision will necessitate a careful cost/benefit study at substantial investment. Mangrove is a good firewood, although little utilized in the area. A possible use of mangrove is to produce charcoal. The Gambia has outlawed this practice for conservation reasons, but in Senegal it is still done. It is, then possible to transport the wood to Senegal (a few kilometers and very good road from the project area) and convert it there for the Senegalese market. With this particular option there is no need to clearcut prior to inundation since collection can be done during the dry season when the drawdown will make the area accessible by land. Also, it may be convenient to start the cutting at least one season after flooding, when some of the mangrove will be dead and easier to harvest.

The dead and decaying organic matter from the vegetation that will be flooded will cause eutrophication (nourishment) of the reservoir. This will cause changes in the water chemistry that will alter aquatic life (See Twilley, 1984). There is a strong possibility of hypereutrophication, which will encourage the proliferation of aquatic plants. These may become pests if proper means to control them are not taken (encouraging manatee habitat, herbicides and mechanical removal). The presence of aquatic vegetation will worsen the loss of water during the dry season (discussed previously) because of its high evapotranspiration.

The exposure of the soils to dry conditions, such as those described above, for a long period of time may cause their acidification. This is the subject of a special study by the River Resources team (Colley, 1984).

5.2.2. Impacts on Mammals

5.2.2.1. Construction Zone. The interaction of the construction activities with wildlife is largely confined to mammals. In general, most of the impacts are not expected to be severe.

5.2.2.1.1. Access roads. The impact of the project roads will be negligible and amenable to mitigation.

- Red Colobus Monkeys will be slightly negatively impacted if routing destroys any tall, closed forest habitat. Displacement/loss of habitat for other species is negligible due to low densities, and non-involvement of critical habitat.

- Direct mortality from vehicle-animal contact will be negligible based on minimal roadkills observed on Gambia highways. Warthog, baboon, patas and vervet monkeys are considered to be numerous and are considered pest animals. Leopard, hyaena and aardvark are extremely unlikely to be involved. There may be an occasional loss of an antelope or small carnivore.
- Roadside riparian growth, early green-up of herbaceous plants resulting from rain runoff from roads, is not considered to be an important food supply nor attractive to the roadside.
- Incidental poaching from vehicles is not expected to change substantially from the current situation and might be decreased if additional traffic displaces target species, warthog, antelope, and hares.

5.2.2.1.2. Borrow areas for dam and access road materials; also, (spoil and material storage areas, construction village and support facilities). Impacts of borrow areas and other land destruction would be slight; mitigation is possible for some of the slightly adverse impacts.

- As it is unlikely that river bottom silts will be used as construction materials, an increased silt load from dredging for fill is not anticipated. This would have had an adverse effect on manatees.
- Habitat destruction in upland areas is not expected to be extensive (perhaps two sq km) and will be located as near as possible to the construction site. As this locality already includes a major highway, several sizable towns and associated agricultural land, and no critical wildlife habitat or populations, impacts will be negligible. This negative impact is considered slight, because displaced warthogs and other monkeys would simply reside in new areas, and no net negative impact would occur unless the region's carrying capacity is saturated, which is probably not the case. Any resident antelope are very few, and would simply displace to other understocked areas nearby.
- Incidental poaching during work at borrow sites is not anticipated to have a significantly adverse impact because game species are not common and the noise will drive some away from the immediate activity center.

5.2.2.1.3. Work force village and inhabitants. The impact of the work force will be slightly negative in general, mostly for the short term. But there is definite potential for moderate to severe negative impacts. All impacts can be mitigated.

- Increased subsistance hunting can affect manatees. This would be a severe negative impact because their numbers are few and construction activities might concentrate them within easy reach of hunters. Additionally, hippos in the locality may be shot to meet the increased meat demand of the work force. This would be slightly negative impact. Sitatunga, reedbuck and oribi are uncommon to rare, preferred hunting targets which could be eliminated in the vicinity of the dam site; this we consider a moderately severe negative impact. Oribi and reedbuck would eventually repopulate from adjacent areas and sitatunga are very difficult to hunt. Warthog would feel only a slightly negative impact because muslim workers do not eat them and warthog population levels are high. Bushbuck and red-flanked duiker, although preferred targets, are not often encountered and seem to be resilient in such situations; the impact on them would be slightly negative. Servals and most other small carnivores, as well as aardvark and pangolin, will be taken for food if encountered by hunters, which will result in a slight but infrequent negative impact.
- Commercial hunting will have a slightly negtive affect on hippos, which are occasionally taken for ivory and salable meat. Leopard, serval, otter and red colobus are likely to be sought for skins and warthog for meat (to be sold to expatriate community). All of these activities are currently extant in The Gambia (with most of the products except warthog meat destined for Dakar) and the construction village, especially the sizable foreign population will certainly attract several enterprising merchants.
- Wildlife-livestock disease exchange might affect a variety of species, with a slightly negative impact. Sitatunga have a high susceptibility to rinderpest and an outbreak could kill a substantial number of the few remaining animals but currently the disease is not considered a

problem. Bushbuck and oribi show high and moderate susceptibility to rinderpest and an outbreak could spread rapidly through these species and to other animals. Warthog also carry trichinosis and swine fever and an influx of domestic swine could increase the prevalence of these diseases. Trichinosis, if widespread, can be a limiting factor for large predators such as the leopard and hyaena. Rabies is endemic in domestic canines and the sylvatic cycle can include the jackal, mongoose, civet, ratel and hyaena.

- Habitat destruction from fuelwood cutting will affect red colobus monkeys, galago and pangolin over the long term, and bushbuck and duikers in the short term. This would be a slightly negative impact.
- Injury to wildlife attracted to garbage will be a slightly negative impact and will include warthog, hyaena and many of the small carnivores. In addition to injuries from broken glass and other debris, some of these animals will be easier targets for hunters.

5.2.2.1.4. <u>River diversion</u>. There will be some effects of the diversion of the river, especially on manatees.

- Manatees will be moderately negatively impacted because human activities are known to alter normal behavior patterns such as feeding, movements and resting increasing stress on this endangered species. Increased boat traffic, both locally and for transport of materials, and probably increased fishing and use of nets will increase boat-manatee contacts, which are often fatal. Any increased mortality of manatees is a negative impact. The likelihood that these encounters will be few due the scarcity of the species means that the impact will be moderate, rather than severe. Displacement of hippo, sitatunga, leopards and other larger predators, red colobus monkeys and several antelope species will be slightly beneficial because opportunistic hunting will be decreased. All of these species are capable of adjusting their home range areas.
- Localized destruction of the river bed and bank is not foreseen to have any appreciable impact, because of the small area involved, and no species is restricted to this specific area.

- Channelization or constricted flow caused by the enclosure dam will have a moderately negative effect on manatees, due to an increased river flow velocity and their demonstrated reluctance to move through restricted waterways, the combined factors may be an effective barrier to manatee movements.
- Increased silt load from construction activities both downstream and upstream due to tidal effects might be slightly negative to coastal manatees, if sea grass beds and other aquatic vegetation decrease from attenuation of light and silt deposits. It may also be slightly detrimental to sitatunga and otter.
- Use of explosives underwater might kill or injure any manatees in the immediate area. We consider this moderately negative, rather than severe, due to the likelihood that few or no manatees will be present at the time. Any hippos or otters in the immediate area will be adversely affected (slightly negative because the chance of hippos being at the site at explosion time is small). Otters are relatively common so a few killed would not be exceptionally detrimental to the species. If explosives are used on land, red colobus monkeys and galagos in the immediate vicinity could be killed or deafened (slightly negative). Land explosions might be slightly beneficial by driving any local leopards or sitatunga farther away from human activity and opportunistic hunting.

In summary, collective impact of river diversion and dam construction activities is in general slightly beneficial for the largest predators and antelope; possibly slightly detrimental to all semi-aquatic mammals, and moderately detrimental to the aquatic manatee. Some mitigative measures are possible.

5.2.2.1.5. <u>Filling of the reservoir</u>.

- Physical displacement of wildlife from flooding will have moderately negative impacts on all antelope species that utilize the lowland riverine habitats due to disorientation as they are driven from their familiar home ranges. The impacts will be only slightly negative on warthog because the animal is more numerous and can more easily absorb the additional losses of those animals shot in agricultural fields. The impact on red colobus will be slightly negative because little of their tall tree habitat occurs in the floodplain. Some small small carnivores might be displaced to areas already at their carrying capacity.

- In addition to the immediate displacement and disorientation, the loss of riparian and wetland habitat due to inundation will be more adverse to more species. Only the manatee will have a slight, short-term benefit, as the higher water will provide access to vegetated areas and increased food supply. Loss of this habitat will be severely detrimental to sitatunga and reedbuck as these areas are critical habitat, and moderately sc for hippo and warthog. These riparian zones provide easy access to forage areas, buffer zones from agricultural areas where the animals can be shot for depretation. Loss of this preferred cover type will likely make the small population of bushbuck more vulnerable to hunters. Species which will experience slightly negative impacts include the leopard, hyaena, and several species of small carnivores which utilize these lowlands for travel corridors and hunting areas. Vervet monkeys use these areas for cover and forage, which does not currently force them to agricultural areas. Red flanked duiker and oribi undoubtedly have protective cover in some of these areas.
- Inundation of river island habitats may be the single most detrimental impact to many of the endangered species. Only the manatee might realize substantial benefits from better access to food supplies. However, if they move into these submerged areas and are discovered by hunters, the manatees would be likely to suffer severe hunting losses. These slightly inundated islands may eventually suport a perennial source of emergent vegetation. Hippo could experience severely negative impact due to loss of resting sites and feeding areas. Sitatunga may well disappear entirely from the loss of these critical habitats and sanctuaries. The chimpanzee rehabilitation project on Baboon Island would be decimated if the islands are substantially inundated

over a long period (although this not currently anticipated). The otter and warthog will be moderately negatively affected because these islands in general provide habitat which does not conflict with human uses. Baboons and vervet monkeys will be affected similarly, but losses due to increased conflict are less critical because populations can sustain some additional losses. If galagos or pangolins occur on the islands, they will eventually disappear.

- Extension of freshwater habitat farther downstream will in general be slightly beneficial. Manatees may benefit most, as they require freshwater and known freshwater springs in brackish water areas seem to be dissappearing, due to drought effects. Other species that prefer freshwater, such as hippo, antelope, and small to medium carnivores, should realize slight benefits. The fact that all of these species currently exist in predominantly brackish water regions suggest that adequate freshwater is available in those regions.
- Loss of reservoir mangrove habitat will be a severely negative impact on manatee and sitatunga, which utilize this habitat for both food and cover. Moderate negative impact on vervet monkey will also occur as this habitat type meets the species' requirements without conflicting with human activities. Leopard and otter might experience slightly detrimental effects.
- Disruption of downstream mangrove habitat will have similar effects on the species noted above.
- Increased water surface area due to the raised water level of the reservoir will probably be moderately negative for hippo because access to upland agricultural areas will be easier and prolonged, resulting in more interactions with farmers. There may be slight benefits for otter due to the increase perimeter. Figure 5.1 summarizes construction impacts on mammals.

5.2.3. Impact On Birds

5.2.3.1. Construction area. In general, birds are less affected by direct habitat intrusions than are mammals. Many species will tolerate

Mammal Species Impact Identification Matrix **BALINGHO** **CONSTRUCTION PHASE**

Construction Activity →	ROADS	BORROW-SPOIL-VILLAGE			WORK FORCE					RIVER DIVERSION/ DAM CONSTRUCTION					
IMPACTS → scientific name	SUMMARY OF ACCESS ROAD IMPACTS	INCREASED SILT LOAD FROM DREDGING NOT ANTICIPATED	LOSS OF UPLAND HABITAT	INCIDENTAL POACHING AT BORROW SITES	INCREASED SUBSISTANCE HUNTING	COMMERCIAL POACHING	DOMESTIC WILD ANIMAL DISEASE EXCHANGE	HABITAT DESTRUCTION FROM FUEL WOOD CUTTING	INJURY TO WILDLIFE ATTRACTED TO GARBAGE DUMPS	DISPLACEMENT OF WILDLIFE BY ACTIVITY AND NOISE	LOCALIZED DESTRUCTION OF RIVER BED AND BANK	CHANNELIZE RIVER FLOW	INCREASE SILT LOAD IN RIVER	USE OF EXPLOSIVES	common names
TRICHECHUS SENEGALENSIS					⬤					⬤		⬤	●	⬤	MANATEE LAMANTIN
HIPPOPOTAMUS AMPHIBIUS					●	●				○				●	HIPPOPOTAMUS HIPPOPOTAME
AONYX CAPENSIS						●							●	●	CLAWLESS OTTER LOUTRE A FOUES BLANCES
TRAGELAPHUS SPEKEI					⬤		●			○			●	○	SITATUNGA SITATUNGA
PAN TROGLODYTES															CHIMPANZEE CHIMPANZEE
PANTHERA PARDUS						●				○				○	LEOPARD PANTHERE
COLOBUS BADIUS	●		●			●		●		○				●	RED COLOBUS MONKEY COLOBE BAI
REDUNCA REDUNCA	●				⬤					○					REEDBUCK COBE DES ROSEAUX
PAPIO PAPIO															BABOON BABOUIN DE GUINEE
ERYTHROCEBUS PATAS															PATAS MONKEY PATAS
CERCOPITHECUS AETHIOPS															VERVET MONKEY SINGE VERT
GALAGO SENEGALENSIS			●					●						●	LESSER GALAGO GALAGO DU SENEGAL
PHACOCHOERUS AETHIOPICUS					●	●	●		●						WARTHOG PHACOCHERE
TRAGELAPHUS SCRIPTUS	●			●	●		●	●		○					BUSHBUCK GUIB HARNACHE
CEPHALOPHUS RUFILATUS	●			●	●			●		○					RED FLANKED DUIKER CEPHALOPHE A'FLANCS ROUX
OUREBIA OUREBI	●			●	⬤		●			○					ORIBI OUREBI
FELIS SERVAL CARNIVORA (small)					●	◐	●		●	○					SERVAL & SMALL CARNIVORES
CROCUTA CROCUTA							●		●	○					SPOTTED HYAENA HYENE TRACHETEE
ORYCTEROPUS AFER			●		●										AARDVARK ORYCTEROPE
MANIS GIGANTEA			●		●			●							GIANT PANGOLIN PANGOLIN GEANT

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Mammal Species Impact Identification Matrix **BALINGHO** **CONSTRUCTION PHASE**

scientific name	Construction Activity: FILLING OF RESERVOIR — IMPACTS → ANIMAL DISPLACEMENT BY INUNDATION	LOSS OF RIPARIAN AND WETLAND (SWAMP) HABITAT	POSSIBLE INUNDATION OF RIVER ISLAND HABITAT	EXTENSION OF FRESHWATER HABITAT DOWNSTREAM TO DAM	LOSS OF RESERVOIR MANGROVE HABITAT	DISRUPTION/LOSS OF DOWNSTREAM MANGROVES	INCREASED SURFACE AREA OF WATER-BALINGHO LAKE								common names
TRICHECHUS SENEGALENSIS		○	○	○	●	●									MANATEE LAMANTIN
HIPPOPOTAMUS AMPHIBIUS		●	●	○			●								HIPPOPOTAMUS HIPPOPOTAME
AONYX CAPENSIS		•	●	○	•	•	○								CLAWLESS OTTER LOUTRE A FOUES BLANCES
TRAGELAPHUS SPEKEI		●	●	○	●	●									SITATUNGA SITATUNGA
PAN TROGLODYTES			●												CHIMPANZEE CHIMPANZEE
PANTHERA PARDUS		•			•	•									LEOPARD PANTHERE
COLOBUS BADIUS	•			○											RED COLOBUS MONKEY COLOBE BAI
REDUNCA REDUNCA	●	●		○											REEDBUCK COBE DES ROSEAUX
PAPIO PAPIO			•												BABOON BABOUIN DE GUINEE
ERYTHROCEBUS PATAS															PATAS MONKEY PATAS
CERCOPITHECUS AETHIOPS		•	•		●	•									VERVET MONKEY SINGE VERT
GALAGO SENEGALENSIS			•												LESSER GALAGO GALAGO DU SENEGAL
PHACOCHOERUS AETHIOPICUS	•	●	●	○											WARTHOG PHACOCHERE
TRAGELAPHUS SCRIPTUS	●	●		○											BUSHBUCK GUIB HARNACHE
CEPHALOPHUS RUFILATUS	●	•		○											RED FLANKED DUIKER CEPHALOPHE A'FLANCS ROUX
OUREBIA OUREBI	●	•		○											ORIBI OUREBI
FELIS SERVAL CARNIVORA (small)	•	•	•	○											SERVAL & SMALL CARNIVORES
CROCUTA CROCUTA		•		○											SPOTTED HYAENA HYENE TRACHETEE
ORYCTEROPUS AFER															AARDVARK ORYCTEROPE
MANIS GIGANTEA			•												GIANT PANGOLIN PANGOLIN GEANT

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high levels of vehicular noise and visual disturbance if food supplies and cover remain adequate. Most bird species currently found in The Gambia are faced with habitats that have been heavily altered by man, so that species not tolerant of such alteration already are rare or absent. This habitat flexibility and the mobility provided by flight will provide bird populations with a buffer against the direct impacts of dam construction. Nevertheless, those species that breed in the habitat that will be altered or removed will undergo population reductions in proportion to the loss of nesting area, in those cases where nest site wields an important influence on population size. Most of these are water-related species, such as herons, ibises, cormorants, waders, and a few specialized landbirds such as the fishing eagle.

5.2.3.2. Reservoir area. More important than the impacts of habitat loss and disturbance in the construction zone will be the ecological changes brought about by fixing the upstream pool at 1.3 to 1.7 m GMD, since this will mean the loss of mudflats that currently provide feeding areas for thousands of resident and visiting waterbirds. The presence of these birds contributed substantially to the enjoyment of tourists who rode the "Lady Chillel Jawara." Not all water-related birds will disappear with the loss of mudflats, but this is one of a set of factors that will lead to a decrease in visible bird life upstream of the dam.

The rapid death of the mangrove community, without replacement by riverine forest (for several decades) will cause a decline in some of the herons, ibises and other species that now nest and feed among the mangroves. The mobility of these species, however, will enable them to reestablish colonies outside of the affected area, while visiting the Balingho Reservoir area to feed.

5.2.4. Reptiles

We do not at this time foresee substantial impacts of the project on reptiles. Within the construction areas, natives lizards, turtles, and snakes will be eliminated through habitat loss, direct contact with vehicles, and killing by workers (especially of snakes). The smaller lizards

(*Agama*, *Gekko*, and *Mabuya*), which are able to survive around human habitations, will increase as offices and dwellings are built.

Within the reservoir area and adjacent lands, the rapid loss of riverine habitat will drive some snakes, including the venomous mambas and cobras, into upland areas. This will put the local human population at risk, if precautions are not taken. An increase in snake killing should also be expected.

5.3. Operation Phase

Even after the Balingho Reservoir has reached chemical stability, some 10 to 20 years after closure, the flood plain vegetation will continue to respond to new conditions and the fauna will continue to respond to vegetation changes. The changes in vegetation composition may be considered secondary effects, the changes in water chemistry and level being the primary affects. Viewed in this way, most of the effects on wildlife are tertiary impacts.

In addition to the impacts of the Balingho Reservoir, there are likely to be some impacts of the barrage itself and of the operating crew. A few species, such as the manatee, are likely to feel the effects of increased hunting pressure, if the presence of the freshwater pool leads to an increase in fishing.

5.3.1. Vegetation

The effects of the Balingho Barrage on vegetation will be most severe immediately above and below the barrage. The class of vegetation that will be most severely affected is mangrove (1.6), of which 7,930 ha lies in the inundation zone, 12 percent of the mangrove in the Basin. If the water level in the reservoir remains relatively constant at 1.3-1.7 m GMD for weeks at a time, the mangrove will die relatively quickly, due to suffocation of the preumatophores (Snedaker, 1985). Eventually the mangrove areas will be revegetated with flood tolerant species of the riverine community, but this may take decades. In the interim, once the water has become fresh and the pH has stabilized above about 6.5, floating aquatic vegetation, such as _Salvinia_, _Pistia_, and _Eichhornia_, is likely to colonize the edges of the reservoir.

Downstream of the barrage, increased salinities and higher tides are expected to cause losses in mangrove along the edges of some mangrove areas.

5.3.2 Mammals

The operation of the barrage has the potential for severe impacts on one species, the manatee, and slight impacts on nearly all the wildlife that now inhabits the flood plain.

The manatee is vulnerable to both direct and indirect impacts. The direct impacts, which if not prevented could cause major losses to the already meagre population of manatees, stem from the fact that fresh water seeping through the locks, ship gate, and spillway gates will attract manatees from the estuary. These animals are likely to be injured or killed in several ways (Powell, 1985).

- Crushing behind lock gates as the gates are opening. Entering lock in search of resh water, manatees sometimes get caught behind lock gates and killed as the gates are pressed against the lock walls.
- Crushing in closing lock gates. Manatees attempting to leave locks occasionally are pinched and killed by closing lock gates. This tends to occur when a female manatee attempts to follow her calf through the diminishing space.
- Collisions with boats in locks and lock entrance channels. Manatees are crushed between barges or other large boats and the lock walls; or are killed by propellors.
- Jamming in water control gates. This usually occurs when a relatively small gate is opened insufficiently to pass a fullgrown manatee. A mother attempting to follow her calf becomes jammed and drowns.

- Ship gate trapping. The danger of a manatee being crushed in the ship gate seems to be less than in the lock, but the guide channel for the ship gate represents a potential collision area.

Indirect hazards to manatee also will exist during project operation. Any increase in river-edge activity such as increased fishing will place manatees in jeopardy, since the control of illegal hunting by Gambian fishermen is almost impossible. The use of gill-nets by fishermen in the reservoir may also pose a threat to manatees, which tend to get tangled in the nets and drown.

Other wildlife in the Balingho area are less threatened by the operation of the project itself. The activities of fishermen along the reservoir margins will present a moderate threat to wetland-loving antelope such as the sitatunga, but the death of the mangrove forest, soon after dam closure, will have driven the sitatunga dowsntream into the more coastal mangrove or upstream into the riverine forest. Increased fishing in the inundated stretch of the reservoir will increase the likelihood of interactions between man and hippopotamus, usually with fatal consequences for the latter.

Increase traffic on the Trans-Gambia Highway will put all forms of local wildlife at risk, especially along the newer sections of the highway.

Agricultural development associated with the new freshwater pool will exert a slight to moderate negative impact on species that lose habitat and/or become crop pests. Hippopotamus will be the most affected, since they are already crop pests in many areas. Reedbuck also will moderately affected. Nearly all other mammals will suffer somewhat from a more intensive livestock husbandry and cropping situation.

The resident operating staff is expected to be fairly small, about a dozen technically trained individuals (lock operators, engineers, an administrator) and perhaps twice that number of semiskilled and unskilled workers, plus a substantial security force. There are two ways in which these personnel may exert a negative impact on wildlife: 1) by illegal hunting and 2) by creating a demand for game meat, which would stimulate local hunters to poach commercially. This impact would be distributed among wildlife species (mammals and birds) in proportion to the relative desirability and obtainability to each species. We doubt that any species except the manatee is likely to be strongly affected. Figure 5.2 summarizes the impacts on mammals resulting from project operation.

5.3.3. Birds

The gradual conversion of the stands of dead mangrove into, first, floating aquatic vegetation, then riverine forest will generally benefit birds, but the species that increase will not be the same as those that decreased with the death of the mangrove forest.

The conversion of areas of rainfed agriculture to irrigated multicrop rice will tend to exacerbate the already serious pest bird problem. Species such as the Village Weaver that now subsist on wild seeds during part of the year will be able to remain in the rice areas longer, moving to millet, sorghum, and maize when necessary. Some species, such as the Sudan golden sparrow (Passer luteus), which has only recently appeared in the Gambia and has not become a major pest, may be able to capitalize on the expanded niche to increase their numbers.

Mammal Species Impact Identification Matrix **BALINGHO** **OPERATION PHASE**

Operation Activity	HIGHWAY USE			DAM & RESERVOIR OPERATION						RESIDENT STAFF/ VILLAGE RESIDENTS					
scientific name / IMPACTS →	DIRECT MORTALITY FROM WILDLIFE-VEHICLE CONTACTS	INCREASED COMMERCE/ TRAFFIC IN WILDLIFE PRODUCTS		NAVIGATION LOCK OPERATION	FLOOD GATE OPERATION	INCREASED SHIP AND BOAT TRAFFIC	RESERVOIR LEVEL FLUCTUATIONS	SEDIMENT DEPOSITION IN RESERVOIR		SUBSISTANCE HUNTING	DESTRUCTION OF HABITAT FOR FUELWOOD	COMMERCIAL HUNTING TRADE			common names
TRICHECHUS SENEGALENSIS				●	●	●	●			●					MANATEE LAMANTIN
HIPPOPOTAMUS AMPHIBIUS		●				●	○			●		●			HIPPOPOTAMUS HIPPOPOTAME
AONYX CAPENSIS		●					○					●			CLAWLESS OTTER LOUTRE A FOUES BLANCES
TRAGELAPHUS SPEKEI						●	○			●					SITATUNGA SITATUNGA
PANTHERA PARDUS		●									●	●			LEOPARD PANTHERE
COLOBUS BADIUS		●									●	●			RED COLOBUS MONKEY COLOBE BAI
REDUNCA REDUNCA							○			●	●				REEDBUCK COBE DES ROSEAUX
PAPIO PAPIO	●														BABOON BABOUIN DE GUINEE
ERYTHROCEBUS PATAS	●														PATAS MONKEY PATAS
CERCOPITHECUS AETHIOPS	●										●				VERVET MONKEY SINGE VERT
GALAGO SENEGALENSIS											●				LESSER GALAGO GALAGO DU SENEGAL
PHACOCHOERUS AETHIOPICUS	●	●				●	○			●	●	●			WARTHOG PHACOCHERE
TRAGELAPHUS SCRIPTUS	●	●					○			●	●	●			BUSHBUCK GUIB HARNACHE
CEPHALOPHUS RUFILATUS	●						○			●	●				RED FLANKED DUIKER CEPHALOPHE A'FLANCS ROUX
OUREBIA OUREBI	●						○			●	●				ORIBI OUREBI
FELIS SERVAL CARNIVORA (small)	●	●								●		●			SERVAL & SMALL CARNIVORES
CROCUTA CROCUTA															SPOTTED HYAENA HYENE TRACHETEE
ORYCTEROPUS AFER										●					AARDVARK ORYCTEROPE
MANIS GIGANTEA										●	●				GIANT PANGOLIN PANGOLIN GEANT

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Mammal Species Impact Identification Matrix — **BALINGHO** — **OPERATION PHASE**

Reservoir Use Activities → IMPACTS / scientific name	INCREASED ACTIVITY ALONG SHORELINE	DEATH-INJURY FROM FISHING NETS	HUMAN-WILDLIFE CONFLICTS	WILDLIFE-LIVESTOCK DRY SEASON FORAGE COMPETITION	DOMESTIC-WILD ANIMAL DISEASE EXCHANGE	INCREASE PREY FOR PREDATOR SPECIES	INCREASE HUNTING BY HERDERS	LOSS OF WILDLAND HABITAT	INCREASED KILLING OF CROP DEPREDATING SPECIES						common names
			FISHING			LIVESTOCK HUSBANDRY			AGRICULTURE DEVELOPMENT						
TRICHECHUS SENEGALENSIS	●	●													MANATEE LAMANTIN
HIPPOPOTAMUS AMPHIBIUS			●	•				●	●						HIPPOPOTAMUS HIPPOPOTAME
AONYX CAPENSIS	•		•												CLAWLESS OTTE[R] LOUTRE A FOUES BLA[NCHES]
TRAGELAPHUS SPEKEI	●			•	●										SITATUNGA SITATUNGA
PANTHERA PARDUS	•		•				•	•							LEOPARD PANTHERE
COLOBUS BADIUS								•							RED COLOBUS MON[KEY] COLOBE BAI
REDUNCA REDUNCA	•			•	•		•	•	●						REEDBUCK COBE DES ROSEAU[X]
PAPIO PAPIO									•						BABOON BABOUIN DE GUINE[E]
ERYTHROCEBUS PATAS									•						PATAS MONKEY PATAS
CERCOPITHECUS AETHIOPS									•						VERVET MONKEY SINGE VERT
GALAGO SENEGALENSIS								•							LESSER GALAGO GALAGO DU SENEGA[L]
PHACOCHOERUS AETHIOPICUS			•	•	•			•	•						WARTHOG PHACOCHERE
TRAGELAPHUS SCRIPTUS	•			•	•		•	•	•						BUSHBUCK GUIB HARNACHE
CEPHALOPHUS RUFILATUS	•			•			•	•	•						RED FLANKED DUIKE[R] CEPHALOPHE A'FLANCS
OUREBIA OUREBI	•			•	•		•	•	•						ORIBI OUREBI
FELIS SERVAL CARNIVORA (small)			•		•		•								SERVAL & SMALL CARNI[VORES]
CROCUTA CROCUTA					•	○	•								SPOTTED HYAENA HYENE TRACHETEE
ORYCTEROPUS AFER							•	•							AARDVARK ORYCTEROPE
MANIS GIGANTEA								•							GIANT PANGOLIN PANGOLIN GEANT
CERCOPITHECUS AETHIOPS															

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6. POTENTIAL IMPACTS OF KEKRETI DAM

6.1. Characteristics of the Project

The Kekreti Dam Project will be located on the mainstem Gambia River in Senegal Oriental, about 3 km north of the village of Lenguekoto. A larger town, Salemata, is 11 km south of the dam site.

6.1.1. Primary Structures

The complete complex at the dam site will consist of a number of structures:

- An embankment dam across the river from the slope of the north bank to a small hill (elevation 92m) on the south bank, a distance of about 1,300 m.
- A second embankment dam in the saddle between that hill and the next one to the south.
- A concrete gravity dam along a low ridge connecting this second hill to a third hill, 625 m to the southwest.
- A 125-meter saddle dike between the third hill and the main slope that will form the south shore of the reservoir.
- An intake structure, near the left (south) abutment of the main dam, leading to a tunnel 10 m in diameter, 325 m long. Two 5.5-meter power tunnels branch off the main tunnel, which goes on to discharge water for irrigation flow augmentation.
- An above-ground powerhouse, approximately 100 by 20 meters, located on the north slope of the first hill.
- A tailwater channel, about 100 m wide and 300 m long, to convey water used for power generation and that released for irrigation to the Gambia River.
- A service spillway located on the south slope of the first hill, that discharges into the river 800 m downstream of the dam.
- An emergency spillway, probably built into the concrete gravity dam. It's placement is unclear in the AHT/HHL (1983) report, but

an emergency entry to the lower part of the service spillway channel is shown.

The height of the main dam has not been established. A reservoir surface elevation of 78.3 m was proposed by AHT/HHL (1983) but a later report (1984) suggested lowering it to 65.0 m. The lower figure, which we will use here, would provide a maximum height of 35 m for the main dam, with a crest length of 1,300 m. The second embankment would have a height of about 15 m and the gravity dam a height of 9 m.

6.1.2. Work Area

The maximum base width of the main dam will be 120 m and the dam will cover approximately 14 ha, including the area of river bed. The second embankment will have an area of five hectares and the gravity dam about 0.7 ha. The intake, powerhouse, outlet channel and spillway works will occupy an area of about 100 ha. Shops and offices will require some 20 ha. Allowing for work areas at abutments and along the dams, the area required for structures will be 300 to 400 ha.

6.1.3. Transmission Lines

There is at present no national power grid system in Senegal, but one is projected for completion prior to the completion of the Kekreti Dam Project. This system will link Kedougou with Tambacounda and points north and west by a high voltage (132 kV) transmission line.

We can only speculate on the exact routing that will be used to put Kedougou in a national grid system. The AHT/HHL (1984) report considered two possible routings to connect the Kekreti Project with the national grid at Tambacounda.

Through the park, exact route not specified. Kekreti-to Dar Salam (90 km); Dar Salam to Tambacounda (70 km).

Around the park (west), exact route not specified. Kekreti to Medina- Gounas (130 km); Medina-Gounas to Tambacounda (70 km). This route was recommended by AHT/HHL.

The same report proposed routings to connect Kekreti with Kedougou (80 km) along the existing road via Salemata, presumably rerouted to parallel the relocated road. A connection to Mali, Guinea, also was suggested; it would pass via Segou and Kerouane, a distance of 63 km.

We consider it unthinkable that planners would seriously route the transmission line through the center of Niokolo-Koba National Park. We note that the west route also would pass through the southernmost limit of the Park, which extends all the way to the Guinea border.

6.1.4. Access Roads

The Kekreti Reservoir will thoroughly inundate parts of the present road between Kedougou and Salemata, which may be considered the most logical outside access to the Project area. The AHT/HHL report (1984) suggests a new road to the south of the reservoir. We consider that the proposed routing must be considered in a broader context than mere Project access; some possible alternatives are examined in subsequent sections of this report.

Within the immediate Project area, a network of roads will be required: from Salemata, about 25 road kilometers; others connecting the site with the workers' village, shops and offices, the various embankments, and borrow areas. The total length of such roads could well reach 80-100 km.

6.1.5. Airstrip

The airstrip at Kedougou, 70 km east of the site, will serve the Project adequately, perhaps with some improvments. It is possible, however, that one will be built nearer the site. Helicopters will be used where fast local transportation is required.

6.1.6. Workers' Village

We estimate that the work force will consist of about 200 expatriate workers (managers, office staff, engineers, and equipment operators) and 800 laborers and semi-skilled workers (drivers, technicians, etc.) hired locally. This number could be reduced slightly if the Project were stretched out in time but would be substantially increased if the Project construction were accelerated.

A housing complex for workers, their families, and service personnel will be constructed between the site and Salemata, perhaps somewhat off the main access road to the site. If the majority of laborers are housed here on single status--it is difficult but not impossible to exclude families--and the expatriates and higher ranking service personnel are provided one- or two-family dwellings, a town of some 2,000 persons will be produced. We are basing our environmental assessment on the assumption that the usual amenities of electricity, cooking gas, domestic water and waste treatment will be provided, as well as markets, schools, religious centers, health services and recreation facilities. The residence complex will occupy approximately 200 hectares.

6.1.7. Borrow Areas

The volumes of the embankment dams have been estimated for the purpose of envisioning the amount of land to be disturbed for fill. We estimate, on the basis of dimensions given in the AHT/HHL (1983) report, that the main dam will require about $2.3 \times 10^6 m^3$ of fill. By comparison, the larger saddle dam will require only about $0.09 \times 10^6 m^3$. A reasonable estimate of total fill for all embankments would be $2.4 \times 10^6 m^3$. Some of the required fill will be obtained from the excavation of the diversion channel, the power tunnel and the outlet channel, but the amount thus obtained will be only a few percent of the total.

The embankment crossing of the Diarrha River by the new access road will require about $0.8 \times 10^6 m^3$ of fill.

6.1.8. Resettlement and Relocations

As of this writing, the criteria for determining who will be resettled and in what manner have not been established.

The only major relocations required will be roads and river crossings. The number of these that will be directly affected will depend on the reservoir surface elevation ultimately selected. At maximum elevation of 65.0 m, the main crossing of the Kedugou-Salemata road over the Tiokoye and Diarrha Rivers would be inundated. These would be replaced by the new access road further south and new roads to Tiankoye and several smaller villages would be reached with spurs.

6.1.9. Operation

The Kekreti reservoir at maximum surface elevation of 65.0 m, will extend up the Gambia River about to Tamban, some 65 river kilometers above the dam. This surface elevation, nearly 10 m lower than the 78.3 recommended in earlier studies, provides a useful storage volume of 89 percent of the average annual flow. A higher dam would provide more volume but the reserovir would fail to fill in many years. It also will extend 40 and 30 km up the valleys of the Diarrha and Tiokoye Rivers, respectively. These constitute the only major tributaries to the Gambia within the reservoir area; both flow in from the south.

The maximum width of the reservoir will be about 3 km, some 4 km upstream of the dam. The surface area at maximum level will be 338 km^2, at minimum level 48 km^2.

Kekreti Reservoir will be operated for hydroelectric power and for low flow augmentation. It is planned as a staged hydroelectric project with two 20-MW generators initially and a third to be added about 18 years later. Each turbine will release 100 m^3/s of water when in full operation. When downstream demand is greater or the reservoir is full, more water can be released through the tunnel or by the service spillway.

The total volume of water in the reservoir, even with the lowest of the alternative dam heights studied, will be approximately 3,500 x $10^6 m^3$. This means that reservoir filling could be achieved in two years of average (3,665 x $10^6 m^3$) flow but it would mean reducing the wet season flow downstream of the dam by about 50 percent. This would allow dry season flow augmentation in the first and second years of operation.

6.2 Planning and Design Phase Impacts

The Planning/Design Phase of the Project involves mostly activities that are minimally intrusive, but which may have considerable effects, due to the relatively undisturbed nature of the Project area. The activities are the following:

- Intrusion of personnel for surveying and exploratory drilling.
- Construction of an access road to the site. There currently is no road between Lenguekoto and the Project area capable of transporting a mobile drilling rig.
- Noise from drilling and personnel.

6.2.1. Exploratory Investigations

The potential for impacts of exploratory operations stems from the fact that a small number of personnel are thinly scattered, under rather light supervision, throughout the Project area. If these men wish to conceal firearms and hunt illegally, they are much less likely to be detected than later in the development of the Project, when the area is more crowded and enforcement staff probably will be constantly present.

The primary danger of killing of animals lies in the exploration for the right abutment, where surveying and drilling crews will be well inside the Park.

6.2.2. Access Road

In order to get a drilling rig to the Project site, the OMVG will have to construct an access road where no road at all exists at present. The possibility exists that this road will be routed and constructed on an "ad hoc" basis, without a study of alternative routes and of environmental impacts. Often such roads are positioned by a man on foot with a local guide, marking the route with colored tape.

The road itself and attendant "traffic" do not of themselves constitute a great environmental hazard. Topographic modification visually is minimal when the land is rolling or relatively flat and the cutting of large trees is avoided as being too costly. The river crossing and routing within the Park undoubtedly will have to be cleared with the Park administration.

The real danger in the routing of the road by the "ad hoc" method is that it is liable to become the permanent route, bypassing the study of alternatives.

6.2.3. Noise

The noise of the drilling rig, truck, and operators will be audible for a kilometer or so in still air. Some of the shyer animals will avoid the area, incuding the camp, during the period of exploration. Wildlife will quickly resume use of the area following departure of the equipment and personnel.

6.3 Construction Phase Impacts

6.3.1. Summary of Direct Effects

The direct effects of the Project derive from structures, equipment, actions, and personnel. They act on vegetation (affecting wildlife secondarily) and on wildlife, and may be summarized as follows:

- Additional road construction, noise, dust, traffic movement.
- Primary structures (dam, spillway, outlet, powerhouse), including borrow and spoil areas; transmission lines and switchyards.
  - Habitat loss through clearing.
  - Noise, dust, movements, lights.
  - Personnel/wildlife interactions at periphery.
- Clearing and leveling work areas, alignment (except river bed), workers' village area,
  - Initial sudden habitat loss; increased man-wildlife interactions.
  - Noise, dust, and movement will drive many species further away, even on the Park side.

- Work Force and Squatters.
  - Danger of illegal hunting/poaching.
  - Resource demand (fuelwood, game meat).
  - Waste production (solid, liquid).
- Inundation.
  - Habitat loss.
  - Movement of animals out of reservoir area.

6.3.2. Vegetation-Land Clearing

6.3.2.1. Activities in the National Park. Throughout our discussion of ecologic impacts, we will assume that intrusions into the Niokolo-Koba National Park will be strictly minimized, even where this adds to the cost of the Project. Clearing will be required on the right abutment, but it is taken for granted in this report that access roads, workshops and offices, borrow areas and other construction-related clearing will be restricted to the south bank of the river. In the section "Mitigation Activities" we will make further recommendations for protecting the Park and its wildlife.

6.3.2.2. Access roads. One of the first acts of the construction contractor is to prepare access roads to the site. In accordance with the AHT/HHL (1984) report, we consider Project access to start from Kedougou. Attention must be given, however, to Project traffic into Kedougou and we will discuss such impacts later in this section.

Project roads may be treated as three components:

- Kedougou-Salemata. The existing gravel road will be upgraded and a new section of about 46 km added. With the selection of the lower reservoir elevation this new section may be shortened. The AHT/HHL report indicates that some 8 km of the 46 km will be upgrading an existing road (Kiongol to Tiankoye), in which case the amount of land clearing (114 ha) would be less than that (138 ha) required for 46 km of new 30-meter right-of-way. The AHT/HHL plan provides for a dike crossing the Diarrha arm of the reservoir. It would be 2,600 m long, with a basal area of about 15.6

ha, but all within the reservoir area. The 114 ha of new right-of-way will remove about 46 ha of closed forest, 51 ha of open forest, 2 ha of riverine forest, and 15 ha of agricultural land.

- Salemata-Dam Site. A 12-km section of new road will lead from Salemata to the site. It will require clearing 36 ha, of which approximately 10 ha currently is covered by open forest, 12 ha by closed forest, 12 ha by riverine forest, and 2 ha by cultivation.
- Access Roads Connecting Project Components. Without knowing the sources of fill material for the embankments, one cannot determine the length or routing of access roads to borrow areas. Some of these may be five to ten kilometers from the dam, others may be close. We believe that it will be found practical to utilize some of the alluvial material within the reservoir area, in which case the roads would disturb areas that would be flooded in a few years anyway.

The Wildlife/Vegetation Team was shown a map by the Conservateur of the Park, which he explained the routing of a new high-speed road from Dialakoto to Kedougou, around the north and east end of the Park. With that road in service, he said, the Park would close the existing road to through traffic. This would greatly reduce the contacts between vehicles and wildlife and make control of poaching a little easier.

On the other hand, during the January, 1985, Ann Arbor meeting of Project and USAID staff, Dr. Ames was informed by Louis Lucke (USAID) that funds had been allotted by the Government of Senegal to pave and otherwise upgrade the existing road from Dialakoto to Kedougou. Such upgrading would effectively kill any plans for a perimeter routing.

6.3.2.3. Project structures. The 300-400 hectares that we estimate will be cleared for Project structures includes an area extending about 1,500 m along the river and 250 m away from it. That area, if not totally denuded of vegetation, will be sufficiently cleared as to lose all ecological identity. Similarly, the dam alignments will be totally cleared. The areas to be cleared are now divided between Closed Forest (1.2), totaling about 80 ha near the river, and Open Forest, (1.3), about 320 ha, in the more elevated areas.

6.3.2.4. Workers' village. The support community for the Project will be located on high ground on the west side of the access road (the east side of the road lies largely within the zone of inundation) and sufficiently distant from the site to avoid noise and dust. It will certainly be close enough to the site to minimize the transit time of workers.

The area of the workers village probably will not be totally cleared; large trees usually are left standing for shade. The general area in which it is likely to be located currently is in open forest, with some areas under cultivation. Between the clearing for streets and that for buildings, drainage, water and electrical systems and other structures, destruction of the vegetation complex will be intense over an area of about 200 ha.

6.3.2.5. Resettlement. The people displaced by the Kekreti reservoir will have to be resettled on new land. If the resettlement is planned and conducted in accordance with the guidelines of the World Bank, which are somewhat more stringent than those of most other international lending agencies, the land provided each village will be as large in area and of comparable quality to that lost. In actual practice, this is extremely difficult to obtain in an area relatively densely populated.

Existing counts of villages in the reservoir area have been based on the higher reservoir elevation and were done without recourse to guidelines from OMVG on resettlement criteria. West (1984) estimated that the resettled population would be between 4082 and 8400 (1990 figures) depending upon the criteria for selection. He estimates that the amount of new agricultural land required would be 6,500 to 13,500 ha, to which must be added the actual village areas and pastures.

It is doubtful that satisfactory land can be found near the Kekreti Reservoir for even a fraction of the resettled population. West points out that any inadequacies in the land selection program will lead to greater pressure on all areas not now in agriculture and possibly to an organized challenge to the inviolability of the National Park.

6.3.2.6. Borrow areas. The location and depth of borrow areas can only be speculated upon, but the area is likely to be considerable. The $2.4 \times 10^6 m^3$ required for the dam and associated dikes, if taken from deposits two meters thick, would disturb 120 ha, plus the areas in which unwanted overburden is spoiled (stored). It is unlikely that the entire volume will be taken from one area, so we may expect to see a number of borrow areas five to ten hectares in area, scattered in a radius of several kilometers from the construction area, some within, others outside the reservoir limits.

We deem it likely that the planners and contractors will point out the economies of utilizing alluvial deposits on the north bank of the river in place of more distant deposits on the south bank. Were this permitted, the savings achieved in construction would be more than outweighed by the damage to the National Park.

About 0.8 million cubic meters of fill will be required for the dike transporting the access road across the Diarrha arm of the reservior. This embankment, as currently planned, will freely pass water, so may be constructed largely of rock. Depending on the depth of rock quarried, this will disturb 20 ha (4 m depth) to 80 ha (1 m depth) of land, which probably will be in the cultivation cycle or in open forest.

6.3.2.7. Other effects of land clearing. In addition to the destruction of wildlife habitat, the clearing activities will exert other adverse impacts:

- Increased contact between man and wildlife, usually at the expense of the latter. Snakes and other slow moving animals are especially vulnerable.
- Noise, dust and vehicle movement will cause the shyer and more mobile animals to leave the area. While this reduces the likelihood of their being illegally shot, it also increases the level of intrusion of the Project into the region.

6.3.2.8. Inundation. A second type of habitat loss occurs at the end of the construction period of a dam, as the reservoir is filled. Terrestrial habitat of various kinds is converted into aquatic habitat, which recovers its terrestrial nature, but not its plant cover, during each dry season drawdown.

The initial alteration of habitat that occurs on filling the reservoir sometimes is preceded by artifical deforestation, when the reseroir area is cleared of standing timber. This may be performed for any one or several diverse reasons, relating to tourism, fisheries, timber or fuelwood salvage, or navigation. We will discuss the pros and cons of reservoir clearing in the chapter on mitigation.

The short-term effects of inundation on wildlife depend in considerable measure on the rate of filling. It is unlikely that the Kekreti reservoir will reach its maximum elevation of 65.0 m in less than three rainy seasons and it may take five. Much will depend on how the reservoir is operated during the intervening dry seasons. Eventually, all of the vegetation within the reservoir area will be killed, beginning with the least flood-tolerant species.

Once it has reached its maximum surface elevation, in, say, five years, the reservoir will contain thousands of leafless tree skeletons, some of which will remain standing for decades. This assumes that pre-impoundment clearing is not performed.

The 338 km^2 of land to be inundated by the reservoir currently contains six vegetation or land use categories, the amounts and distribution of which are shown in Table 6.1.

TABLE 6.1

LAND USE/COVER CLASSES IN THE KEKRETI RESERVOIR AREA

Class	Area (Km)	%	Within PNNK[a/]
1.2 Closed Forest	91	27	50
1.3 Open Forest	172	51	9
1.4 Riparian Forest	47	14	12
1.5 Grassland	3	1	3
2.2 Rainfed Agriculture	21	6	-
4.4 Bare Land	4	1	3
	338	100	77

a/ Niokolo-Koba National Park

6.3.3. Impacts on Wildlife

Impacts of the proposed Kekreti development on wildlife have a special significance due to the close proximity of Niokolo-Koba National Park. This Park is not only the last remaining refuge for the large mammalian fauna of Senegal Oriental and much of the semi-arid regions of West Africa, but is also listed as a World Heritage Area.

Because of the great importance of this area for wildlife conservation, the impact analysis was pursued to a much greater level of detail: the Species-Impact Identification Matrix presented in Figure 6.1 was expanded to 48 impacts for the Construction Phase, and 35 impacts for the Operational Phase, which includes the corollary developments of reservoir fishing, livestock husbandry and rainfed, subsistence agriculture. Although the extent and specific locations of resettlement activities have not been determined, the impacts will be similar to those identified for the Agricultural Development and Work Force Village and Inhabitants.

Mammal Species Impact Identification Matrix **KEKRETI** **CONSTRUCTION PHASE**

Activity → / IMPACTS →	ACCESS ROAD KEDOUGOU-SALEMATA						SALEMATA TO DAM SITE & ENVIRONS					BORROW PITS			
scientific name	ANIMAL DISPLACEMENT DURING CONSTRUCTION	CONTINUED DISPLACEMENT DURING HEAVY TRAFFIC USE	DIRECT ANIMAL MORTALITY FROM VEHICLE-ANIMAL CONTACT	INCIDENTAL POACHING OR INDISCRIMINATE KILLING	DEVELOPMENT OF ROADSIDE RIPARIAN		ANIMAL DISPLACEMENT DURING CONSTRUCTION PHASE	DIRECT ANIMAL MORTALITY	INCIDENTAL POACHING OR INDISCRIMINATE KILLING	DEVELOPMENT OF ROADSIDE RIPARIAN		INCIDENTAL POACHING OR INDISCRIMINATE KILLING	LOSS OF UPLAND HABITAT	ADVANTAGEOUS SITE SELECTION & RECLAMATION OF BORROW PITS	common names
COLOBUS BADIUS															RED COLOBUS MONKEY COLOBE BAI
CERCOPITHECUS AETHIOPS			●	●	○				●	○		●		○	VERVET MONKEY SINGE VERT
ERYTHROCEBUS PATAS				●	○				●	○		●		○	PATAS MONKEY PATAS
PAPIO PAPIO				●	○				●	○		●		○	BABOON BABOUIN DE GUINEE
PAN TROGLODYTES															CHIMPANZEE CHIMPANZEE
CANIS SPP.			●		○					○				○	JACKAL CHACAL
LYCAON PICTUS			●	●	●				●	●		●		○	WILD HUNTING DOG LYCAON
AONYX CAPENSIS															CLAWLESS OTTER LOUTRE A FOUES BLANCES
CARNIVORA (small)			●		○			●		○				○	SMALL CARNIVORES*
CROCUTA CROCUTA	●						●								SPOTTED HYAENA HYENE TRACHETEE
FELIS SERVAL					○				●	●				○	SERVAL
PANTHERA LEO															LION LION
PANTHERA PARDUS									●					○	LEOPARD PANTHERE
LOXODONTA AFRICANA							●		●			●			AFRICAN ELEPHANT ELEPHANT D'AFRIQUE
ORYCTEROPUS AFER				●					●						AARDVARK ORYCTEROPE
PHACOCHOERUS AETHIOPICUS				●	○				●	○		●		○	WARTHOG PHACOCHERE
POTOMOCHOERUS PORCUS									●					○	RED RIVER HOG POTAMOCHERE
HIPPOPOTAMUS AMPHIBIUS									●						HIPPOPOTAMUS HIPPOPOTAME
ALCELAPHUS BUSELAPHUS				●	○		●		●	○		●		○	BUBAL HARTEBEEST BUBALE
CEPHALOPHUS SPP. SYLVICAPRA GRIMMIA				●	○		●	●	●	○		●		○	DUIKERS CEPHALOPHE
HIPPOTRAGUS EQUINUS	●			●	○		●	●	●			●		○	ROAN ANTELOPE HIPPOTRAGUE
KOBUS ELLIPSIPRYMMUS				●			●	●	●	○		◐		○	WATERBUCK COBE DEFASSA
KOBUS KOB							●	●	●	○		●		○	KOB ANTELOPE COBE DE BUFFON
OUREBIA OUREBI	●		●	●	○		●	●	●	○		●		○	ORIBI OUREBI
REDUNCA REDUNCA									●	○				○	REEDBUCK COBE DES ROSEAUX
SYNCERUS CAFFER							●	●	●					○	AFRICAN BUFFALO BUFFLE D'AFRIQUE
TRAGELAPHUS ORYX				●					●			●		○	GIANT ELAND ELAND DE DERBY
TRAGELAPHUS SCRIPTUS	●			◐	○		●	●	◐	○		◐		○	BUSHBUCK GUIB HARNACHE

*GENETTA, CIVETTICTIS, HERPESTES, MUNGOS, ETC.

Mammal Species Impact Identification Matrix

KEKRETI

CONSTRUCTION PHASE

Activity →	Borrow areas for dam materials								Spoil/storage areas			Site support buildings			
IMPACTS → / scientific name	Displacement of animals by noise/activity	Materials taken from river bed	Materials taken from other sites within reservoir	Borrow pit design for water retension	Habitat destruction by pits outside of reservoir	Advantageous reclamation of sites outside reservoir	Incidental poaching		Localized destruction of habitat	Animal displacement by continual noise/activity		Loss of small area of prime riverline habitat	Continual human activity center-displacement		common names
COLOBUS BADIUS	●						●					●			RED COLOBUS MONKEY COLOBE BAI
CERCOPITHECUS AETHIOPS				○		○	●								VERVET MONKEY SINGE VERT
ERYTHROCEBUS PATAS				○		○	●								PATAS MONKEY PATAS
PAPIO PAPIO				○		○	●								BABOON BABOUIN DE GUINEE
PAN TROGLODYTES															CHIMPANZEE CHIMPANZEE
CANIS SPP.				○		○									JACKAL CHACAL
LYCAON PICTUS	○			○		○	⬤								WILD HUNTING DOG LYCAON
AONYX CAPENSIS		●													CLAWLESS OTTER LOUTRE A JOUES BLANCES
CARNIVORA (small)				○		○									SMALL CARNIVORES*
CROCUTA CROCUTA	●					○									SPOTTED HYAENA HYENE TRACHETEE
FELIS SERVAL						○	●								SERVAL
PANTHERA LEO	○						●			◯					LION LION
PANTHERA PARDUS	○					○	●			○		●			LEOPARD PANTHERE
LOXODONTA AFRICANA	◯						⬤			○		●	○		AFRICAN ELEPHANT ELEPHANT D'AFRIQUE
ORYCTEROPUS AFER							●								AARDV'RK ORYCT(...)
PHACOCHOERUS AETHIOPICUS				○		◯	●								WARTHOG PHACOCHERE
POTOMOCHOERUS PORCUS	○					○	●			○		●	○		RED RIVER HOG POTAMOCHERE
HIPPOPOTAMUS AMPHIBIUS							●					●			HIPPOPOTAMUS HIPPOPOTAME
ALCELAPHUS BUSELAPHUS	○			◯		◯	●			○			◯		BUBAL HARTEBEEST BUBALE
CEPHALOPHUS SPP, SYLVICAPRA GRIMMIA	○					○	●			○			○		DUIKERS CEPHALOPHE,
HIPPOTRAGUS EQUINUS	○			◯		◯	●			○			○		ROAN ANTELOPE HIPPOTRAGUE
KOBUS ELLIPSIPRYMMUS	○			◯		◯	●			○		●	○		WATERBUCK COBE DEFASSA
KOBUS KOB	○			◯		◯	●			○		●	○		KOB ANTELOPE COBE DE BUFFON
OUREBIA OUREBI	○			○		○	●			○			○		ORIBI OUREBI
REDUNCA REDUNCA	○			○		○	⬤			○		●	○		REEDBUCK COBE DES ROSEAUX
SYNCERUS CAFFER	○			◯		○	●			○		●	○		AFRICAN BUFFALO BUFFLE D'AFRIQUE
TRAGELAPHUS ORYX	○			◯		◯	⬤			○			○		GIANT ELAND ELAND DE DERBY
TRAGELAPHUS SCRIPTUS	○			○		○	●			○		●	○		BUSHBUCK GUIB HARNACHE

*GENETTA, CIVETTICTIS, HERPESTES, MUNGOS, ETC.

Figure 6.1

Mammal Species Impact Identification Matrix — **KEKRETI** — **CONSTRUCTION PHASE**

Activity →	LANDING STRIP USE			WORK FORCE VILLAGE & INHABITANTS								CLEARING TREES FROM RESERVOIR			
IMPACTS → / scientific name	LOST OF HABITAT	DISPLACEMENT BY NOISE/ACTIVITY		INCREASED SUBSISTENCE HUNTING	SPORT/RECREATIONAL HUNTING	ORGANIZED/COMMERCIAL POACHING	UNAUTHORIZED NON-CONSUMPTIVE PARK VISITS	DISTURBANCE/LOSS OF HABITAT TO FUELWOOD CUTTING	DOMESTIC-WILD ANIMAL DISEASE EXCHANGE	RISKS TO WILDLIFE ATTRACTED TO GARBAGE		INCIDENTAL POACHING	REDUCTION OF WOOD CUTTING FROM OTHER AREAS	DISPLACEMENT OF WILDLIFE PRIOR TO RESERVOIR FILLING	common names
COLOBUS BADIUS				●		•		•				•	○	●	RED COLOBUS MONKEY COLOBE BAI
CERCOPITHECUS AETHIOPS				●	•							•			VERVET MONKEY SINGE VERT
ERYTHROCEBUS PATAS				•	•							•			PATAS MONKEY PATAS
PAPIO PAPIO				•	•							•			BABOON BABOUIN DE GUINEE
PAN TROGLODYTES															CHIMPANZEE CHIMPANZEE
CANIS SPP.				•	•				•	●					JACKAL CHACAL
LYCAON PICTUS				●	●				●			●			WILD HUNTING DOG LYCAON
AONYX CAPENSIS						•									CLAWLESS OTTER LOUTRE A FOUES BLANCES
CARNIVORA (small)				•					•	•					SMALL CARNIVORES*
CROCUTA CROCUTA		•						•	•	•				○	SPOTTED HYAENA HYENE TRACHETEE
FELIS SERVAL				•		•		•				•	○		SERVAL
PANTHERA LEO					●	●		○				•	○		LION LION
PANTHERA PARDUS					●	●		○					○		LEOPARD PANTHERE
LOXODONTA AFRICANA		◯			●	●	•	•				●	○		AFRICAN ELEPHANT ELEPHANT D'AFRIQUE
ORYCTEROPUS AFER				•									○		AARDVARK ORYCTEROPE
PHACOCHOERUS AETHIOPICUS				•	●			•	•	•		•	○		WARTHOG PHACOCHERE
POTOMOCHOERUS PORCUS		○		●	•		•	•	•			•	○	○	RED RIVER HOG POTAMOCHERE
HIPPOPOTAMUS AMPHIBIUS				•	•	•						●			HIPPOPOTAMUS HIPPOPOTAME
ALCELAPHUS BUSELAPHUS		◯		•	•			•				•	○	○	BUBAL HARTEBEEST BUBALE
CEPHALOPHUS SPP, SYLVICAPRA GRIMMIA				•	•			•				•	○		DUIKERS CEPHALOPHE,
HIPPOTRAGUS EQUINUS		○		•	●	●		•	•			•	○		ROAN ANTELOPE HIPPOTRAGUE
KOBUS ELLIPSIPRYMMUS		◯		●	●	●		•				•			WATERBUCK COBE DEFASSA
KOBUS KOB		◯		●	●			•	●			•			KOB ANTELOPE COBE DE BUFFON
OUREBIA OUREBI				•	•			•	•			•	○		ORIBI OUREBI
REDUNCA REDUNCA				•	•			•	•			•	○		REEDBUCK COBE DES ROSEAUX
SYNCERUS CAFFER		◯		•	●	●	•	•	●			•	○	○	AFRICAN BUFFALO BUFFLE D'AFRIQUE
TRAGELAPHUS ORYX		◯		◐	●	◐	•	•	◐			◐	○	◯	GIANT ELAND ELAND DE DERBY
TRAGELAPHUS SCRIPTUS				•	•			•	◐			•	○		BUSHBUCK GUIB HARNACHE

*GENETTA; CIVETTICTIS; HERPESTES; MUNGOS; ETC.

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Figure 6.1

Mammal Species Impact Identification Matrix **KEKRETI** **CONSTRUCTION PHASE**

Activity → / IMPACTS → / scientific name	DISPLACEMENT OF ANIMALS BY ACTIVITY/NOISE	LOCALIZED DESTRUCTION OF RIVER BED	TEMPORARY BLOCKAGE OF RIVER FLOW	INCREASED SILT LOAD IN RIVER	PERMANENT LOSS OF HABITAT AROUND DAMSITE		DISPLACEMENT OF ANIMALS AS WATER LEVEL RISES	POSSIBLE ANIMAL ISOLATION, STARVATION, DROWNING	IRREPARABLE LOSS OF SOME RIPARIAN HABITAT	LOSS OF UPLAND HABITAT DUE TO INUNDATION	BLOCKAGE OF RETURN ANNUAL MOVEMENTS OF CERTAIN SPECIES	NECESSITY OF RELOCATING WUROLI-BANGARE CORNISH ROAD			common names
Activity	DAM CONSTRUCTION						RESERVOIR FILLING								
COLOBUS BADIUS	○				●		●	●	⬤						RED COLOBUS MONKEY COLOBE BAI
CERCOPITHECUS AETHIOPS	○			●											VERVET MONKEY SINGE VERT
ERYTHROCEBUS PATAS	○														PATAS MONKEY PATAS
PAPIO PAPIO	○														BABOON BABOUIN DE GUINEE
PAN TROGLODYTES															CHIMPANZEE CHIMPANZEE
CANIS SPP.							○								JACKAL CHACAL
LYCAON PICTUS	◯									⬤					WILD HUNTING DOG LYCAON
AONYX CAPENSIS	○		●	⬤	●		○								CLAWLESS OTTER LOUTRE A JOUES BLANCHES
CARNIVORA (small)							○								SMALL CARNIVORES*
CROCUTA CROCUTA	●						●			●		●			SPOTTED HYAENA HYENE TACHETEE
FELIS SERVAL	○						○		●	●					SERVAL
PANTHERA LEO	○									●	●				LION LION
PANTHERA PARDUS	○				●				●	●					LEOPARD PANTHERE
LOXODONTA AFRICANA	◯		●		⬤		●		⬤			⬤			AFRICAN ELEPHANT ELEPHANT D'AFRIQUE
ORYCTEROPUS AFER								●		●					AARDVARK ORYCTEROPE
PHACOCHOERUS AETHIOPICUS															WARTHOG PHACOCHERE
POTOMOCHOERUS PORCUS	○		●		●				●	●					RED RIVER HOG POTAMOCHERE
HIPPOPOTAMUS AMPHIBIUS	○		⬤		●										HIPPOPOTAMUS HIPPOPOTAME
ALCELAPHUS BUSELAPHUS	○		●				●			●	●	●			BUBAL HARTEBEEST BUBALE
CEPHALOPHUS SPP. SYLVICAPRA GRIMMIA	○						●			●		●			DUIKERS CEPHALOPHE,
HIPPOTRAGUS EQUINUS	○		●				●			●	●	●			ROAN ANTELOPE HIPPOTRAGUE
KOBUS ELLIPSIPRYMNUS	○		●		●		●		●			●			WATERBUCK COBE DEFASSA
KOBUS KOB	○		●		●		●		●						KOB ANTELOPE COBE DE BUFFON
OUREBIA OUREBI										●		●			ORIBI OUREBI
REDUNCA REDUNCA	○						●		●	●					REEDBUCK COBE DES ROSEAUX
SYNCERUS CAFFER	○		●		●		●		●	●	●	●			AFRICAN BUFFALO BUFFLE D'AFRIQUE
TRAGELAPHUS ORYX	○		●		●		◯			●	◯	●			GIANT ELAND ELAND DE DERBY
TRAGELAPHUS SCRIPTUS	○		●		●		●		●			●			BUSHBUCK GUIB HARNACHE

*GENETTA, CIVETTICTIS, HERPESTES, MUNGOS, ETC.

Figure 6.1

Mammal Species Impact Identification Matrix **KEKRETI** **CONSTRUCTION PHASE**

Activity → / scientific name	TRANSMISSION LINE CONSTRUCTION: CONSTRUCTION VIA SHORTEST ROUTE KEKRETI-TAMBACOUNDA	DISPLACEMENT/DISTURBANCE DURING CONSTRUCTION	INCIDENTAL POACHING			ROAD CLOSURE: ABANDON/RECLAIM EXTRA SITE ACCESS ROADS								common names
COLOBUS BADIUS	●	●												RED COLOBUS MONKEY COLOBE BAI
CERCOPITHECUS AETHIOPS			●			○								VERVET MONKEY SINGE VERT
ERYTHROCEBUS PATAS			●			○								PATAS MONKEY PATAS
PAPIO PAPIO			●			○								BABOON BABOUIN DE GUINEE
PAN TROGLODYTES														CHIMPANZEE CHIMPANZEE
CANIS SPP.						○								JACKAL CHACAL
LYCAON PICTUS	●		●			○								WILD HUNTING DOG LYCAON
AONYX CAPENSIS														CLAWLESS OTTER LOUTRE A FOUES BLANCES
CARNIVORA(small)						○								SMALL CARNIVORES*
CROCUTA CROCUTA	●	⬤												SPOTTED HYAENA HYENE TRACHETEE
FELIS SERVAL			●			○								SERVAL
PANTHERA LEO	○		●											LION LION
PANTHERA PARDUS	○		●											LEOPARD PANTHERE
LOXODONTA AFRICANA	⬤	●	⬤											AFRICAN ELEPHANT ELEPHANT D'AFRIQUE
ORYCTEROPUS AFER														AARDVARK ORYCTEROPE
PHACOCHOERUS AETHIOPICUS			●			○								WARTHOG PHACOCHERE
POTOMOCHOERUS PORCUS	●	●	●											RED RIVER HOG POTAMOCHERE
HIPPOPOTAMUS AMPHIBIUS														HIPPOPOTAMUS HIPPOPOTAME
ALCELAPHUS BUSELAPHUS	○	●	●			○								BUBAL HARTEBEEST BUBALE
CEPHALOPHUS SPP. SYLVICAPRA GRIMMIA	●		●											DUIKERS CEPHALOPHE,
HIPPOTRAGUS EQUINUS	●	●	⬤			○								ROAN ANTELOPE HIPPOTRAGUE
KOBUS ELLIPSIPRYMMUS	●	●	⬤			◯								WATERBUCK COBE DEFASSA
KOBUS KOB	●	●	⬤			◯								KOB ANTELOPE COBE DE BUFFON
OUREBIA OUREBI		●	●											ORIBI OUREBI
REDUNCA REDUNCA			●			○								REEDBUCK COBE DES ROSEAUX
SYNCERUS CAFFER	●	●	⬤			◯								AFRICAN BUFFALO BUFFLE D'AFRIQUE
TRAGELAPHUS ORYX	⬤	●	⬤			○								GIANT ELAND ELAND DE DERBY
TRAGELAPHUS SCRIPTUS	●	●	●			○								BUSHBUCK GUIB HARNACHE

*GENETTA, CIVETTICTIS, HERPESTES, MUNGOS, ETC

The mammalian species list has also been expanded to 28 species or faunal assemblages (group of species expected to be impacted in a similar manner). Although this includes all of the species considered to be important, it is far from a complete listing. Such groups as bats and rodents have been omitted, as have the galago, pangolin, ratel, wildcat, porcupine and several other small and medium size mammals. In general, even though some numbers of these animals will be killed by hunters or by inundation, or affected by other impacts, they are not threatened in any way, and are omitted from the Kekreti analysis in order to maintain a manageable number of species. Many of these animals have been included in the analyses of the other proposed developments, which can be consulted for information on anticipated impacts. The manatee has also been excluded because it would only occur in the Kekreti development area as a rare transient. However, the introduction of this rare species into the new reservoir is included as a recommendation.

This impact analysis is based on two fundamental assumptions. The first is that an absolute minimum of activity will take place within the Park itself. This minimum activity is defined as only the work necessary to construct the right abutment of the dam and should be restricted only to the immediate area, not to exceed about 50 hectares. All transport and access, borrow pits, and support facilities are assumed to be only the south bank. The routing of the transmission line will be discussed as a separate issue. The second assumption involves an understanding of the "present" environment and situation. It is recognized that, for example, sport and recreational hunting are not legal activities in the vicinity of the Park, and that this law is reasonably enforced currently by both the Park and Forest and Wildlife Service agents. However, illegal hunting does occur, and can certainly be expected to increase with the substantially enlarged human population (both expatriates and indigenes) and the current staffing of Park and Forest and Wildlife Service agents will be inadequate to police this activity. Accordingly, the impacts that would occur if the Project were constructed under the present conditions would be substantially adverse, but could be largely mitigated by providing adequate staffing. Similarly, rinderpest is virtually extirpated from Senegal, but is known to be extant in both Mauritania and Mali. With an anticipated increase in immigrant livestock, this disease is a possibility which could prove to be devastating to many of the wild animals, and therefore is presented as a negative impact which can be mitigated by improved livestock veterinary services. If any of these assumptions should prove unwarranted, the impacts of the Project would be much more severe than indicated below.

Whenever possible, the following text descriptions of the impacts parallel those previously presented for the Balingho Barrage.

6.3.3.1. Mammals.

6.3.3.1.1. Access roads. Roads and borrow pits are subdivided to the Kedougou-Salemata route and the Salemata-Kekreti segment. Although the actual routing will be altered, the road between Kedougou and Salemata currently exists and is distant enough from the Park that many of the wild mammals either do not occur, or are quite uncommon, due to long coexistence with the resident human populations. This segment is also anticipated to be a high-speed road. The segment from Salemata to Kekreti will be essentially a new intrusion into an area immediately adjacent to the Park, where wildlife currently is relatively abundant. Accordingly, these two road segments will impact different species, and to a different degree. Similarly, borrow pits are differentiated between those required for road construction materials, which we assume will be scattered along the rights-of-way, and those which will provide materials for the dam and related embankments. As these will be selected as near as possible to the dam site, the impact will be more localized to the area immediately outside the Park.

The potential impacts of the Kedougou-Salemata segment fall into the following categories.

- Displacement of animals during road construction might be slightly adverse for certain antelope species, if they are driven from well known areas into possible conflicts with local inhabitants, and for hyaena, which are strongly territorial and are known to enter into fatal combat when adjacent groups encounter each other.

- Direct animal mortality (roadkills) is expected to be minor, due to relatively low animal densities, but the impact will be slightly negative for jackal, and other small carnivores, possibly for the wild hunting dog, vervet monkey (the least common of the terrestrial monkeys) and the oribi.
- Incidental poaching could have a slightly negative impact on vervet and patas monkeys, baboon and warthog, if Bassari people are hired as workers because these are common food species; and on antelope (notably bubal, duiker, roan, waterbuck, oribi, eland and bushbuck) encountered by workers of any ethnic group. Aardvark will suffer slight adverse impact to the extent that road workers take note of areas exhibiting sign of their presence. Wild hunting dog, if encountered, will suffer because these animals are often shot indiscriminately on sight. The hunting dog is becoming increasingly rare, and any losses sustained by this species are considered to be an adverse impact.
- Development of "roadside riparian" vegetation will be a slight benefit for most herbivores, including all terrestrial monkeys, warthog and certain antelope species: bubal, roan, duikers, oribi and bushbuck. This benefit results from the additional run-off from the road surface that usually provides adequate moisture for seed germination after the first rains and therefore an early source of green vegetation at the end of the dry season: throughout the year these roadside belts often support increased vegetation. Small carnivores, including the jackal and serval, will also benefit due to an increase in rodents and amphibians along the roadsides. This roadside riparian may provide a slightly negative impact on wild hunting dogs if they are attracted to the increase in prey animals along the road, since that would increase the opportunity for indiscriminate shooting.

The segment of new road from Salemata to the dam site is expected to have more severe impacts:

- Displacement of animals by road construction will be slightly negative for territorial hyaena (for the same reason as with the other segment), elephant and most antelope, due to loss of habitat on the south bank.
- Direct mortality (roadkills) on this slower speed road will be less than along the other segment. There will be a slightly negative impact on many small carnivores. A similar effect can also be expected for many antelope species, which are relatively common along this routing through moderately dense woodland and unaccustomed to vehicular traffic.
- Incidental poaching and indiscriminate killing will negatively impact most species used for food or other commercial products, or generally considered as nuisance or dangerous animals. Vervet and patas monkeys and baboon will be slightly impacted if, as expected, Bassari form a sizable proportion of the workers; vervet monkey, the least common of the three species, could be locally decimated. Serval and leopard will be slightly negatively impacted by illegal hunting for their skins, as will elephant and hippo for ivory. Less common species utilized for food (aardvark, red river hog, oribi, reedbuck and possibly eland) might be taken occasionally and thus slightly negatively affected. Buffalo and common antelope including bubal, duikers, roan, bushbuck, kob and waterbuck will be regularly hunted (illegally) and locally will experience a moderately negative impact. Wild hunting dog, not especially fearful of humans, will be occasionally killed indiscriminately, which will be at least a slightly negative impact, due to their scarcity.
- The roadside riparian strip will be slightly beneficial for most species, as described above. In addition to the wild dog, the serval might be slightly negatively impacted because animals

attracted to prey species along the roadway will be more accessible to hunters resident in the worker village.

6.3.3.1.2. Borrow for access road construction materials. In the absence of mitigation, the following impacts may be expected:

- Incidental poaching at these sites will exert a slightly negative impact on monkeys, baboon, and warthog as with the road itself and for most antelope species, especially at those sites nearer to the Park. The impact on waterbuck will be moderately negative, as this species is reportedly easy to hunt due to its curiosity. There is potential for a slightly negative impact on elephants if they continue to utilize the southbank after construction activities begin. The occasional killing of wild hunting dogs can also be expected. Many animals are attracted to these disturbed sites, for a variety of reasons, and the cleared terrain facilitates hunting.
- Loss of upland habitat to roads and borrow pits will have a negligible impact, due to the relatively small areas involved.
- Advantageous reclamation of borrow pits can provide slight to moderate benefits to numerous species. This reclamation would entail modifying these disturbed landscapes to form water catchment basins which would seasonally provide a better distribution of water and forage in the upland habitat types. Monkeys and baboon, a variety of predators including the wild hunting dog, serval and leopard; and most antelope, especially the roan, waterbuck, kob, eland and bushbuck would all benefit from this resource enhancement measure.

6.3.3.1.3. Borrow areas for dam construction materials. The impacts of these borrow activities, more extensive than those for road construction:

- Displacement by this major activity will be a slightly negative impact for red colobus monkey if it is found to occur in the locality because the species is extremely uncommon and has limited habitat. The impact on hyaena will be like that of roads. For most other mobile species the displacement affect is considered to be beneficial because it will reduce the opportunity for illegal hunting.

- Excavation within the river bed may exert a slightly negative impact on the clawless otter due to localized habitat destruction.
- Extraction of materials from other sites within the proposed reservoir and loss of habitat are unavoidable impacts of the development, but are not foreseen to have significantly detrimental or beneficial affects on mammals. This habitat eventually will be lost to inundation.
- Habitat destruction by borrow pits outside of proposed reservoir will have negligible effects due to the relatively small areas involved.
- Incidental poaching around borrow sites for dam materials will have slightly negative impacts on virtually all species and potentially moderate to severe negative impacts on threatened species such as the wild hunting dog, elephant, eland and reedbuck. Many of these sites will be in operation for a considerable period of time and thus offer multiple opportunities for illegal hunting, and some of the wild animals will be attracted to the disturbed sites.

6.3.3.1.4. Spoil and storage areas. The impacts of these areas, which we assume will be near the construction sites, will be similar to those of borrow areas.

- Loss of habitat to areas designated as spoils will only affect a very small locality near the construction site and will have negligible impacts.
- Animal displacement by the continued activity around these spoil areas will be beneficial because many of the target species for hunters will be driven away and thus provide less opportunity for illegal hunting. The displacement should not be significant enough to disrupt home range movements of most species involved,

but will serve to keep them away from the workers' village and construction site.

6.3.3.1.5. Site support buildings. Although the area will not be extensive, these buildings will be located as close as possible to the dam site and a small area of prime riparian habitat will be lost. This will be a slightly negative impact, not only because of the habitat loss, but because of disruption of the riparian corridor. Species likely to be affected are leopard, elephant, red river hog, hippopotamus, buffalo and the more mesic-adapted antelope (waterbuck, kob, reedbuck and bushbuck). If red colobus monkeys inhabit the locality, the impacts will be detrimental. Displacement of animals due the continual human activity is expected to be slightly beneficial.

6.3.3.1.6. Light airplane landing strip. If a landing strip is constructed near the dam site (probably on a laterite bowel) it will take about 60-70 ha. The habitat loss will simply be added incrementally to other habitat loss by the project. Displacement of animals from the noise will generally be slightly to moderately beneficial if such species as elephant and larger antelope are scared further away from human activity centers.

6.3.3.1.7. Workers village. The potential for adverse effects here is very large and depends considerally on the nature of the work force and on the measures taken to control illegal activities.

- Increased subsistence hunting will negatively impact most species used for food. Kob and waterbuck will be moderately negatively affected because they are easy to hunt. Red river hog and eland are not common and if any appreciable numbers are taken it will have a moderately severe impact on the species. Vervet and red colobus monkeys might be taken in enough numbers to be moderately to severely affected. All other species, including small and medium carnivores, aardvark, hippo, warthog and all antelope, will be only slightly affected.
- Sport and recreational hunting, although illegal in the locality of the dam site, can be expected to be difficult to control. If

allowed at all, it will have slight to moderately negative impacts on numerous species, due to the increase in the expatriate community. Even under the present situation, with few expatriate hunters frequenting the area, there is a modest degree of poaching, especially around the periphery of the Park. Trophy species such as lion, leopard, elephant, warthog, roan and kob antelope, waterbuck, buffalo and eland could well experience moderately to locally severe impacts. Even such animals as the jackal, wild hunting dog, and monkeys will be shot by indiscriminate hunters.

- Organized, commercial poaching currently is a substantial activity in the locality, despite active efforts by the authorities. It can only be expected to increase with the growing human population and vastly improved local facilities and transportation network. Target species will include red colobus monkey, clawless otter and serval for their skins (a slightly negative impact on these secondary target species). Lion, leopard, buffalo and trophy antelope such as roan, waterbuck, and eland, could be moderately affected (especially if there is a priority selection for dominant males). Some hippo will be taken for ivory and elephant could be decimated if any of the 50-odd remaining individuals are killed. Even if adequate protection is provided for the elephants during the construction phase, knowledge gained by some workers concerning areas preferred by elephants might prove detrimental in the future.
- Unauthorized, non-consumptive visits to the National Park (northbank) will exert a slightly negative impact on some of the riparian species which may be routinely disturbed along the river. These would include elephant, red river hog, buffalo and possibly eland. This impact might be considerably more detrimental for other species during the end of the dry season, when most animals rely for water on access to the river.

- Disturbance and loss of habitat due to fuelwood cutting can be expected to increase the extent of reservoir impacts beyond those areas which will be inundated. Slightly negative impacts can be expected for red colobus monkey, hyaena and serval, warthog and red river hog, elephant, and all antelope species and buffalo. Lion and leopard might benefit slightly if prey species are disoriented.
- Disease exchange between domestic and wild animals has the potential for severe impact on numerous species. This will depend on whether workers are allowed to keep livestock. An outbreak of rinderpest would be devastating if spread to wild ungulate populations. The increase of distemper or rabies in the wild hunting dog population could well be severely detrimental.
- The risks to animals attracted to garbage will be slightly negative for small carnivores, hyaena, and possibly warthog; and moderately negative for jackal.

6.3.3.1.8. Reservoir clearing/salvage operation. This program may be urged by project planners under the banner of environmental protection. We believe the negative impacts out weigh the benefits.

- Incidental poaching by woodcutters could be expected to be slightly to moderately negative for many species as unsupervised woodcutters (probably not even under control of the construction contractor) work in areas near the National Park where game animals are abundant. This activity would affect virtually all animals, but could be especially detrimental for elephant, hippo, eland, wild hunting dog and red river hog.
- Reduction of woodcutting and habitat destruction in other areas would be a slight benefit for most species if a salvage operation is undertaken in the area scheduled for inundation.
- Displacement of animals prior to reservoir filling would be a possible benefit if the woodcutting activity tends to drive certain species across the river to the northbank sanctuary of the Park. This would probably only affect the more mobile species

that are particularly intolerant of human presence, such as the bubal, buffalo, red river hog and eland.

6.3.3.1.9 Dam construction activities.

- Displacement of animals by human activity and noise probably will be beneficial for most animals because it would decrease their contact with humans while at the same time probably not displacing them from their entire home range or known territories.
- Destruction of river bed is anticipated to have a negligible impact because of the small area involved.
- Increased silt load in the river as the river bed is disturbed and the earthen dam is begun might be detrimental to aquatic vegetation and aquatic invertebrates. If this effect is prolonged or especially severe it would be slightly to moderately negative to the clawless otter and possibly vervet monkey, which feed on these animals.
- Permanent loss of upland and riparian habitat around the dam site will have a slightly negative impact on red colobus monkey, clawless otter, leopard, elephant, red river hog, hippopotamus, waterbuck, kob antelope, buffalo, eland and bushbuck. This effect derives not so much from the loss of tens of hectares of prime riverine habitat, as from the disruption of the riparian corridor used for food, water and cover by many species.

6.3.3.1.10. Reservoir filling. The magnitude of impacts during filling will be strongly dependent on the rate of filling. In general, the fewer seasons used for filling, the more severe the impact.

- Displacement of animals as water level rises will be a slightly negative impact on a variety of animals as they are forced from familiar areas and may become disoriented, increasing contacts with predators and hunters. Species expected to be affected include red colobus monkey, spotted hyaena, elephant, and most antelope. Because this will occur gradually, it is anticipated to have only a slight affect, rather than a more severe one. The notable exception to this would be eland, if any substantial number are trapped on the south bank and denied access to the National Park. Under these circumstances, depending on the number involved, this impact could range from moderate to severe because the animals would eventually be shot by hunters. Much would depend on whether the eland would swim to the north bank. Small and medium carnivores should benefit slightly as rodents, hares and other prey are displaced and concentrated along the edge of the rising reservoir.

- Animal isolation and starvation or drowning is not anticipated as a major detrimental effect because water levels will rise slowly, and there appears to be only a single island which might develop. If this does not prove to be the case, the two main species which might suffer (slightly negative effects) would be red colobus monkey and aardvark. Virtually all other species are just capable of swimming or are excellent swimmers, and the strong flow of the river under current flood stage will be dissipated in the lake.
- Irreparable loss of riparian habitat is expected because existing areas within the reservoir will be inundated, and the annual drawdown of the lake will preclude the establishment of phreatophyte plants around the new preiphery of the reservoir. Based on GRBS Vegetation Maps, 12 sq km of riparian habitat will be inundated, but this should not be a devastating affect since the total riparian type within the Park (including the Koulountou) is approximately 366 sq km and widely distributed. Red colobus monkey and elephant could experience moderately severe negative impacts; serval and leopard, red river hog, waterbuck, kob, buffalo, reedbuck, and bushbuck will be slightly negatively impacted.
- Loss of upland habitat, mostly forest and woodland vegetation, totaling around 300 sq km, will have only slight impacts on a variety of species because the majority of the inundated areas will be outside the National Park, where animals are less densely

distributed--less than 65 sq km of upland Park habitat types will be affected; whereas the total Park area is about 8,000 sq km). Species which will be slightly affected will include hyaena, serval, leopard, lion, aardvark, red river hog, bubal, duiker, roan, oribi, reedbuck, buffalo, eland, and bushbuck. The wild hunting dog will be moderately adversely affected because the area inundated includes habitat where it can range relatively unmolested by humans.

- Blockage of return annual movements will be detrimental to a few species. None of the Park's large mammals exhibit definitive migration habits, but there seems to be a dispersal of lion, bubal, roan, buffalo and possibly eland at the beginning of the rainy season, and a general return movement after the rainy season. The exodus will not be impaired except during exceptionally wet years because the reservoir will be at lowest drawdown level, projected to be nearly at the present river channel. However, when animals attempt to return later in the year, they will encounter a substantial lake, which will continue to expand for several weeks. Although all of these species are capable of swimming, and the lake will be easier to swim than a fast flowing river, it is not known whether the animals will decide to cross or remain on the south bank. Animals remaining will be much more susceptible to hunting. Eland are known to utilize the south bank locality, and if a substnatial number are ever trapped on that side, the impact might well be moderate to severe.
- The relocation of the Wuroli-Bangare road in the Park because of inundation will be detrimental due to further disturbance and loss of habitat within the Park. This will have slightly negative effects on elephant because this is a preferred habitat area. Corollary impacts such as increased poaching are not expected since this work will undoubtedly be done by or closely supervised by Park personnel.

6.3.3.2. Birds.

6.3.3.2.1. Construction zone. The clearing of construction and service areas will remove nesting and feeding areas for some members of 100-150 bird species. The number will vary from year to year, due to the mobility of birds and to the changing nature of the existing habitat. All of the species likely to be found as residents or transients are distributed through most of the upper part of the Basin, within and outside the National Park.

Landscaping, usually performed by construction contractors around offices, workshops and residences, will provide support for 20-30 species of birds common to disturbed areas throughout the Basin.

6.3.3.2.2. Reservoir Area. The ultimate result of habitat loss always is population decrease, but the mobility of birds often means that they move into marginal habitat or seek appropriate habitat some distance (tens of kilometers, often) away. No two of the more than two hundred bird species found in the Kekreti Reservoir inundation zone will react in precisely the same manner, but certain mechanisms of population reduction will occur repeatedly.

- Reduced breeding. As habitat is gradually altered or destroyed, the individuals remaining in place may cease to reproduce, although they may survive normally.
- Emigration to adjacent habitat. Species inhabiting riverine forest, for instance, will move along the riverine corridors as trees die from gradual encroachment of the reservoir. This will result in crowding of species into available adjacent habitat and this, in turn, to higher losses to predators, higher juvenile mortality, susceptibility to disease, and other factors that will gradually reduce bird populations in the adjacent areas to about the levels that they were before the influx of displaced individuals.

The end result of the removal of 338 km^2 of assorted habitats will be an overall reduction in the populations of most bird species. Numercially the reductions will vary with abundance and flexibility of habitat requirements. A small songbird such as the red-checked cordon-blue (Estrilda bengala) attains densities of several pairs per hectare in suitable habitat (open woodland and savanna) and a total reservoir area population of 100,000 individuals is not unlikely. Other species, such as the West African goshawk (Accipiter tousseneli), are restricted to closed forest and occupy fairly large home ranges, so that the entire reservoir area might contain only 40 to 50 pairs of the species.

Considered in terms of the total bird population, the loss of 33,800 hectares of various habitats probably means a reduction of one to two million birds, possibly more. While the figure seems large, one must bear inmind that bird populations undergo annual turnovers of up to 60 percent through natural mortality and replacement.

Viewed in the regional context, the decreases in individual species are not severe. No species found in the reservoir area is restricted to it; on the contrary, all birds known from the project area are widespread in eastern Senegal.

A small number of bird species may be expected to benefit from the habitat changes brought about by inundation. These are principally:

1. Waterbirds. Gulls, terns, some ducks, herons, spoonbills, ibises, some palaearctic waders (migrants), some kingfishers, the fishing eagle, and a few other species will find the reservoir margins and open water suitable for feeding and, in some cases, nesting. Fish eating birds and carrion feeders will be attracted to the powerhouse discharge area to feed on fish killed or stunned by passage through the turbines.
2. Bark-foragers. Woodpeckers, wood-hoopoes, and some warblers and thrushes will feed on insects flourishing on the dead trees killed by inundation. Some may actually live entirely in the inundation area; others will make daily or seasonal movements in and out of the area.

6.3.3.3. Reptiles. As with birds, the destruction and alteration of habitat will negatively affect several dozen species of snakes and lizards. Unlike birds, reptiles suffer direct mortality from land clearing activities, through exposure to men and machines and occasionally from the burning of brushpiles. Large snakes, whether dangerous or not, usually are killed on sight by construction workers.

A few species of lizards (Agama agama, Mabuya species, and some geckoes) are able to survive and even increase in developed areas, even within buildings. As weeds and shrubs become established in the work area, these reptiles will also become established, as they have in urban areas throughout the Basin.

6.4. Operation Phase

6.4.1. Vegetation

6.4.1.1. Structures. There is no reason why operation of the Project should exert any continuing adverse effects on vegetation around Project structures. Downstram, the silt-free water released from the reservoir will wet the outsides of bends faster than the river is wetting at present. Slumping by the banks is likely to take out quite a few large trees along the bank.

The operating work force and resettled residents of the reservoir area are likely to have a substantial adverse effect on forest resources around their residences, unless they are given the opportunity to buy cheap alternate fuels. Livestock of the resettled residents will accelerate the process of deforestation by the related dry season fires started for pasture improvement.

6.4.2. Wildlife

6.4.2.1. Mammals. The impacts of the operational Project on mammals are expected to stem from the mode of operation of the reservoir, the actions of Project vehicles, the transmission of high voltage electrical energy, and the behavior of the operating staff. Of the mode of operation, we know only that the combined functions of downstream flow augmentation and power generation will draw the reservoir down by the end of the dry season to about one-seventh of its area. The impacts of the operation phase on mammals are summarized in Figure 6.2.

6.4.2.1.1. Flow effects.

- Retention of sediment in the reservoir will reduce the downstream silt load and increase the erosivity of the water. This will result in less turbid water, with lower nutrient levels. We cannot say at this time whether the lower nutrient levels will be offset by increased light penetration or whether there will be a decrease in productivity. If the latter occurs and results in reduced macroinvertebrate densities, there would be a slight negative impact on the clawless otter and some other small carnivores, and on vervet monkeys. A decrease in aquatic vegetation would have a slightly adverse effect on hippo and waterbuck.
- Reduced sediment load downstream also will increase streambank and bed erosion. Bank erosion, if severe, would cut into the riverine forest and adversely affect red colobus monkeys. The same bank erosion would be slightly beneficial to elephant, hippo, buffalo, and many antelope, by providing improved access to the water. Over many years, the river would develop oxbows, which would provide improved off-channel habitat for waterbuck, kob, reedbuck, and buffalo.
- The increase in erosivity of the water also will result in removing some sandbars, a slight negative impact on the many mammals that use the bars: vervet and patas monkeys, baboon, otter and other small carnivores, warthog, red river hog, hippo, bubal, roan, waterbuck, kob, reedbuck, bushbuck, and buffalo.

6.4.2.1.2. Reservoir effects.

- Reservoir drawdown, which will create some large expanses of unvegetated bare ground, will present a hazard to species (most ungulates) that must cross it to reach water, but will be slightly beneficial to the larger carnivores (lion, hyaena, wild hunting dog), providing there are enough boulders around for hunting cover. The experience of Kariba Reservoir, Zambia, indicates

Figure 6.2

Mammal Species Impact Identification Matrix — KEKRETI — OPERATIONAL PHASE

Activity →	Operation of Dam & Physical Plant									Use of Road Ways					
Impacts → / scientific name	Bright security lights around dam site	Maintenance of low flow release	Retension of sediments behind dam (in reservoir)	Erosion of stream banks	Erosion/removal of sand bars	Annual drawdown foreshore exposure	Permanent blocking of previous river crossings	Increased amounts and distribution of water	Injury/death from turbine intack structures/floodgates		Mortality from animal-vehicle contacts - high speed roads	Mortality from animal-vehicle contacts - low speed roads	Incidental poaching	Roadside riparian	common names
COLOBUS BALIUS				●		⬤									REU COLOBUS MONKEY COLOBE BAI
CERCOPITHECUS AETHIOPS			●		●	●					●		●	○	VERVET MONKEY SINGE VERT
ERYTHROCEBUS PATAS					●						●		●	○	PATAS MONKEY PATAS
PAPIO PAPIO					●						●		●	○	BABOON BABOUIN DE GUINEE
PAN TROGLODYTES															CHIMPANZEE CHIMPANZEE
CANIS SPP.											●	●	●	○	JACKAL CHACAL
LYCAON PICTUS						◯					⬤	●	⬤	●	WILD HUNTING DOG LYCAON
AONYX CAPENSIS		⬤	●	●	⬤	●		○	●						CLAWLESS OTTER LOUTRE A FOUES BLANCES
CARNIVORA (small)			●		●	●					●	●		○	SMALL CARNIVORES*
CROCUTA CROCUTA						◯									SPOTTED HYAENA HYENE TRACHETEE
FELIS SERVAL						●					●		●	○	SERVAL
PANTHERA LEO						◯							●		LION LION
PANTHERA PARDUS						●							●	○	LEOPARD PANTHERE
LOXODONTA AFRICANA		●		○		●									AFRICAN ELEPHANT ELEPHANT D'AFRIQUE
ORYCTEROPUS AFER	●														AARDVARK ORYCTEROPE
PHACOCHOERUS AETHIOPICUS				○	●						●	●	●	○	WARTHOG PHACOCHERE
POTOMOCHOERUS PORCUS				○	●	●							●		RED RIVER HOG POTAMOCHERE
HIPPOPOTAMUS AMPHIBIUS		●	●	○	●	●		○							HIPPOPOTAMUS HIPPOPOTAME
ALCELAPHUS BUSELAPHUS		●		○	●	●	○				●		●	○	BUBAL HARTEBEEST BUBALE
CEPHALOPHUS SPP, SYLVICAPRA GRIMMIA						●					●	●	●	○	DUIKERS CEPHALOPHE,
HIPPOTRAGUS EQUINUS		●		○	●	●	○				●		●	○	ROAN ANTELOPE HIPPOTRAGUE
KOBUS ELLIPSIPRYMMUS		●	●	◯	●	●	◯						●		WATERBUCK COBE DEFASSA
KOBUS KOB		●		◯	●	●	◯						●		KOB ANTELOPE COBE DE BUFFON
OUREBIA OUREBI											●	●	●	○	ORIBI OUREBI
REDUNCA REDUNCA				◯	●	●							●		REEDBUCK COBE DES ROSEAUX
SYNCERUS CAFFER		●		◯	●	●	○						●		AFRICAN BUFFALO BUFFLE D'AFRIQUE
TRAGELAPHUS ORYX		●		○		●	◐						◐		GIANT ELAND ELAND DE DERBY
TRAGELAPHUS SCRIPTUS		●		○	●	●					●	●	●	○	BUSHBUCK GUIB HARNACHE

*GENETTA, CIVETTICTIS, HERPESTES, MUNGOS, ETC.

Figure 6.2

Mammal Species Impact Identification Matrix **KEKRETI** **OPERATIONAL PHASE**

Activity → / IMPACTS → / scientific name	Continuation of Village: Incidental poaching by resident staff	Subsistance hunting by residual worker population	Habitat distruction from fuelwood cutting etc.	Raze and rehabilitate construction village	Remand control to local inhabitants, new migrants	Transform village to a regional facility		Transmission Lines: Annual right-of-way vegetation control	Incidental poaching during inspections	Electrocution					common names
COLOBUS BADIUS	●	⬤	●	○	⬤										RED COLOBUS MONKEY COLOBE BAI
CERCOPITHECUS AETHIOPS		●			●					●					VERVET MONKEY SINGE VERT
ERYTHROCEBUS PATAS		●			●	●				●					PATAS MONKEY PATAS
PAPIO PAPIO		●			●	●				●					BABOON BABOUIN DE GUINEE
PAN TROGLODYTES															CHIMPANZEE CHIMPANZEE
CANIS SPP.		●		●	●	○									JACKAL CHACAL
LYCAON PICTUS				○	⬤	○		●	●						WILD HUNTING DOG LYCAON
AONYX CAPENSIS	●	●				○									CLAWLESS OTTER LOUTRE A FOUES BLANCES
CARNIVORA (small)		●				○									SMALL CARNIVORES*
CROCUTA CROCUTA				●	●			●							SPOTTED HYAENA HYENE TRACHETEE
FELIS SERVAL		●			●			○							SERVAL
PANTHERA LEO	●	●		○	●	●			●						LION LION
PANTHERA PARDUS	●	●		○	⬤				●						LEOPARD PANTHERE
LOXODONTA AFRICANA	⬤	⬤		◯	⬤	○		⬤	●						AFRICAN ELEPHANT ELEPHANT D'AFRIQUE
ORYCTEROPUS AFER															AARDVARK ORYCTEROPE
PHACOCHOERUS AETHIOPICUS	●	●			⬤										WARTHOG PHACOCHERE
POTOMOCHOERUS PORCUS		●	●	○	●	●		●							RED RIVER HOG POTAMOCHERE
HIPPOPOTAMUS AMPHIBIUS	●	●			●	○									HIPPOPOTAMUS HIPPOPOTAME
ALCELAPHUS BUSELAPHUS	●	●	●	○	⬤	○		○	●						BUBAL HARTEBEEST BUBALE
CEPHALOPHUS SPP, SYLVICAPRA GRIMMIA		●	●		●				●						DUIKERS CEPHALOPHE,
HIPPOTRAGUS EQUINUS	●	●	●	○	⬤	●		○	●						ROAN ANTELOPE HIPPOTRAGUE
KOBUS ELLIPSIPRYMMUS	●	◑		◯	⬤	●		○	●						WATERBUCK COBE DEFASSA
KOBUS KOB	●	◑		◯	⬤	●		○	●						KOB ANTELOPE COBE DE BUFFON
OUREBIA OUREBI		●			●			○	●						ORIBI OUREBI
REDUNCA REDUNCA		●		○	●										REEDBUCK COBE DES ROSEAUX
SYNCERUS CAFFER	●	●		◯	⬤	●		○	●						AFRICAN BUFFALO BUFFLE D'AFRIQUE
TRAGELAPHUS ORYX	◑	●		○	◑	●			●						GIANT ELAND ELAND DE DERBY
TRAGELAPHUS SCRIPTUS	●	●		○	●				●						BUSHBUCK GUIB HARNACHE

*GENETTA, CIVETTICTIS, HERPESTES, MUNGOS, ETC.

Figure 6.2

Mammal Species Impact Identification Matrix **KEKRETI** **OPERATIONAL PHASE**

Reservoir Use Activities → IMPACTS / scientific name	FISHING LIVESTOCK HUSBANDRY: Displacement disturbance of wild animals	Increased poaching	Other human-wildlife conflicts	Wildlife-livestock dry season forage competition	Domestic-wild animal disease exchange	Increased prey for predatory species	Increased hunting by headers		AGRICULTURAL DEVELOPMENT: Loss of wildland habitat	Displacement/disturbance of wild animals	Increased poaching due to increased human population	Alternative food supply for certain wild animals	Active harassment of crop depredating species	Mortality of crop depredating species	common names
COLOBUS BADIUS															RED COLOBUS MONKEY COLOBE BAI
CIRCOPITHECUS AETHIOPS											●	◯	●	●	VERVET MONKEY SINGE VERT
ERYTHROCEBUS PATAS											●	◯	●	●	PATAS MONKEY PATAS
PAPIO PAPIO											●	◯	●	●	BABOON BABOUIN DE GUINEE
PAN TROGLODYTES															CHIMPANZEE CHIMPANZEE
CANIS SPP.		●		○	○	○					●	○	●	●	JACKAL CHACAL
LYCAON PICTUS	●	●	⬤	○	○	◯	⬤		⬤	●					WILD HUNTING DOG LYCAON
AONYX CAPENSIS		●	⬤												CLAWLESS OTTER LOUTRE A FOUES BLANCES
CARNIVORA(small)			●								●	◯	●		SMALL CARNIVORES*
CROCUTA CROCUTA				○	◯	○	⬤			●					SPOTTED HYAENA HYENE TRACHETEE
FELIS SERVAL			●			○	●				●	○			SERVAL
PANTHERA LEO	●	●	●	○	○	○	⬤		●		●				LION LION
PANTHERA PARDUS		●		○	○	○	⬤				●				LEOPARD PANTHERE
LOXODGNTA AFRICANA	○	⬤					●		●	○	⬤		○	⬤	AFRICAN ELEPHANT ELEPHANT D'AFRIQUE
ORYCTEROPUS AFER							●				●				AARDVARK ORYCTEROPE
PHACOCHOERUS AETHIOPICUS		●			⬤	○					●	◯		●	WARTHOG PHACOCHERE
POTOMOCHCERUS PORCUS	●	●			⬤	○	●		●	○	●	◯	○	⬤	RED RIVER HOG POTAMOCHERE
HIPPOPOTAMUS AMPHIBIUS		●	⬤	●					●		●	○		⬤	HIPPOPOTAMUS HIPPOPOTAME
ALCELAPHUS BUSELAPHUS	●	●		●	●		●		●	○	●	○		●	BUBAL HARTEBEEST BUBALE
CEPHALOPHUS SPP, SYLVICAPRA GRIMMIA		●			●	○	●				●	○		●	DUIKERS CEPHALOPHE,
HIPPOTRAGUS EQUINUS	●	●		●	●		●		●	○	●	○		●	ROAN ANTELOPE HIPPOTRAGUE
KOBUS ELLIPSIPRYMMUS	●	☽		☽	●		●		☽	○	☽	○		●	WATERBUCK COBE DEFASSA
KOBUS KOB	●	☽		☽	☽	○	●		☽		☽	○		●	KOB ANTELOPE COBE DE BUFFON
OUREBIA OUREBI		●			●	○	●				●	○		●	ORIBI OUREBI
REDUNCA REDUNCA		●		●	●	○	●				●	○		●	REEDBUCK COBE DES ROSEAUX
SYNCERUS CAFFER	●	●		●	☽		●		●	○	●				AFRICAN BUFFALO BUFFLE D'AFRIQUE
TRAGELAPHUS ORYX	●	☽		●	☽		☽		●	○	☽				GIANT ELAND ELAND DE DERBY
TRAGELAPHUS SCRIPTUS		●			●	○	●				●	○		●	BUSHBUCK GUIB HARNACHE

*GENETTA, CIVETTICTIS, HERPESTES, MUNGOS, ETC.

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that the upper portion of the drawdown zone will begin to support annual grasses after about ten years of reservoir life (T. Suidder, pers. comm., 1985). If this does occur, it will provide good grazing land for livestock on the south bank and for wild ungulates on the north bank. Red colobus monkeys will suffer a moderate impact because the areas of water will have no large trees for protection in access.

- The reservoir, when full, will present a barrier to some wide-ranging antelope. If this keeps the animals in the National Park, as probably would be the case with bubal and roan antelope, there would be a slight to moderate benefit from the reduced contact with hunters and with diseased livestock. For species (e.g., eland) whose migration patterns place them south of the reservoir when it is full, the impact would be moderately adverse if it denies them access to the sanctuary of the National Park.
- Increased aquatic habitat will be of benefit (slight to moderate) only to otter and hippo. Since these is virtually always enough water in the Gambia River (even in the late dry season, when surface flow nearly ceases and the river is largely a series of pools), additional water will not provide much benefit.
- The spillway gates and trashracks may prove a hazard to otter, which also might pass over the spillway and be injured. It is unlikely that these agile animals would be injured at the trash-racks.

6.4.2.1.3. Roads.

- The access road to the Project will continue to present some risk to the more common and mobile wildlife species, but the relative scarcity of road kills elsewhere in Senegal makes us believe that this impact will not be severe. If any of the few remaining wild hunting dogs should be killed, that would be a moderately severe impact. Road kills on the slower Project roads will be less than on the main road but may slightly impact jackal, wild hunting dog, small carnivores, warthog, and small antelope (duikers, oribi and bushbuck).

- Continued growth of the "roadside riparian" strip will provide slight benefits for most species. An exception would be the wild hunting dog, which has a higher risk of being shot.
- Incidental poaching from the improved roads poses a slight risk to all "huntable" animals.

6.4.2.1.4. Operation staff.

- Incidental poaching by the operational staff or by residual or unemployed workers for the usual game and non-game species would be a slight, adverse impact. If this should include elephant, the impact would have to be considered severe and if eland were taken the impact would be moderately adverse. If this hunting should reach commercial proportions, some of the species more easily taken (waterbuck, kob) could be impacted.
- Fuelwood cutting by the operational staff and others could have some effect on the local forest, but it would not be great.

6.4.2.1.5. Transmission lines.

- Control of vegetation along the transmission line could take many forms. Most likely, it will consist of a combination of labor-intensive land clearing around the towers and burning in between. Performed annually this would maintain the corridor in a permanent grassland condition. The clearing/burning would negatively affect elephant, wild hunting dog, hyaena, and red river hog through habitat alteration and disturbance. The edge effect of plant regrowth would provide a slight benefit to some ungulates (bubal, roan, waterbuck, kob, oribi, and buffalo) and the increase in small mammal populations would slightly benefit the serval.
- Poaching by transmission line inspection and maintenance personnel would slightly impact trophy and food species: lion, leopard, elephant, bubal, roan, duikers, waterbucks, kob, oribi, buffalo, eland, and bushbuck.

- Electrocution on the power lines will pose a slight risk to baboons and vervet and patas monkeys. The extent of this risk will depend in large measure on the transmission voltage and the line spacing.

6.4.2.1.6. Impacts of reservoir fishing. We assume that there will be changes in the land use permitted on the south bank of the reservoir. We consider it unlikely that Park authorities will be able to exclude fishing, livestock, and recession agriculture from the south bank area, as they do now. Population pressure and new access roads will lead to penetration and frequent use of the south side of the reservoir.

- Fishermen operating from the south bank will adversely impact wildlife by frightening the animals from reservoir edge habitat and by poaching. The species affected will be diverse. All meat animals and furbearers are likely to be taken when seen, as well as some, such as wild hunting dog, lion, and hippo, which are shot out of fear. The impact on eland could be moderately severe, if these animals are trapped on the south bank. Elephant would be at substantial risk if any are present on the south shore.

6.4.2.1.7. Livestock.

- The competition between livestock and wild ungulates for fodder will exert a slight, negative effect on wildlife. If this competition weakens either domestic or wild stock to the point of starvation, lion, leopard, hyaena, wild hunting dog and jackal will benefit.
- The potential for transfer of diseases from domestic to wild stock has been a concern of Park authorities for years. If there is increased contact or shared browse plants and drinking water between the two groups, the probability of transfer is increased. This would exert a moderate impact on warthog, red river hog (swine fever), kob, and eland. The last is especially vulnerable to rinderpest and could be severely impacted.

- The herders themselves also will pose a threat to wildlife, largely through poaching. Some will be done under the guise of herd protection. Poison will be employed, as well as guns, against carnivores. All of the ungulates, hippo, and even aardvark, will be taken when seen. The impact will not be severe from this source alone but will be added to other forms of pressure felt by these species.

6.4.2.1.8. Agriculture. We believe it likely that the presence of the reservoir will cause some increase in agricultural activity along the southern margin and, as recession farming, within the reservoir as the water recedes. Like fishing and livestock herding, which may constitute other activities of the same people, agriculture will increase the contact between man and wildlife, with the attendant problems of habitat destruction, poaching, and predation.

- Habitat loss will affect all wildlife species, but especially wild dog, which always suffers from human contact.
- Increased poaching and shooting over crops will slightly affect many species: all ungulates, monkeys, warthog, red river hog, and some carnivores, such as jackals. The impact on red river hog and hippo will be more severe.
- Conversely, the same species that are at risk of being shot or trapped as crop predators will derive moderate nutritional benefits from the availability of additional food. The species benefiting will be monkeys, rodents, warthog, and red river hog. Predators of these species will benefit slightly.

7. POTENTIAL IMPACTS OF KOUYA AND KANKAKOURE DAMS

7.1. Characteristics of the Projects

The Kouya and Kankakoure Projects are so close to one another (about eight kilometers) that they probably will share certain structures, such as access roads, the workers' camp and transmission lines. Our impact assessment assumes that the proximity of the two projects will be taken into account when each is designed.

7.1.1. Kouya

The Project consists of a dam and spillway on the mainstem Gambia River some six kilometers upstream of its confluence with the Litti. The site is about 14 km west of the main road from Medina Salambande to Balaki. The general characteristics of the dam given in the Polytechna report, plus some characteristics common to nearly all hydroelectric projects, form the basis for our environmental analysis.

7.1.1.1. Dam, spillway, powerhouse. An earthfilled dam about 100 meters high and 1,600 m long at its crest will form a reservoir extending about 40 km upstream and having a maximum surface area of 116 km^2. The powerhouse will be located at the downstream face of the dam. We assume that the spillway will be an integral part of the dam, rather than, as preferred, discharging into a separate drainageway.

7.1.1.2. Work area for main features. For impact analysis, it is necessary to determine the location and extent of land that will be cleared for the Project. Assuming that the dam has a 1:2 slope on both the upstream and downstream faces, the base of the dam will cover about 75 hectares, which may be taken at 100 ha to cover peripheral clearing. The diversion tunnel or channel to pass the river around the dam site will consume another 80-90 ha. Cofferdam construction and work areas at both abutments will require another 100 ha. Thus a reasonable estimate of land to be nearly totally cleared at the site would be 300 ha or 3 km^2.

7.1.1.3. Transmission lines. The prefeasibility report does not indicate the load centers to be served by the Kouya Project and Guinea has no national grid to receive the power. If power were sent to Mali, a new transmission line would be required, crossing some difficult country. Alternatively, power could be transmitted to proposed mining areas to the southeast.

7.1.1.4. Access roads. Connections with the rest of the country probably will be made through Medina-Salambande and Mali, which are connected by an existing road. The rough road that now leads from the main road (Balaki-Medina Salambande) to the dam site, a road distance of approximately 20 km, will have to be upgraded or perhaps rerouted if it is not to destroy Project vehicles.

Within the general Project area, roads will be required, connecting the dam site with the workers' village, shops, borrow areas and other Project subsites. A service road will follow the transmission line corridor unless the towers are placed by helicopter.

7.1.1.5. Airstrip. We believe that an airstrip capable of handing Short Take-Off and Landing (STOL) aircraft will be a necessity for this Project even with considerable helicopter transportation. The rugged nature of the terrain and the poor quality of regional roads will make it necessary for the contractor to fly in critical items of equipment and supplies and this can most economically be done by the use of STOL aircraft.

7.1.1.6. Workers' village. We estimate that the work force on this Project will comprise about 100 expatriates and 600 Guinean workers. Some expatriate heavy equipment operators, mechanics and service personnel may be replaced by Guineans if skilled operators are available. The workers village will house single workers and families, with some variation according to status, in dormitories and one- or two-family houses. Complete support facilities will be provided: schools, stores, church and mosque, recreation facilities (including tennis courts and football field). The total number of persons will be about 2,000 and the residence complex will cover or disturb about 200 ha. If agriculture is permitted, another 100 hectares will be cleared, possibly more.

The workers village will require electricity and domestic water. The former will be generated on-site and will be sufficient for construction requirements as well; this will require substantial diesel fuel. Domestic water probably will be drawn from the Gambia River pooled behind the cofferdam, treated and piped to dwellings. We assume that wastewater will be collected, given primary treatment (removal of ca 95 percent BOD), chlorinated and discharged into the Gambia River downstream of the project. Solid waste should be collected, salvaged if desired, and the residue incinerated.

We also assume that, in keeping with the usual practice on large projects, cooking by and for the work force will be performed with gas or other fuel supplied (or sold) by the Project.

7.1.1.7. Borrow areas. The total volume of the Kouya Dam will be roughly 16 x 10^6 m^3. This will consist of earth and crushed rock, with an impervious clay core. We are not told where these materials will be obtained, but it is a safe assumption that it will be as close to the Project site as possible, due to the economics of transportation. If suitable soil could be found a meter deep, 1,600 hectares of surface would be required. In reality, the rock portions of the dam probably will be obtained from thicker deposits, so it is more reasonable to expect somewhat deeper borrow pits and quarries, covering less than the 16 km^2 indicated above.

Additional fill will be required for the cofferdam, roads, airport and other areas. Often this type of fill (especially for roads) is obtained from road cuts. The net amount taken elsewhere, even assuming a graded landing strip 1,000 m long, will not be large when compared with the amount taken for the dam.

7.1.1.8. Resettlement and relocations. The land to be inundated by the Kouya reservoir is sparsely inhabited. Residents of the area, with their livestock, will be moved to other locations within the general area.

7.1.1.9. Operation. With a total water volume of 4,274 x 10^6 m^3, the Kouya Reservoir will store more water than Kekreti, and with a smaller surface area. The power pool (useful storage) will be 1,940 x 10^6 m^3. Depending on the requirements for downstream releases during filling, the reservoir will require at least three seasons of average flow (2,039 x 10^6 m^3) for initial filling.

During an average dry season of operation, the reservoir will be drawn down approximately 20 meters.

7.1.2. Kankakoure

This Project, as envisioned in the Polytechna report, will consist of an earthen dam on the Litti River about 10 km from that river's confluence with the Gambia. The powerhouse will be about 2,800 m downstream of the dam.

7.1.2.1. Dam, spillway, penstock. The dam will be somewhat smaller than the Kouya Dam, having a maximum height of 43 m and a crest length of 1,000 m. The reservoir will extend about 20 km upstream and will have a maximum surface area of 8.3 km^2.

7.1.2.2. Work area. The dam itself will cover about 10 ha of river bed and bank slopes; the penstock (assuming a 10-meter diameter with a 5-meter service road) will require a corridor some 15 m wide and 2,800 m long, or 42,000 m^2, 4.2 ha. The powerhouse and its construction area will require about 5 ha. The main dam abutment work areas and cofferdams will take about 100 ha, so a total area of project clearing at the site would be perhaps 150 ha.

7.1.2.3 Transmission lines. The question of transmission from Kankakoure is essentially like that of Kouya; whichever project is built first will establish the transmission system and the other will simply hook into it.

7.1.2.4. Access roads. The Kankakoure Project, being more spread-out than Kouya, will require somewhat more in site roads. The road connecting the Project with the primary national road network will be somewhat longer than that of Kouya.

7.1.2.5. Airstrip. The same airstrip is expected to serve both the Kouya and Kankakoure Projects.

7.1.2.6. Workers' village. Although the Kankakoure Project utilizes a smaller dam than its neighbor, the work force will not be much smaller, due to the greater complexity of the Project. The same workers' village and other support facilities could serve both projects.

7.1.2.7. Borrow areas. Being roughly the half the size of the Kouya Dam, the dam at Kankakoure will have one-eighth the volume, i.e., about 2×10^6 m^3. The borrow areas will be proportionately smaller.

7.1.2.8. Resettlement and relocations. The reservoir area of the Kankakoure Project appears to be as sparsely settled as that of the Kouya Project. Nevertheless, some hundreds of people will have to be resettled.

7.1.2.9. Operation. The total volume of water in the reservoir is estimated by Polytechna (1981) as 130×10^6 m^3, nearly all of it, 127×10^6 m^3, considered useful storage. With an average annual discharge in the Litti of 524×10^6 m^3, the reservoir will fill easily in almost any season. Drawdown during operation will lower the surface of the reservoir by up to 31 m, reducing the area to about one square kilometer.

7.2. Impacts

7.2.1. Kouya

7.2.1.1. Vegetation.

- Project infrastructure constructions: Table 7.1 summarizes the areas to be affected by construction activities at Kouya and Kankakoure projects. These areas are mostly forest areas (91 percent of the total) and the rest are rock outcrops. Any areas of agriculture are too small to be seen on the Landsat images. The closed forest area covers 805 ha with a total wood volume of 80,500 m^3 of which 16,100 m^3 can be considered commercial timber and the rest firewood. The open forest is estimated at 200 ha with 2,000 m^3 of timber and 10,000 m^3 fuelwood.

TABLE 7.1

AREA AND PRODUCTION IMPACTS OF KOUYA AND KANKAKOURE PROJECT INFRASTRUCTURE CONSTRUCTION

	Class Affected	Area (ha)	Timber (m^3)	Fuelwood (m^3)	Other Products
Closed Forest	(1.2)	805	16,100	64,400	small building
Open Forest	(1.3)	200	2,000	10,000	materials
Rock Outcrops	(4.4)	100			wildlife habitat
		1105	18,100	74,400	

The removal of closed and open forest areas will affect mostly wildlife since the area is lightly populated. The commercial wood will come mainly from remaining *Khaya senegalensis*, *Parkia biglobaia*, *Erythrophleum guineensis* and *Afzelia africana*.

The total amount of fuelwood that the area could provide, 74,400 m^3, is enormous and we foresee some problems in immediate demand for this wood. It is doubtful that the market value would meet the costs of transportation unless the wood is processed into less bulky and higher value charcoal. Also charcoal could be stored more easily than natural wood allowing local demand to utilize the material over a longer period.

Because of the rocky and rather steep slopes of the area we would expect an increase of soil erosion by rai . Even though erosion does not appear at present to be serious, the removal of the vegetation would cause potential erosion hazards (for a more detailed discussion see Van Krimpen, 1985).

- Work force effects on vegetation: We estimate that the work force will be made up of about 100 professional workers (mostly expatriates) and about 600 skilled and semi-skilled workers.

With dependents and support personnel, the number of people housed near the project may well reach 2,000. If a village of job seekers and hangers-on is allowed to develop, it will put demand on construction wood, firewood, and fronds and grass for thatch, fences, wild fruit and medicines.

Resettlement and Immigration to reservoir margins: Areas around the two reservoirs are sparsely populated and not too many people will have to be relocated. The main problem will come from the people immigrating to the area.

Tables 7.2 summarizes the areas that will be lost to flooding by the two reservoirs. A total of 12,430 ha will be flooded, of which 10,500 ha are classified as closed forest, 1,880 ha as open forest and 50 ha as rock outcrops. The closed forest has a total wood volume of 1,050,000 m^3, of which 210,000 m^3 is timber and the rest fuelwood.

TABLE 7.2
AREA AND PRODUCTION IMPACTS OF KOUYA AND KANKAKOURE RESERVOIR INUNDATION AREAS

	Class Affected	Area (ha)	Timber (m^3)	Fuelwood (m^3)	Other Products
Closed Forest	1.2	10,500	210,000	840,000	construction materials grazing, wild fruits and wildlife habitat
Open Forest	1.3	1,880	18,800	94,000	" "
Bare Areas	4.4	50			wildlife habitat
		12,430	228,800	934,000	

The amount of wood that will be lost due to inundation is substantial, especially in the Kouya reservoir area. Most of the commercially valuable wood in this area is Khaya senegalensis, Parkia biglobosa and some Parinari excelsa that may still remain in the most inaccessible places. The extraction of this wood will most likely take place using the road Balaki-Kedougou which will mean an increase of people settling along the road and creating further pressure on the vegetation and wildlife. We do not foresee an immediate impact on the area to the south of the proposed reservoir (towards Medina Salambande-Koubia-Labe) because of the rugged terrain and the present state of the road to the south of Kouya. However, this road will improve as work on the reservoir progresses and we will see a change of impact from the north to the south of the reservoir areas.

As it has been pointed out previously, there is agricultural activity in the area although the agricultural class does not appear in our estimate. This is due to the small sizes of plots and their difficulty of being resolved in the Landsat imagery. The Socio-economic Team has compiled field data in these areas that should help clarify this point.

The construction of the reservoirs will impact the vegetation of the area by deforestation and forest degradation. The removal of vegetation cover and its degradation will accelerate the loss of the already thin top soil in this rocky and steep area. The influx of people will create further demands on the forest for wood products, agricultural and pasture areas.

7.2.1.2. <u>Habitat impacts on wildlife</u>

7.2.1.2.1 <u>Mammals</u>. Impacts of the Kouya Project on mammals involve the same potential impacts as have been indicated for Kekreti, except that the Kouya area is more heavily forested and does not contain national park land.

- The elimination of closed forest by construction clearing and by inundation will affect monkeys, pangolins, some small carnivores and forest antelope, such as the duikers. We have no population-figures for these species, but the percentage of the total closed forest habitat affected is small.
- Illegal hunting by Project workers and, harder to control, by Guineans hoping to find project work, is going

to be difficult to control, as illegal hunting by local residents is at present.

7.2.1.2.2 Birds. As in all cases where a landscaped settlement replaces natural habitat, the workers' village will quickly be colonized by the dozen or so species most tolerant of human activity (see Balingho section). The destruction of about 200 ha of natural forest, as in all developments, will slightly reduce populations of about 100-150 species of birds.

- Francolins, stone partridge and doves may be hunted, legally or illegally, by some members of the work force, but it is unlikely that this will cause significant changes in the populations of game birds.
- The clearing of abut 300 ha of forest at and near the dam site will affect populations of about 100-150 species of birds. In the long run, these losses will combine with those attributable to the reservoir, which will be an order of magnitude greater.
- Most birds, even those unaccustomed to human activity, accommodate quite readily to noise, vehicles and lights. Some even learn to take advantage of some aspect of human activity to gain food or unusual shelter. With a few exceptions (bustards, some large raptors, touracos), most birds will be little affected by the construction activity when they are outside the area.
- Bird populations in the borrow areas will be adversely affected by habitat loss, as in other areas of land clearing.
- The cleared corridors of the transmission lines provide open hunting areas for certain bird species (hawks, eagles, rollers, bee-eaters, drongos) that use towers and wires for hunting perches. These same species also use low-voltage wires for hunting and resting perches.

- Depending on the spacing of wires, the tranmission line may place large birds at considerable risk of electrocution, through touching a charged wire while also touching a ground such as a tower. This risk occurs primarily on lines of 235 kV and below; the line spacing for higher voltages is too great for short circuiting by any but the very largest birds. In the North America and Europe, reported transmission line losses are primarily of eagles, vultures and large hawks.
- As in other areas of project activity, the primary impact of resettlement will be that of habitat change. If the displaced human population is settled on newly cleared agricultural land elsewhere, most indigenous birds will decline while the dozen or so "village birds" increase.
- The Kouya reservoir will inundate 10,250 ha of closed forest and 1,300 ha of open forest. Because the closed forest normally supports a higher density and greater diversity of birds, the number of species affected will be somewhat greater than at Kankakoure or Kekreti, where a greater proportion of the reservoir is thinly forested. The species in question, however, occur in similar habitat elsewhere in the Basin so the reductions have no special importance.
- When filled to maximum elevation or slightly drawndown, the reservoir will provide habitat for many waterbirds that now occur on the Gambia River. Standing dead trees will provide attractive perches for cormorants, anhingas, herons, ibises, storks and hammerkops seeking small fish and amphibians in shallow water. Ospreys, fishing eagles, and kingfishers also will utilize such perches. As the reservoir is draw down, the narrow

strip of mud at the edge will attract many waders that visit the basin throughout the dry season.

- Even when fully drawn down, the reservoir will continue to attract water birds, being the only large body of surface water around. Water trapped in depressions on the side slopes may continue to support waders.
- Below the dam, vultures, fishing eagles, herons and crows will be attracted to dead or stunned fish that have passed through the turbines. The size and number of such fish will be governed by the design of the trashracks at the intake.

7.2.2. Kankakoure

7.2.2.1. Vegetation. The impacts of the Kankakoure Project on vegetation are discused under Kouya, above.

7.2.2.2. Habitat.

- Mammals and Birds. We assume that this Project and the Kouya Dam will be constructed in a sequence that will allow the use of many of the same project facilities, possibly including the same work force.

  The Project being somewhat more dispersed than the Kouya Project, the habitat destruction will be a bit less intensive. Otherwise, the effect on mammals and birds will be similar: reduction of most species in the forest areas being disturbed and increases in the few species able to capitalize on man-induced changes.

  The effects of borrow areas will be essentially the same as f . Kouya and Kekreti.

8. POTENTIAL IMPACTS OF KOUGOUFOULBE DAM

8.1. Characteristics of the Project

The Kougoufoulbe Dam will be located on the Koulountou River, 8 km southeast of Koundara. It will store water for downstream dry season irrigation and also will produce hydroelectric power.

8.1.1. Primary Structures

An earthfill embankment dam will have a crest height of 37.5 m and a length of 1,000 m. Placement of the spillway has not been determined, but the site demands that it be close to or part of the dam. The powerhouse will be at the base of the dam.

The Polytechna report (1981) mentions irrigation conveyance works but these have not been designed.

8.1.2. Work Area

The dam will have a basal area of approximately 7.5 ha. With cofferdams and work areas at the site, about 150 ha will be cleared.

8.3.3. Transmission Lines

There being no national grid, the Project must be assumed to be serving the load centers closest to it: Koundara, Sambailo, Youkounkoun. This will change if any long distance network is established prior to Project operation. We are assuming that Guinea will adopt the 135 kV system proposed for Senegal, allowing the two countries to transmit power across the border. This would require a right-of-way about 100 meters wide.

8.1.4. Access Roads

The most likely access to the site will be by a Project road from the existing main road between Koundara. Other roads will be required to connect site components.

8.1.5. Workers' Village

The work force, which we estimate at some 100 skilled workers and technical staff and 600 laborers and semi-skilled workers, probably will be provided with a complete village somewhere between the site and the main road. As with the other projects, we assume that the residents will be provided all basic necessities: electricity, potable water, wastewater treatment, etc., without which the contractor probably could not retain his skilled workers. The entire residence complex with its support facilities will occupy about 200 ha.

8.1.6. Borrow Areas

The volume of the Kougoufoulbe Dam will be roughly 1.5 x $10^6 m^3$. This must be procured locally in the form of rock and earth, and transported to the site. The borrow areas probably will involve 100-200 ha of surface clearing.

8.1.7. Resettlement and Relocations

We know of no estimate of the number of people to be resettled from the inundation zone. Presumably, they will be given new land and homes in the general region of Koundara.

We know of no structures within the reservoir area that will have to be relocated.

8.1.8. Operation

The long, narrow Kougoufoulbe Reservoir will have a surface area of approximately 38 km^2 and a total volume of 450 x $10^6 m^3$. Its useful storage will be about 360 x $10^6 m^3$, slightly more than the river's average annual discharge of 353 x $10^6 m^3$. A minimum of two average seasons will be required for the initial filling of the reservoir and downstream water demand may stretch that to three or four seasons.

Utilization of the useful storage will draw the reservoir down about 15 m, reducing its surface area to about 11 km^2.

8.2. Construction Phase Impacts

8.2.1. Vegetation

The area to be directly affected by the construction activities (400-500 ha, including transmission lines) is about 80 percent closed forest. Two possible transmission routes were examined to Koubia and to Youkounkoun, both of which may be required. In each case the class most severely affected will be closed forest. This type of forest covers about 400 ha of the construction area with a total wood volume of approximately 40,000 m^3, of which 8,000 m^3 is considered timber and the rest fuelwood. There is about 40 ha of open forest with about 450 m^3 of fuelwood and 360 m^3, of timber. The riparian forest that will be impacted by construction activities is calculated at about 32 ha, with about 490 m^3 of commercial timber.

About 2 ha of savanna grassland will be affected by a transmission corridor toward Youkounkoun. The losses of these forest areas will mostly affect wildlife habitat. the commercial timber will come mainly from *Khaya senegalensis*, *Parkia biglobosa*, *Erythrophleum guineeusis* and *Afzelia africana*. There also will be some loss of palms, which means loss of house construction material and palm fruit. The loss of open forest will be felt mostly in terms of firewood. The amount of firewood that will be available at construction time, about 37,000 m^3, will more than meet local needs and the surplus may attract people from nearby centers such as Koundara, Youkounkoun, and Guingan. Unless strict control of firewood removal is exerted, one can expect a larger area to be affected than that required for construction.

Throughout the area there is bamboo, which is used by local people in many ways. The removal of vegetation in the construction area probably will create further pressure on bamboo stands in areas outside the Project area. The area also produces several gramineous (grasslike) species used for thatch and fence material. Some of these will be lost by the removal of open, riparian and grassland vegetation.

It is also estimated that 5 to 17 ha of agricultural land will be lost to construction. The main crops in this area are fonio, maize, and rice. The loss of vegetation to construction activities also will eliminate grazing areas.

8.2.1.1. Work force effects on vegetation. We estimate the work force at about 100 professional workers and abut 600 workers (skilled and semi-skilled). With support, service, and security personnel the total population may approach 2,500 people. This population will put the same kind of pressure on the land and other resources as discussed in Kekreti, Kankakoure and Kouya reservoirs.

8.2.1.2. Resettlement and immigration to reservoir area. The low population density of the reservoir area will ease resettlement problems, but one may expect the major problems to come from the people immigrating to the area. The number of people attracted to a major project by the lure of riches can exceed those on the work force. Lacking the amenities of fuel, packaged foods and shelter provided by the Project to its employees, job seekers and entrepreneurs will tend to live off the land.

8.2.1.3. Inundation Areas. Table 8.1 presents the areas that will be lost upon filling the reservoir. A total of 3,800 ha will be flooded, 96% of which (3,600 ha) is classified as closed and riparian forest and 4% as agricultural land. The closed forest, 3,590 ha, has a total wood volume of 359,000 m^3 of which 71,800 m^3 is commercial timber and the wood volume of 8,400 m^3 of which 1,050 m^3 is commercial timber and the rest fuelwood. The agricultural area, 140 ha, produces rice, maize and sorghum.

Table 8.1

AREA AND PRODUCTION IMPACTS OF KOGOUFOULBE RESERVOIR INUNDATION AREA

Class Affected	Area (ha)	Timber (m^3)	Fuelwood (m^3)	Other Products
1.2	3,590	71,800	286,400	construction materials, grazing, wild fruits and wildlife habitat
1.4	70	1,050	7,350	construction materials, grazing, wild fruits and wildlife habitat
2.2	140			rice, maize, sorghum
	3,800	72,850	293,750	

The total amount of timber, 73,000 m^3, is not great, especially when compared to the other areas in Kankakoure and Kouya, but the disappearance of habitat will compromise the wildlife of the area. Wildlife abundance evidently exists because of the low density of the human population -- estimated at 6 inhabitants/km^2 -- and the abundance of tributaries to the Kouregnaki which provide wildlife with shelter and food (especially the riparian forests). This will be drastically altered by the construction of the dam and the resulting influx of people to the area.

The total fuelwood that will be made available, 294,000 m^3, will attract people from the nearby population centers of Koundara, Youkounkoun and Guingan, creating further pressure on wildlife. It will have the benefit of easing the pressure on forest resources elsewhere, while the supply lasts at Kougoufoulbe. It would probably be necessary to convert most of this material to charcoal. This will permit storage of the material to increase the utilization period and to increase the economic transport range.

9. IRRIGATION DEVELOPMENT AREAS

9.1 Characteristics of the Projects

Some 70,000 hectares of land along the Gambia River has been identified as having potential for irrigation. In all, 110 potential sites have been studied at the appraisal level, most being between 200 and 2,000 ha. Water would be pumped from the river into one or more main canals, thence to secondaries and distributaries. The proposed sites lie adjacent to the Gambia River (or, rarely, to tributaries) from Farafenni, in the Gambia, to Wassadou, in Senegal Oriental. Feasibility analysis was not undertaken and some sites may prove to be infeasible for non-agricultural reasons. For example, left bank sites upstream of the mouth of the Koulountou lie inside Niokolo-Koba National Park, so would, we presume, be automatically excluded.

The AHT/HHL (1983) report graded sites from "very poor" to "very good" on the basis of land suitability Just over 60 percent were in the "good" or "very good" categories.

9.2 Construction Phase Impacts

Construction for irrigated agricultural development would involve the following major activities.

1. Land clearing
2. Land leveling
3. Construction of pumping facilities
4. Installation of irrigation and drainage systems to and from the indivdual farms.
5. Construction of access roads
6. Installation of support facilities such as storage, processing, transport and marketing.

9.2.1. Vegetation Changes

The irrigation development areas will be cleared of their natural vegetation. Vegetation types to be cleared vary from high forest to low brush types, depending on the specific area. These areas will be lost as a source of habitat and as a source of forest products of wood, fuel, fruit, etc.

9.2.2 Wildlife Habitat Changes

Wildlife that is dependent on the present vegetative cover as habitat will be excluded from the irrigation development areas. Wildlife to some extent will profit from these areas by using them as a food source. However, the species composition will change favoring those species that can benefit from the food source and also live in or adjacent to the irrigated areas. Pest species of mammals, birds and reptiles will become more numerous, depending on what control measures are implemented to control their numbers.

Loss of production from wildlife pests is a significant restraint to agricultural development. Such losses and the cost of pest control should be carefully studied and included in any agricultural development planning.

9.2.3. Other Impacts

Development of irrigated agriculture will increase the population density in and around these areas. There will be a corresponding increase in demand for fuelwood and construction wood for houses. This demand will impact the adjacent forested areas and cause some depletion of forest reserves. The extent of this depletion will depend on whether mitigation actions are included in project planning. Mitigative actions include establishment of fuelwood plantations and control over cutting in natural forested areas. If such actions are not integrated in the irrigation development, forest depletion adjacent to the development areas could be extensive.

9.3 Operations Phase Impacts

9.3.1. Vegetation

The increase in human population will most likely increase the density of domestic animals and the need for grazing land. Forest land is commonly pasture domestic animals in such circumstances and usually to the detriment of the forest vegetation. Although the domestic animals, by themselves, cause little permanent damage to the vegetation, the people will start brush fires to eliminate woody vegetation and improve grazing. These brush fires are the major cause of forest destruction in the Gambia River basin.

9.3.2. Wildlife

After the initial change in wildlife species composition to those that benefit from agricultural development, there will be a continual depletion of wildlife in adjacent areas. This will result from destruction of habitat from brush fires and from increased hunting pressure.

PART THREE

MITIGATION PROGRAMS

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PART THREE - MITIGATION PROGRAMS

10. BALINGO DAM

10.1 Construction Phase

10.1.1. Vegetation

Two types of mitigation actions are available to lessen the impacts of a project on vegetation resources: salvage of timber and fuelwood in areas where plant life is to be totally destroyed (reservoir, some work areas) and reduced clearing in or selective of rights-of-way, construction zones, and other areas where the total destruction of large plants may not be necessary.

10.1.1.1. <u>Reservoir Clearing</u>. The complete or partial removal of large trees from an area to be inundated often is assumed to be an inevitable project necessity. The decision to clear or not to do so usually is based on little actual data, but assumes one or more of the following benefits:

- Improvement of water quality in the reservoir, with benefits to fisheries, human health, and prevention of aquatic plant infestations.
- Removal of a potential source of debris, which might jam trash-racks and spillway gates.
- Facilitation of fishing with nets and lines.
- Provision of access for boat launching and navigation.
- Avoidance of unsightly dead trees along reservoir margins.
- Recovery of forest resources.
- Facilitation of animal rescue operations.

A number of variables within the natural and social systems of the project affect the cost/benefit analysis. Principally, these are:

- The type, especially the biomass, of vegetation to be inundated.
- The operating characteristics of the reservoir, especially the amount and frequency of flushing.

- The quality of inflowing water.
- Reservoir morphology, especially the average depth, and the relationship between flow and shape.
- Climate, especially average temperature.
- Available clearing methodology.
- Local and more distant demand for forest products.

Less understood by most decision makers, but nonetheless important, are the major arguments against clearing.

- Water quality effects are temporary and often are limited to a particular stratum of the reservoir (usually the bottom), where most of the organic matter accumulates.
- The removal of timber through a selective cutting program often creates more debris that is free-floating after inundation than would be present if the trees were left standing. Many tropical hardwoods remain standing and leafless for years and even decades after inundaton.
- The purported aid to fisheries has been shown to be illusory, since the fish preferentially inhabit areas of a reservoir with standing dead trees. Petr (1969) reported that fishermen in Volta Lake, Ghana, deliberately set their nets among flooded trees because of the higher catches obtained.
- Clearing costs, even in countries where labor is cheap, are high, an order of magnitude higher than the amount of benefits to be realized from the sale of timber or charcoal.
- Aquatic vegetation, especially water hyacinth, may be a severe problem but clearing alone will not prevent it.

Taken singly or collectively, the arguments in favor of completely clearing a resrvoir rarely justify the expensive programs frequently undertaken. The decision to clear the reservoir area usually is made without adequate analysis of costs and benefits, or of alternatives to clearing.

In the case of Balingho Reservoir, we do not recommend an extensive clearing program, for the following reasons:

- Water Quality. The density and biomass of the vegetation, the anticipated slow rate of die-off and the total annual flushing, are such that we do not foresee severe water quality problems in most of the reservoir. The situation will be different in areas of pure mangrove (Snedaker, 1984) where the die-off will be more sudden, but these are the areas in which clearing is most difficult.
- Debris. The riverine forest, if left standing, will not produce significant amounts of floating debris. Any that is produced can be easily passed through th spillway gates.
- Facilitation of Fishing. If necessary, narrow net lanes may be cut in areas of inundated forest. Most fishing, however, will continue to be done in areas of open water.
- Boat Launching and Navigation. We assume that all landings currently in service will be relocated if necessary, and that navigation will continue in the existing channels.
- Aesthetics. The unsightly dead trees along the margins of the new reservoir will provide perches for fishing eagles, palm nut vultures, and water birds. The trees themselves will, it is true, detract from the appearance of the shore as seen from tourist boats. However, the demise of the "Lady Chillel" leaves no tourist boat in existence on the Gambia River.
- Recovery of Forest Resources. Here is the best argument for clearing. The relatively low timber value of most of the floodplain trees, however, and the difficulty with which materials could be extracted make salvage of forest products unlikely to prove economical. We believe that encouraging local individuals and entrepreneurs to use the floodplain as a wood source, in lieu of upland areas, represents the most cost effective way of salvaging resources. It may prove desirable for the OMVG to contract to one entrepreneur the cutting and sale of fuelwood from the reservoir area.

Animal Rescue. Inasmuch as we do not see the need for an animal rescue operation (see below) this consideration does not apply. Moreover, a directed program of forest product salvage is likely to result in increased poaching by lumberjacks.

Recommendation: As soon as Balingho Dam Project becomes a certainty, the Government of the Gambia should open the floodplain forest from Farafenni to Kuntaur to cutting for timber and fuelwood. At the same time, enforcement of existing restrictions on cutting elsewhere should be tightened. This would encourage woodcutters to utilize the riverine resource.

The entire reservoir area within high water should remain open to wood cutting during the life of the project.

10.1.1.2. Placement of Structures. Habitat modification can be minimized by routing access roads and transmission corridors to avoid areas of closed forest. Sometimes a shift of a few tens of meters in an alignment can result in sparing many hectares of habitat.

Habitat preservation by this means requires a firm policy stance by the developing agency. It is not sufficient for the agency--in this case, the OMVG--to assert its interest in habitat protection; the stated policy must be disseminated to all individuals, within and outside the agency, who make decisions affecting habitat. These include the planners who lay out areas that eventually will be cleared, surveyors who stake the route in the field, and contractors who make spot decisions at the local level. If the habitat protection policy is to be effective, a wildlife ecologist or forester must participate in decisions involving the clearing of vegetation.

At the local level, the contractor must be held accountable for unnecessary destruction of vegetation. This includes "convenience" cutting of large trees, injuries by vehicles, unauthorized burning, and spoiling of debris and unwanted fill in areas being protected. Major international construction contractors are not known for their sensitivity to local ecology, as a glance at any large dam projct will show. The developing agency, therefore, must demonstrate its commitment to environmental mangement through placement of an environmental specialist on the long-term project team and by supporting that specialist when violations or conflicts are reported.

Recommendation: The OMVG ecologist should be at the construction site continually throughout the construction period. In addition to reviewing site plans and layouts, he should physically inspect all areas proposed for borrow pits, vehicle yards, office areas and other temporary clearance areas. Large trees that are not directly in the way of Project works should be tagged for protection, then provided the usual girdle of protective timbers so that they will not be subject to damage by trucks and other Project equipment. Project workers will appreciate the shade offered by such trees during the hot times of the year.

10.1.2. Wildlife

The broad Project policy of wildlife protection must be made known to and acknowledged by all employees. This can best be done by having each employee read and sign a policy statement, pledging to obey Gambian law and OMVG policy on wildlife protection. Employees who cannot read should have the declaration read to them and should acknowledge by the customary thumb print.

10.1.2.1. Access Road Mortality. Two types of animal mortality are foreseen: that due to strikes by vehicles and that due to illegal hunting.

Direct mortality from vehicle-animal collisions can be reduced by enforcing lower speed limits on stretches of road where animals are likely to be hit. Since these are areas where habitat exists on both sides of the road and especially where curves result in reduced visibility for both driver and animal, some protective measures are possible.

- Signs should be posted, as they are in Europe and the United States, alerting the driver to be potential for animal crossing.
- Animals can be guided to cross at desired points through habitat modification and placement of barriers at spots where crossings are undesirable.

Hunting by drivers of Project vehicles can be prevented by vigorously enforcing the laws prohibiting firearms. The construction contractor must brief incoming workers on this point. In the event that The Gambia resumes the issuance of gun permits prior to the close of construction, the contractor and local authorities must prohibit the carrying of firearms in project vehicles or in personal vehicles on Project property.

10.1.2.2. Cleared Area Habitat Loss and Mortality. Habitat lost to total site clearing for borrow and spoil ares, and for the workers' village cannot be replaced. In the long term, protection given to some other area of closed or open forest may compensate for these habitat losses and allow animal populations to recover somewhat.

The Project environmental specialist should be alert to be possibility that slow moving animals, such as pangolins or snakes, may be killed or injured by land clearing equipment or captured by workers. The more remote sites will require the physical presence of the environmental specialist (or a warden from the Wildlife Conservation Department) during initial clearing.

10.1.2.3. Impacts of the work force on wildlife. Negative impacts of subsistence hunting can be mitigated by vigorously enforcing existing laws. Monitoring village markets for bush meat and the movements of hunters (guns usually are openly displayed) by a resident game warden should reveal if this practice is substantial. Special attention should be given to identifying sitatunga areas (easily recognized by the distinctive hoof prints) and alertness to the sound of gunshots. Observers should also be regularly deployed to determine if manatees are concentrating, or if they are being taken by fishing nets. The construction company should make sure that their employees have access to good supplies of domestic meat.

Commercial poaching and increased local trade can be mitigated by education programs in the worker village and expatriate community and by regular inspections and harsh penalties for commercial trade. The assistance of the Farafenni customs officers can also be solicited because much contraband (except that acquired by expatriates) will be sent to Dakar, especially if the local market is kept closed. The frequent use of different local informers (or even agents hired from Banjul for one-month periods) to monitor the markets will greatly increase the effectiveness of the resident game warden, who will soon be well known. Regulations prohibiting pet wild animals, especially primates, should be rigidly enforced.

Wildlife-domestic animal disease exchange can be mitigated by routine veterinary inspections and vaccinations. The Gambia has a well-organized and effective animal health program, so this activity can be readily facilitated. The program should include inspection of immigrant livestock, including those pastured farther upstream in the reservoir, and regular rabies/distemper vaccinations for domestic dogs and cats.

Habitat destruction from fuelwood cutting could be mitigated by selecting authorized areas, under the direction of the Project Environmental Specialist, and, near the workers village, establishing tree thinning limits and periodic inspections. A more reasonable action would be to prohibit wood cooking and instead make inexpensive cooking gas available to all project families.

Injury to wildlife attracted to garbage cans be readily mitigated by proper garbage disposal and management which is assumed as a "given" for the workers village. This should be implemented for public health reasons as well.

10.1.2.4. River Diversion and Dam Construction. The species most likely to be affected by the project diversion and dam construction is the manatee. Although this species arouses little concern among most planners, it is protected by Gambian law and is internationally recognized as endangered. No mitigation activity can prevent disturbing and occasional killing of or injury to manatees from construction activities and increased river boat traffic, but some precautions could be taken. Manatee presence in the vicinity of river construction can be monitored to determine the severity of the impact. Additional knowledge acquired during this monitoring activity may suggest some partial mitigative measures, such as avoiding certain sides of the river where they concregate and proceeding with boats at lower speeds with a look-out in sensitive areas, or allowing boat traffic only during high water periods to maintain maximum distance between hull and river bottom (two meters preferable).

Adverse effects of channelization on manatees can be partially mitigated by maintaining the maximum width possible in the channel, and, whenever possible during construction, keep the channel open. This situation should be monitored.

Increase in downstream silt load caused by river bed construction activities will be monitored to protect fisheries and aquatic ecosystems (see Riverine Team Report). This monitoring program, we assume, will determine whether or not submerged vegetation will be affected (if so, adversely affecting manatees).

10.2.1.5. Reservoir Filling. The expected movement of animals away from the inundated floodplain, although hardly greater than currently occurs under annual flood conditions, will warrant monitoring by members of the Wildlife Conservation Department, since these animals will not be able to return to their riverine habitat. The more arboreal species will not be forced to move until the permanent inundation starts to kill trees, but their vulnerability to increased hunting should be considered.

Wildlife on the river islands should be carefully monitored, since ground feeding mammals such as the pangolin will suffer nearly complete loss of habitat. Another reason for increased vigilance on the part of the Wildlife Conservation Department is the likelihood that manatee will move into submerged portions of islands to feed on aquatic vegetation, resulting in greater vulnerability to poaching.

Recommendation: The Wildlife Conservation Department (WCD) should assign at least two additional full-time game wardens to enforce hunting regulations. They should work closely with the OMVG staff environmental scientist. Whether this additional financial burden on the already under-financed Conservation Department should be borne by the Project or through additional funding will have to be worked out between the OMVG and the WCD.

10.2 Operation Phase

10.2.1. Vegetation

10.2.1.1. Revegetation. Areas for which revegetation programs were begun during the construction phase of the Project will require continued protection. The Department of Forestry should be given jurisdiction over revegetated borrow areas.

10.2.1.2. Fuelwood and Timber. Salvage programs begun during the construction phase should be continued, to the extent that the resource remains viable.

10.2.2. Wildlife

10.2.2.1. Enforcement of Game Laws. If the Kiang West National Park is developed, it could serve as a headquarters for wildlilfe protection in the Balingho Reservoir. This will require the funding of a full-time professional warden and probably a field assistant/driver. A vehicle and a fast boat will be required as well.

10.2.2.2. Protection of Manatees. If, as expected, manatees are attracted to the dam and associated structures because these represent a source of fresh water, vigilance will be required to avoid injuring or killing these animals in the lock or the spillway.

Prevention of manatee injuries in the lock system requires only sensitivity and alertness on the part of the lock staff, to be sure that manatees are not in the lock chamber when vessels are locked through or behind the doors when they are opended. Experience has shown that locks can be operated in such a manner as to avoid injury to manatees. This will require an aware lock manager, willing to train and indoctrinate employees.

Avoiding injuries to manatees in spillway gates requires only that each gate not be operated with an opening of less than about one meter. A multiple-gate spillway system can be operated to avoid openings less than one meter high without compromising any objectives of spillway operation.

10.3. Monitoring and Further Studies

10.3.1. Vegetation

The construction of Balingho Dam will offer an exceptional, if not unique, opportunity to study the effect of salinity and water level changes on mangrove and riverine forest ecosystems. Information on the fate of trees and shrubs upstream and downstream of Balingho Dam would aid in future management of the reservoir area and, if published, would prove of aid in predicting and controlling the effects of salt barrages elsewhere. Adequately disseminated, the information would enhance the reputation of the OMVG as a technical agency.

Recommendation: We recommend that the OMVG join with The Gambia Forestry Department and the Wildlife Conservation Department to plan and conduct habitat studies in the Balingo Reservoir area and in the Kiang West area, where hopefully a national park will be established.

Study plots should be established in various habitat types and followed for at least two decades. It may not be necessary to gather the same data yearly over the entire time, but the interval of repeat data shold not exceed two years. The first season will require an exceptional effort, since each tree and shrub in each study plot will be identifed, marked, mapped, and measured. Health data and some physiological data (e.g., tissue salintiy) will be needed. Control plots, possibly in an adjacent basin (Saloum or Casamance) will be required in order to isolate project-related effects from changes due to climate or other causes.

10.3.2. Wildlife

Monitoring studies begun during the construction phase should be continued into the operation phase. As new information develops on certain species of wildlife whose ecology is poorly known (e.g., manatee, sitatunga), research programs should be developed to aid in management and to expand the general knowledge of those species.

If Kiang West National Park is developed, it could serve as a base for a coordinated research program covering the park and the reservoir area.

Recommendation: We urge the OMVG to work closely with the Wildlife Conservation Department to develop a joint program of wildlife research on the affected reach of the Gambia River. Areas of interest initially could be the ecology and movements of manatees and sitatunga, effects of the changing riverine forest on the various monkey species, and the ecology and numbers of waterbirds in the large breeding colony east of the mouth of Bintang Bolon. Some specific programs and studies that can be implemented are the following:

1. Improvement of veterinary services. Sufficient assistance to the Livestock Veterinary Service (part-time veterinarian expenses and additional fuel allocations) should be provided to insure that adequate inspections of immigrant herds and vaccinations of domestic pets can be accomplished. This should not require a resident veterinarian in the construction village, but will require regular visits and services. A modest sampling program to ascertain the incidence of certain diseases (such as trypanosomiasis) in the wildlife populations (especially warthog) should be included.

2. Protection of hippos and agricultural areas. Hippos are becoming increasingly rare in The Gambia and definitive actions will be required if the species is to survive. Since the Balingho development will adversely impact this species by inundating sizable areas of existing floodplain, and by providing easier access to the expanding agricultural zones where hippos are often shot for depredations, funding of certain efforts designed to conserve the species and protect croplands should be considered as a cost of the development. The survey of hippo centers and access routes can be conducted during the reservoir periphery survey. The primary expense will be a modest amount for materials and local labor used to construct and test devices which will deter or prevent hippos from entering fields.

3. Mammalian crop pest research and management. Large mammals, notably warthog, baboon, patas and vervet monkeys and hippos, are regularly identified by local farmers and government reports as being significant crop pest species in the Basin. Data collected during this study suggests that conservative estimates of damage to standing crops, both grains and

groundnuts, range between 5-10 percent. Unlike similar problems with small mammals and birds, no systematic studies have been undertaken either to determine the true magnitude of this problem, or to identify and implement control measures. If the true magnitude of crop damage by these large mammals even approaches the estimated amount, it is certainly an economic problem which will substantially affect the anticipated benefits of many of the proposed developments and continue to hinder the attainment of national goals of food self-sufficiency. Accordingly, it is recommended to instigate a study which will:

a) Gather both intensive and extensive original field data to enable an accurate numerical assessment of crop damage caused by large mammals.

b) Document and evaluate the effectiveness of those practices currently used to combat this problem.

c) Design and test minor modifications to these current practices which might improve their effectiveness.

d) Propose specific and practical measures which should improve crop protection at the local level, and

e) Prepare a plan for basinwide implementation which would include both member state and external intervention, if necessary, to test other new and innovative methods for crop protection and wildlife conservation.

4. Commercialized Exploitation of Warthogs. The abundance of this species in The Gambia, its status as a "vermin animal" on account of crop depredations, current laws which prohibit sport hunting and the issuance of gun permits, and the fact the majority of the populace do not use the warthog for food due to religious restrictions all combine to make this animal a nuisance species and at the same time an underexploited natural resource. Inquiries made during this study indicate that a commercial market exists in Banjul and elsewhere for the tourist (hotel) industry and expatriate community. It is recommended that a market analysis survey be made to determine the feasibility of a commercialized utilization program, with the goal of establishing a small, local business. If this survey is positive,

a wildlife biologist should be employed to design a sustained yield cropping program. Since a refrigerated or ice truck would be required, the feasibility study should also include the marketability of refrigerated or frozen products (such as saltwater fish) in the areas where the warthog will be taken.

If such a program can be realized, in addition to the establishment of a small local enterprise, farmers would benefit from a more cost-effective approach to protecting their fields by having a limited market for animals usually left to rot, and an economically detrimental species would have a positive monetary value.

5. Research and management for the manatee and sitatunga. The manatee and sitatunga are two rare species in The Gambia which have continued to survive in their aquatic and semiaquatic habitats while many of the large terrestrial mammals have been extirpated. Both of these species are, in effect; heritage species for the Gambia, with good opportunities for continued survival if adequate research can be accomplished to formulate rational management plans. Although suggestions for such studies were made more than eleven years ago, no progress was made until this study. Since both of these species will be sustantially impacted by the proposed development, it is recommended that some financial commitment be made to further their survival. Much of this research could be accomplished if the Project Environmental Specialist position is provided, with some additional short-term involvement from a manatee expert. It is further known that IUCN/WWF has interest in a joint study. Accordingly, it is recommended that both the financial assistance of IUCN/WWF and contributions from the project development funds be made to enhance the future of these two species.

6. Establishment of additional Gambia River Island wildlife sanctuaries. The possibility of establishing additional wildlife sanctuaries on selected Gambia River islands should be seriously considered. Although this would contribute to the conservation of numerous species, it would be especially beneficial for the sitatunga. Many of these islands are critical habitat areas for this species and the protection they afford, combined with the unique semiaquatic habits of the sitatunga, are the only

reason that the animal is still extant in the Gambian wilds. Most of the islands are used by people for various purposes, including <u>Raphia</u> and grasscutting for building materials; dry season grazing; agriculture and hunting. Pasari and Deer Islands, known sitatunga habitat for over 45 years, are reportedly used for all the above purposes except farming, and probably offer the most viable options as sanctuaries.

7. <u>Support for Kiang West National Park</u>. In view of the loss and alteration of habitat caused by the dam, it is recommended that the Balingho development provide some form of support for this National Park. In essence, it would constitute partial compensation for lost habitat. This support could take the form of a direct cash contribution to augment the funding anticipated from the Federal Republic of Germany; allocations of fuel and/or building supplies; free use of the construction company river boats to transport materials; or even heavy equipment assistance with road construction, fence and firebreak right-of-way; etc. The OMVG Environmentalist should take the lead in coordinating this assistance.

11. KEKRETI DAM

11.1 Construction Phase

Our recommendations in this section are predicated on the assumption that the OMVG will provide the Project with a full-time Project Environmental Scientist. This specialist would work with the contractor's staff to ensure that the environment is protected to the extent possible.

11.1.1. Vegetation

There are three types of mitigative activities under consideration that involve vegetation: reservoir clearing, control of unnecessary destruction of plant life, and revegetation.

11.1.1.1. Reservoir clearing. The pros and cons of clearing the Balingho Reservoir also apply to Kekreti, albeit weighted somewhat differently.

- Water Quality. The riverine forest will be the first plant community to be inundated and is the richest in organic matter. Nutrient levels will rise in the reservoir during the first season of filling, but we believe that the flushing action achieved by downstream releases will prevent severe eutrophication problems in the new reservoir.
- Debris. We have seen no published accounts of debris from flooded open forest (the predominant plant formation in the Kekreti area) causing difficulties at intake structures.
- Facilitation of Fishing. Some net lanes and boat launching areas could be created by selective cutting.
- Boat Launching and Navigation. The depth of the reservoir will be such that most of the canopy of the drowned forest will be far below the water surface by the second or third year of reservoir filling. Straight-line navigation should be possible in most parts of the reservoir.

- Aesthetics. Selective clearing of areas near tourist camps and near the dam may be desirable. Even in these areas, a few large trees should be left standing, to provide perches for some birds, such as fish eagles, herons, and waders, whose presence enhances the public perception of the area.
- Recovery of Forest Resources. Opening some areas outside the Park to commercial cutting for fuelwood or timber might result in some entrepreneurs salvaging some wood, especially during the construction season.
- Animal Rescue. The slow filling rate of the reservoir and the absence of low hills within it are expected to render an animal rescue operation unnecessary.

Recommendation: The OMVG should determine the need for construction timber and fuelwood in the construction areas and undertake a study to find out whether these needs can be satisfied from within the reservoir area. A selective cutting plan, restricted to areas outside the National Park, should result from that study.

Once a fisheries management plan has been developed for the reservoir, areas to be cut for net lanes and boat access should be incorporated into the selective clearing plan.

11.1.1.2. Selective clearing in construction areas. The OMVG should mark and protect large trees in all areas to be disturbed by construction. These trees will provide welcome shade for Project workers and will improve the appearance of the Project area post-construction.

We believe that a major consideration in the selection of the worker's village site and in its layout should be its intended post-construction use. In this regard, it should be considered in terms of the future planning of the region and of the National Park. Some possibilities are:

- Tourism. The dwellings provided the skilled workers would be suitable, with little modification, for housing tourists. This would be feasible, however, only if the National Park were to establish an entry point at the north end of the dam.

- Regional Education Center. More modification would be needed for this purpose than for tourists, since the types of buildings for a residence complex might not readily convert to classrooms.
- Regional Veterinary Center. Dwellings could be converted fairly easily into research and analytical laboratories, and would of course provide residences for the staff without modification. In this event, it would be necessary to plan the facility so that buildings that will remain residences (for the operating staff of the dam as well as the staff of the veterinary center) are somewhat apart from those to be used for livestock studies.

On the National Park side of the river, the Project Environmental Scientist should work closely with a responsible member of the construction contractor's staff to establish and enforce the limits of clearing at the right abutment of the dam. These limits should err on the side of conservation, rather than, as usual, on the side of clearing.

11.1.1.3. Revegetation. All borrow areas, spoil heaps, and other bare-earth areas not within the zone of innundation should be planted with native trees and shrubs according to a plan to be developed by the OMVG Project Environmental Scientist.

Advantageous reclamation of borrow pits can provide slight to moderate benefits to numerous species. This reclamation would entail modifying these disturbed landscapes to form water catchment basins which would seasonally provide a better distribution of water and forage in the upland habitat types. Monkeys and baboon, a variety of predators including the wild hunting dog, serval and leopard; and most antelope, especially the roan, waterbuck, kob, eland and bushbuck would all benefit from this resource enhancement measure.

11.1.2. Wildlife

11.1.2.1. Protection of National Park. The proximity of the main Project features to the Niokolo-Koba National Park, and the intrusion of the dam and the reservoir into the Park necessitate special protective measures to avoid or minimize impacts. These may be divided into several categories.

- Measures to strengthen National Park staff and those of other regulatory agencies.
- Measures directed at construction force personnel.
- Structural measures.

11.1.2.1.1. Staff augmentation. The presence of a major population center just outside the National Park will necessitate additional vigilance on the part of Park management. This should take the form of assigning special wardens to the section of the Park nearest the project. These should be drawn at least partly (senior personnel) from the regular Park guard staff, but new personnel should be hired to fill the vacancies created by these withdrawals.

The guard team assigned to the reservoir and dam area should coordinate their activities closely with the Project Environmental Scientist and with wardens of the Forest and Wildlife Service. The enforcement and conservation education plan for the Project will require the joint effort of all three entities.

Recommendation: The National Park administration should create a special Kekreti team of Park guards to manage wildlife and forestry impacts related to the Kekreti Dam Project. The team, comprising five or six men, should be led by an experienced senior staff member. It could be based at park headquarters or at the Project offices (there are pros and cons for each).

The Kekreti guard team should be provided with at least two vehicles and a boat. The men should be armed and have arrest powers.

11.1.2.1.2. Nonstructural conservation measures by the project. The OMVG and the construction contractor can accomplish a lot toward protecting wildlife inside and outside of the Park. Possible measures include weapons control and education.

Recommendation: All Project personnel other than the security force should be prohibited from possessing firearms in the Project area, except for rifles and shotguns registered with the Project administration and accompanied by valid permits to carry firearms. Such weapons should be stored by the administration in a secure vault, from which they may be removed only by their owners, only during the hunting season, and only by presentation of valid hunting licenses.

Recommendation: The OMVG Project Environmental Scientist and the staff of Niokolo-Koba National Park should develop and administer a program of environmental protection that will reach all levels of project personnel.

- Topics to be covered include respecting the National Park habitat and its animals; respect for, but not fear of, snakes; avoiding fires; avoiding contamination of soil and water; suppressing the sale of wild meat, skins, and pets by refusing to buy and reporting violators to authorities, reporting gunshots heard (or poachers seen).
- Methods of presentation should include all available means, but principally posters and talks. Wildlife movies could be used to raise consciousness. If there is a Project newsletter, wildlife articles should be a regular part of it.

11.1.2.1.3. Structural measures. The main structural means of protecting the Park from the project will be to create barriers at the points where the two come in contact. These barriers will keep construction personnel out of the Park and animals out of the construction area. At present, this seems likely to be needed only at the right abutment area of the embankment dam. Any other areas, such as borrow areas where one can walk across the river dry-shod during the dry season, should be similarly protected.

Recommendation: The periphery of the cleared area on the right abutment should be securely fenced. Chain-link fencing, two-meters high, with barbed- wire supported by V-post caps will be minimal; three meters high would be better. This should be provided with a securely locked gate for use of the Park's Kekreti guard team.

It is likely that clearing the work area will leave a jumble of logs and brush at the edge of the area. The fence should enclose this perimeter barrier, which will protect the fence from damage by vehicles.

Recommendation: The existing road between Wuroli and Bangare, in the Park, will be a relocation required of the Project. The routing of the relocated road should be discussed between the director of the National Park, the Project design engineers and the Environmental Scientist.

11.1.2.2. Wildlife protection outside the National Park. The basic principles applied to protect the Park's wildlife also apply outside the park, but with changed emphasis.

- Augmentation of Enforcement Staff. The game wardens of the Forest and Wildlife Service should be increased in number to counter the increased threat of poaching.
- Education. The conservation education program established for Project personnel should be broad enough to include local schools, posters and public movie sessions.
- Structural Measures. These will vary from one part of the Project to another.

A modest increase in the Forest and Wildlife Service enforcement personnel should be provided. This would comprise two or three additional wardens. The individual responsible for the sector would be assisted by the Project Environmental Scientist in:

11.1.2.2.1 Increased enforcement of game laws. Additional vigilance on the part of anti-poaching forces will be required if impacts on local wildlife are to be minimized. The Forest and Wildlife Service should appoint one of its local staff to work with the Project Environmental Specialist to dovetail enforcement with Project activities.

- Identifying areas in which additional vigilance by Forest and Wildlife Service will be needed, and the timing of operations in those areas. These would be areas of road construction, borrow or spoil, or reservoir clearing.
- Establishing lines of communication through which Project activities that might jeopardize wildlife are brought to the attention

of Forest and Wildlife Service and violations by Project workers are reported to the Project Manager. We suggest a system of regular monthly meetings to exchange such information.

11.1.2.2.2. Education. Programs to indoctrinate Project employees with respect for the National Park and its animals should not stop with the Park, but should generate a protective interest in wildlife everywhere. Such programs also should stress the risk to the employee or nonemployee who poaches: arrest, confinement and fines, and loss of Project job (if any).

One advantage of the increase in human population in the Project area is that it becomes more difficult to fire a gun without being heard. It is important that educational programs stress this fact and that Project staff and local people be urged to report gunshots heard.

Education also should take the form of wildlife conservation posters in public places such as markets and schools. Radio announcements and other media presentations also should be used. It is important that the public be made aware of enforcement activities, including convictions of poachers.

11.1.2.2.3. Structural measures. Animal protection can be achieved by some minor structures, especially fencing.

- Animal losses at garbage dumps can be minimized by controlling the discharge of garbage and other solid waste, through a collection and disposal system. Fencing the dump will discourage the entry of small mammals.
- Mammal deaths from vehicles on the access road can be minimized by preventing crossings at blind corners; this can be accomplished through fencing. A small section (10-20 m) of two-meter chain-link fence, placed parallel to the road will force the animals to cross where they can be seen at greater distance. Known crossing points should be marked with appropriate warning signs.

11.1.2.3. Actions pertaining to the river and reservoir

11.1.2.3.1. Diversion. Closure of the river for diversion around the damsite will be done during the dry season. For a day or two, probably, the flow will be completely blocked by the cofferdam, while the water level rises to the level of the diversion channel. The contractors' diversion plan should be carefully reviewed by the Project Environmental Scientist with an eye to ensuring the adequacy of downstream water supplies for wildlife and man.

11.1.2.3.2. Consumptive water use. We assume that all water used in construction will be drawn from the pool in the river behind the cofferdam. The amount of water used will be considerable and might be enough to significantly decrease the already weak downstream flow.

Recommendation: A water supply plan for the entire project should be drawn up in advance of construction, including both service (including site runoff) and domestic water. We understand that this is routine construction planning. This plan should also include the following elements.

- Minimum downstream release.
- Method of treatment of service water and site runoff. At the minimum, this water should be routed to a settling pond, (to remove most of the silt) for controlled discharge to the river downstream of the dam.
- Method of treatment of domestic wastewater. This should be given secondary treatment and discharged to the river.

The water use plan should be reviewed by the Project Environmental Scientist with attention to possible downstream impacts.

11.1.2.3.3. Discharge of seepage water. The work area on the river bed, isolated from the river by cofferdams upstream and downstream, will accumulate seepage water and, during the rainy season, a certain amount of surface runoff. There is always some service water discharged as well. Normally, such water is collected in a sump and pumped back into the river. At times of low flow, such water, laden with silt and often with pertroleum products, might substantially degrade the river downstream.

Recommendation: Water pumped from the cofferdammed work area on initial dewatering and subsequently, should be placed in a settling basin prior to discharge into the Gambia River. The basin should be placed on the south bank of the river in a location where it can be drained and re-vegetated after the project has been constructed. The basin should be sized to allow sufficient residence time for the silt to settle from the water.

11.1.2.4. Transmission lines. We have already noted that traversing the National Park with the transmission line would be an unconscionable violation of the integrity of the Park. Mitigation actions described below apply equally to lines within or outside the Park, however.

11.1.2.4.1. Design of towers. The design of the transmission towers, particularly as regards the spacing of power lines and numbers of insulators, should conform to state-of-the-art standards laid out by the Federal Energy Regulatory Commission (USA) and similar agencies in Europe, in order to avoid the electrocution of large birds and of monkeys. Such electrocutions may cause system-wide power outages.

In areas where the line is close enough to the National Park to be visible, the towers should be painted green or camouflaged, in order to minimize aesthetic intrusion into the Park.

11.1.2.4.2. Poaching along the right-of-way. We assume that the transmission towers will be moved in by flat-bed truck and placed along a cleared right-of-way with its own access road. If the foreman of the construction crew is properly trained to prevent poaching by his men, there need be no problem with poaching. The Project Environmental Scientist should visit the right-of-way periodically during construction, to demonstrate administrative interest in enforcing game laws.

11.1.2.5. Reservoir topography. We propose two types of reservoir modification, with roughly the same objectives: 1) design of borrow areas to provide livestock watering away from the Park, and 2) addition of a water control structure to the dike where the access road crosses the Diarrha.

We have no way of knowing which borrow pits will be within the reservoir areas, but those that are may offer an opportunity to create supplementary watering lagoons for livestock. These may save livestock and herders a long trek to the Gambia River when the reservoir is drawn down and would reduce the probability of contact between livestock and wildlife. If borrow pits are to become catch basins, they must be designed with that in mind. This will affect the way in which overburden is removed and formed into dikes. A small concrete control structure will be required, so that water flowing out during drawdown or in during filling does not erode the retaining dike. A graded approach area, on the uphill side should be provided if cattle are to enter the water. Alternatively, water could be pumped or allowed to flow by gravity into a concrete drinking trough. We envision these basins of three types: 1) those in which the top of the retaining dike lies below the surface of the filled reservoir, 2) those in which the top of the dike is above maximum reservoir elevation but the bottom is low enough to be filled from the reservoir, and 3) those wholly above reservoir elevation, requiring the diversion of a tributary stream for filling. Which category a given borrow pit falls into will be determined largely by the type of fill needed and its availability locally.

The other type of watering area, formed where the access road crosses the Diarrha River, will require merely a control structure, instead of a bridge or a set of culvert pipes. During the rainy season, water in the Diarrha would be ponded behind the dike to the desired depth, and the excess released to the reservoir. As the reservoir is drawn down, the water behind the dike would be retained.

The cost of providing one or more watering areas for livestock can be measured in construction cost, which would be slight, since the retaining systems would be in place anyway, and in water lost to the reservoir. Water would be lost consumptively and through evaporation. The former probably would not be greater than that amount the same livestock would remove from the reservoir anyway, and the latter would be about 2,000 mm, over the small surface areas of the borrow pits. Incrementally, the 2,000 mm evaporation would be additional only in the period when the lake is drawn down past the pit. A small amount of residual water, perhaps a few thousand cubic meters might become unavailable to the reservoir in the course of the dry season.

The benefits of these water holes whould be substantial. Cattle that now water in the remnant pools of the Diarrha and Tiokoye Rivers (being denied access to the Gambia by the Park authorities) would be provided water through the dry season. Watering these cattle several kilometers from the mainstem Gambia River would further the National Park objective of keeping cattle (believed capable of infecting wild ungulates with livestock diseases) out of contact with Park wildlife. Furthermore, keeping the herder at the southern margin of the reservoir area during the drawdown period will minimize the opportunities for poaching and facilitate anti-poaching efforts.

11.1.2.6. Reservoir filling. The filling of the reservoir will affect wildlife in two ways: 1) animals will be more vulnerable to poaching as they are driven from the riverine forest, and 2) animals moving uphill may find themselves on islands which are subsequently inundated, or subject to crowding.

In both cases the severity of the impact depends strongly on the rate of reservoir filling; the more slowly the water rises, the longer animals will have to adjust to new conditions.

11.1.2.6.1. Poaching. We suggest that the game wardens on the south side of the reservoir be alerted to the possibility that disoriented animals may move into areas adjacent to the reservoir. No special mitigation measures are needed beyond the overall increase in vigilance by the game wardens.

11.1.2.6.2. Rescue program. In general, we do not advocate extensive animal rescue programs in projects involving loss of wildlife habitat, since the animals whose habitat is removed are themselves effectively removed from their species' populations. We do however, advocate selective rescue of valuable animals in cases where the individuals rescued are vulnerable to death by drowning or poaching and where they can be placed in secure habitat.

Recommendation. The Project Environmental Scientist and wildlife personnel from the National Park and the Game Department should develop a contingency program for the removal of animals from hills or islands in the reservoir area. The program should designate the responsible agency and the roles of others, and establish guidelines for the capture and disposition of animals. It should determine to the extent possible, the capture and handling techniques to be used, where animals are to be released, and the types of follow-up studies to be done. The responsible agency, aided by the OMVG, should assemble the complete kit of field equipment and train the designated team in its use, so that it can effect a quick response to a situation requiring animal transfer.

11.2. Operation Phase

11.2.1. Vegetation

11.2.1.1. Reservoir clearing. The decision to partially clear or not to clear at all should be reviewed during the first year after dam closure, in case some changes in the plan are warranted. It is possible that the tourism potential of the reservoir will be sufficiently high to warrant aesthetic improvement of the reservoir drawdown area. This should be done cautiously, so that standing dead trees that serve as perches for water birds are not removed. If a tourist boat service is developed, access to animal watering areas could be developed, to improve viewing.

11.2.1.2. Revegetation. Areas such as spoil banks, borrow pits and road shoulders should be monitroed frequently during the first year, especially during the rainy season, to ensure that trees and shrubs have become established. The areas should be protected from fires for several years.

11.2.2. Wildlife

11.2.2.1. Livestock-wildlife interactions. We believe that the problems of disease transfer between livestock and wild ungulates and poaching by herders can be partially alleviated by controlling the entry of livestock into certain parts of the reservoir area. We do not believe that the present system of prohibiting cattle on the south bank of river can be justified, in view of the intense need for watering areas for cattle during the dry season.

Recommendation: The area between the Diarrha and Tiokoye Rivers and between the reservoir and the access road should be designated a "no livestock" area. This assumes that small impoundments are maintained on both tributaries south of the road and that some diked water traps are placed on the south bank of the reservoir upstream of the Tiokoye and downstream of the Diarrha. Maintenance of the area between the rivers as a limited use wildlife reserve will be a continuation of existing policy, except that hunting should be allowed on a limited basis.

The possibility of bringing livestock diseases into the area and infecting local livestock and wildlife will be increased if the reservoir draws herders from other regions. Additional animal health activities will be required.

11.2.2.2. Herder-wildlife interactions. The presence of a major new water body in the region, although it may offer (due to drawdown) less satisfactory livestock watering conditions in the dry season than currently exist, will be a magnet for herders. If more herders do move into the region, bringing more cattle, there is likely to be more predation by large carnivores and hence more countermeasures (shooting and possibly poison) by herders.

Recommendation: The game wardens operating in the south bank areas will have to make a special effort to establish rapport with itinerant herders, while making clear that the shooting or poisoning of predators will not be tolerated.

11.2.2.3. Park guard-local resident interactions. The installation of a clear-cut water barrier at the south edge of the Park provides an opportunity to improve the strained relationships between the Park authorities and the local people south of the Park.

Recommendation: The OMVG should orchestrate a new policy of public relations in the buffer zone south of the Gambia River, where unauthorized "inforcement" activities by the Park guards have created considerable animosity. Park guards should visit the buffer zone only on "hot pursuit" (including investigation of heard gunshots) and should be required to file a report on each instance of enforcement activities outside the Park.

Enforcement jurisdiction in the buffer zone should be firmly the responsibility of the Forest and Wildlife Service. Rather than a random enforcement effort, that organization should develop a coordinated program aimed at conservation education and wildlife management.

11.2.2.4. Regulated hunting for local residents. We see no future for wildlife outside the National Park as long as enforcement remains in the hands of the Park guards and hunting permits remain too costly for the local people. A major revision in game management technique will be required if the situation is to change.

Recommendation: The agencies responsible for wildlife management in the area (Forest and Wildlife Service, National Parks and now OMVG) should cooperate to effect changes in the game laws and to establish village committees to control the taking of game. It is unlikely that much poaching will go on completely unnoticed by local residents, who now turn a blind eye. The agencies should establish areas in which each village would have hunting rights. The wildlife reserve between the Tiokoye and the Diarrha should be excluded from hunting, at least initially. We believe that if the villages are allowed a harvest quota for those species that can tolerate some hunting, they will aid in the protection of the less abundant species.

11.2.2.5. Downstream releases. The release of water downstream during reservoir filling and during the subsequent dry season probably will be determined by downstream water needs and by the need for electricity. We suggest that the OMVG Project Environmental Scientist monitor the appearance and disappearance of sand bars and the extent of bank erosion. Although it is unlikely that major changes could be made in the rates of release, some remedial measures, such as placing large boulders in the river bed at strategic locations, could be employed to form replacement sand bars.

11.2.2.6. Regional Master Plan for Senegal Oriental. Numerous aspects of regional development in Senegal-Oriental were not included in the available Project documents, and the Kekreti development will either impact or offer opportunities which should be considered. It is recommended that appropriate authorities and agencies coordinate and prepare a comprehensive Master Plan for the long-term development of Senegal-Oriental. Those items which will be affected by the Kekreti Project should be elaborated as necessary to avoid future conflicts and the fullest advantage of all opportunities. Topics affecting wildlife which should be included in this outline are:

a) Roadway and transportation system plans should include access to the dam site; transportation through and around Niokolo-Koba National Park; major towns in the locality, and access to Guinea.

b) Regional power grid and optimal routing of transmission lines should be considered not only in terms of the shortest route between the dam and the major distribution center (presumably Tambacounda), but also as they relate to future regional energy requirements and sales opportunities (i.e., Guinea); use of roadway right-of-ways instead of preparing an entirely separate routing; and protection of the Park and the wildlife resources.

c) The expansion of the tourist industry in southeast Senegal and especially the Salemata area can be expected due to the improved access and the attraction of the Bassari ceremonies. As routes are improved into Guinea, there will probably be opportunities for outfitting trips into the scenic Fouta Djallon mountains. This should provide opportunities for increased revenue both at the local level (guides, camps, support personnel, souvenirs, etc.) and at the national level (visas and permits, transportation, large city services, etc.) and this revenues can be maximized if regional plans and regulations prohibiting complete control by external interests are carefully formulated. Other possibilities include hotel and reservoir tour boat accomodations at Kekreti; increased small game and warthog hunting in the Salemata locality; and some changes in tourist activities within the Park. The possibility of keeping at least the east side of the Park open year long should be objectively considered (local concessioners believe the roads could be operational through the rainy season). "Nightlight" tours could also be considered - i.e., drivinng at night along certain authorized routes using powerful 12 volt spotlights to observe nocturnal animals. Special fees could be levied for this uniquely interesting field experience, which would not only add to the overall profits of the tourist industry, but could also pay for the services of the guard who would accompany the group. A corollary benefit of these excursions would be more frequent patrolling of the Park, at no additional expense to the Park Service, which would discourage some poaching activities.

d) Educational and human health care aspects of regional development should also be examined for possible corollary benefits from the Kekreti project.

e) Wildlife would also benefit from a regional perspective for management. The potential for impacts of the proposed dam on Nikolo-Koba National Park underscores the need for a more coordinated and integrated program. Some of the aspects of regional wildlife management which should be considered include long-term plans and objectives for the Park; simiiar plans for the Faleme locality as the only other major large mammal habitat remaining in Senegal, which is also threatened by mining development (in particular, faunal contacts between these two areas should be investigated); the possibility of game ranching or other sustained harvest of wildlife; and coordination with Guinea wildlife conservation efforts in the region.

f) Wildlife and livestock research and management, including veterinary programs, could be substantially augmented in the region if a centralized facility could be developed. With its proximity to the Park as well as rangelands to the south, Kekreti would be an ideal location as a regional headquarters. If such a facility could be realized, international specialists and universities could be invited for study and meetings. The conversion of surplus buildings after the construction period to offices, laboratories and dormatories would probably provide the impetus for the development of such a facility.

g) Some of the other aspects of regional planning which will have an impact on wildlife and should be considered in a Master Plan include resettlement and immigration; allocation and management of upland areas in view of the increased human populations and improved water supply; and access and use of the reservoir.

12. GUINEA DAMS

The mitigation actions available for the Kouya, Kankakoure and Kougoufoulbe Projects are essentially the same, so will be discussed collectively.

12.1. Construction

12.1.1. Vegetation

The similarity of the three Guinea dams to Kekreti indicates that the appropriate mitigative actions will be similar: reservoir vegetation management, timber salvage and revegetation of disturbed areas.

12.1.1.1. Vegetation Management. The same arguments for and against reservoir clearing apply to all projects, suitably tailored to local conditions.

- Water Quality. The three Guinea projects are more likely to experience poor water quality due to inundated vegetation than Kekreti Reservoir, since they have a higher percentage of closed forest, nearly 85 percent in Kouya and Kankakoure Reservoirs and nearly 95 percent in Kougoufoulbe. This fact alone would not justify an extensive clearing program.
- Debris. Modern dams are designed to accommodate floating debris, though the use of trashracks and logbooms. Clearing forest in the reservoir will not completely prevent floating debris, some of which will originate upstream of the reservoir. If improperly carried out, the forest clearing program may exacerbate the debris problem.
- Facilitation of Fishing. Standing dead trees interfere with the use of nets and hand lines, but experience with African reservoirs (summarized by Lowe-McConnell, 1973) has shown that the standing dead vegetation so enhances the fishery that fishermen preferentially fish areas with underwater snags.

- Salvage of Timber and Fuelwood. The amounts of timber and fuelwood are so large, totaling nearly 300,000 m^3 of timber and 1,100,000 m^3 of fuelwood for the three reservoirs, that a sizable local industry could be supported. Unfortunately, the deplorable state of the regional road network (at present) and the dispersed nature of potential lumber and fuelwood markets make the extraction of this resource marginally economical.
- Cost. The cost of clearing reservoirs often is a shock to developers, even in countries where labor is cheap. The cost of clearing parts of the Mantali reservoir exceeded estimates severalfold and ran to millions of dollars. Much of the cost of clearing results from the tedious hand labor of piling and burning, without which the clearing program cannot accomplish its goals.

Recommendation. We recommend that the benefits and costs of clearing the Guinea reservoirs be examined carefully during feasibility-level studies. This must be done for each dam on an individual basis. We suggest that only tangible benefits and costs be used.

- Benefits. The only tangible benefit is the return on timber and fuelwood. To determine the net value of this return will require a detailed study of the timber resource, local and regional demand, transportation, and felling/handling costs.
- Cost. The cost of felling, trimming, piling and burning of trees and brush can be calculated on the basis of man-hour requirements and local wage scales.

12.1.1.2. Revegetation. All borrow pits, road shoulders and other disturbed areas should be revegetated with native grasses, shrubs and/or trees according to a plan worked out between the OMVG Project Environmental Specialist and the Guinean Wildlife agency.

12.1.2. Wildlife

Little can be done to mitigate the loss of wildlife habitat that will be caused by each of these projects in proportion to its size, other than the revegetation described above, but other wildlife impacts are amenable to mitigation.

12.1.2.1. Control of Hunting. The control of illegal hunting by project workers and others will require great effort by the contractor, the OMVG Project Environmental Specialist, and the Guinean Wildlife Agency. As with Kekreti, adequate control will require a major change of local attitudes, which now see any animal as fair game. It would be foolish to expect a hydroelectric project to cause a region-wide program of wildlife management, but the presence of the OMVG Project Environmental Specialist might be the catalyst for effective interaction among Guinean agencies.

12.1.2.2. Education. Much could be done to change public attitudes and to instill environmental consciousness in the project workers through an education program in schools, the workers camp and elsewhere in the region. This should include posters, lectures, and movies.

12.1.2.3. Routing of Transmission Lines. The selection of the transmission line routing, usually of the shortest possible distance between two points, should take into account the quality of the ecosystem traversed and avoid areas of unspoiled native forest.

12.2. Operation

12.2.1. Vegetation

A continuing review of reservoir clearing (or the lack of it) should determine whether post-impoundment clearing is needed in certain areas. If such clearing is needed, to facilitate boat landings, wildlife crossings or other objectives, it could be done during the drawdown period.

Areas revegetated during or immediately following construction should be followed closely for a year or so, then examined after several years, at which time some plantings may have to be replaced with the same or other species.

12.2.2. Regional Planning for the Fouta Djallon

The OMVG, with three potential projects in this region, is in a position to influence substantially the course and direction of development. Undoubtedly the next few decades will see important changes in the Fouta Djallon, in response to population pressure, political change, and increased resource accessibility. Uncoordinated or unrestricted development could lead to the development of one resource (i.e., mining) at the expense of others (e.g., tourism).

The OMVG has the opportunity to bring an international consciousness to the development of the Fouta Djallon, which could benefit from development across the border in Senegal. These benefits could include improved access to markets and resources, energy (electricity and fuelwood) and a synergistic effect on tourism (in which the combination of two areas is sufficient to provide a viable package that neither can achieve alone).

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Duto:	Cordyla africana
Tabo:	Coal cordiflora
Manankaso:	Icacina senegalensis (small bush red fruits edible)
Baro:	Combretum micranthum
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WILDLIFE/VEGETATION TEAM LITERATURE

MAMMALIAN WILDLIFE

GRBS W/V TEAM LITERATURE WORKING LIST

MAMMALIAN WILDLIFE

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WILDLIFE/VEGETATION TEAM LITERATURE

ANIMAL DISEASES

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APPENDICES

APPENDIX 1: SPECIES FOUND IN CLOSED OR DENSE FOREST SITES

Scientific Names	Habitat Range	Abundance	Family	Observations
Pterocarpus erinaceus	14/16	3.1	Papilionaceae	B13 HDI518A314
Combretum spp.	13/16	3.0	Combretaceae	BII,323-373 B239HDI264A490
Parika biglobosa	11/16	2.1	Mimosaceae	B49 HDI487A249
Ficus pp	11/16	1.4	Moraceae	B226HDI600A334
Bombax costatum	11/16	2.6	Bombacaceae	BII,75/B15HDI334A170
Daniellia oliveri	9/16	3.2	Caesalpinaceae	B62HDI463A235
Terminalia sp.	9/16	2.1	Combretaceae	B24 HDI277A123
Bauhinia thonningii	8/16	2.3	Caesalpinacee	B HDI444A215
Khaya senegalensis	8/16	1.3	Meliaceae	B62 HDI698A377
Vitex sp.	6/16	2.1	Verbenaceae	B38 HDI1445A500
Erythrophleum guineensis	5/16	2.2	Caesalpinaceae	B49 HDI484A241
Acacia spp.	6/16	1.0	Mimosaceae	B44 HDI496A250
Oxytenanthera obyssinica	4/16	3.0	Andropogonaceae	B388

APPENDIX 1: SPECIES FOUND IN CLOSED OR DENSE FOREST SITES (cont'd)

Scientific Names	Habitat Range	Abundance	Family	Observations
Cola cordifolia	4/16	1.2	Sterculiaceae	B230HDI330A159
Afzelia africana	3/16	2.3	Caesalpinaceae	B63 HDI459A238
Sterculia setigera	4/16	1.3	Sterculiaceae	Sap used in sauce preparation for cus-cus; bark for rope. B211HDI320A159
Detarium senegalensis	3/16	1.0	Caesalpinaceae	B60 HDI457A229
Anogeisus leiocarpus	2/16	3.0	Combretaceae	B116HDI280A135
Carapa procera	1/16	1.0	Meliaceae	B63 HDI702A377
Hannoa undulata	1/16	1.0	Simaroubaceae	B71 HDI691A368
Cordyla pinnata	1/16	1.0	Ceasalpinaceae	B70 HDI446A304
Adansonia digitata	1/16	1.0	Bombacaceae	B39 HDI334A165
Lannea acida	1/16	1.0	Anacardiaceae	Edible fruit; young leaves can be eaten; leaves medicinal astringent aid to make cord; later can be drunk dissolved in water; firewood for carpentry; small tree. B247/B16 HDI732A394

APPENDIX 1: SPECIES FOUND IN CLOSED OR DENSE FOREST SITES (cont'd)

Scientific Names	Habitat Range	Abundance	Family	Observations
Parinari excelsa	1/16	1.0	Rosaceae	B241HDI429A201
Markhamia tomentosa	1/16	1.0	Bignoniaceae	B65 HDII387A499
Landophia sp	1/16	1.0	Apocynaceae	Edible fruits; latex used on B393/B105HDII54
Spondias mombin	1/16	1.0	Anacardiaceae	Edible fruits; flowers and leaves medicinal; latex used glue; wood used for handles of machets and axes. B284/ B77 HDI728
Sterospermum kanthianum	1/16	1.0	Bignoniaceae	Tree, up to 12m, flowers in dry season. B12 HDII386A497
Vapoca togoensis	1/16	1.0	Euphorbiaceae	B216HDI390A190

APPENDIX 2: SPECIES FOUND IN OPEN, LESS DENSE FORESTED OR WOODED SAVANNA AREAS

Species	Habitat Range	Abundance	Family	References
Parmari excelsa	4/31	1.5	Rosaceae	B241HDI429A201
Oxytenanthera abyssinica	4/31	1.2	Andropogonaceae	B388
Cordyia pinnata	4/31	1.0	Caesalpinaceae	BIV350 B70HDI446A304
Saba senegalensis	4/31	1.0	Apocynaceae	B103HDI161
Detarium microcarpum	4/31	1.0	Caesalpinaceae	BIV374 B59HDI457A229
Annona sp.	3/31	1.7	Annonaceae	B243HDI51 A38
Hexalobus monopetalus	3/31	1.7	Annonaceae	B242HDI48 A38
Tamarindus indica	3/31	1.0	Caesalpinaceae	BIV430 B59 HDI477A226
Hymenocardia lyrata	3/31	1.0	Euphorbiaceae	B236HDI377A184
Gardenia ternifolia	3/31	1.0	Rubiaceae	B139HDI123A461
Syzygium guineensis	3/31	1.0	Myrtaceae	B111HDI240A88
Ceiba pentandra	2/31	1.5	Bombacaceae	B39 HDI335A169
Musanga sp.	2/31	1.5	Moraceae	HDI616
Lophira lanceolata	2/31	1.0	Ochnoceae	B242HDI231
Nauclea latifolia	2/31	1.0	Rubiaceae	B142HDI163
Adansonia digitata	2/31	1.0	Bombacaceae	B39 HDI334A165
Afrarmosia laxiflora	1/31	3.0	Papilionaceae	BIV
Albizzia malacophylla	1/31	2.0	Mimosaceae	B48 HDI502A
Anacardium occidentalis	1/31	2.0	Anacardiaceae	B233HDI727A393
Raphia gracilis	1/31	1.0	Cycadaceae	B354
Combretum sp.	27/31	2.9	Combretaceae	B239HDI264A90
Bombax costatum	27/31	2.0	Bombacaceae	B39 HDI334A170
Pterocarpus erinaceus	23/31	2.2	Papilionaceae	B13,77HDI518A314

APPENDIX 2: SPECIES FOUND IN OPEN, LESS DENSE FORESTED OR WOODED SAVANNA AREAS (cont'd)

Species	Habitat Range	Abundance	Family	References
Terminalia sp	21/31	2.3	Combretaceae	B241HDI277A123
Parkia biglobosa	20/31	2.1	Mimosaceae	B49 HDI487A249
Acacia sp.	20/31	1.7	Mimosaceae	BIV.438-488
				B44 HDI496A272
Ficus sp.	18/31	1.4	Moraceae	B22 HDI600A334
Daniellia oliveri	17/31	2.1	Caesalpinaceae	BIV.366
				B62 HDI463A235
Bauhinia thonningii	17/31	1.7	Caesalpinaceae	HDI444A159
Sterculia setigera	12/31	1.6	Sterculiaceae	B211HDI320A159
Vitex sp.	10/31	1.8	Verbenaceae	B38 HDII1445A500
Khaya senegalensis	10/31	1.6	Meliaceae	B60.74HDII698A500
Borassus flabellifer	9/31	1.6	Cycadaceae	B355
Prosopis africana	9/31	1.4	Mimosaceae	BIV574
				B50 HDI492A285
Lannea acida	9/31	1.1	Anacardiaceae	B16,74HDI732A394
Afzelia africana	8/31	1.9	Caesalpinaceae	B63 HDI459A238
Cola cordifolia	7/31	1.6	Sterculiaceae	B230HDI330A159
Cassia sp.	7/31	1.1	Caesalpinaceae	BIV300-349
				B54 HDI450A219
Erythrophleum guineensis	5/31	1.6	Caesalpinaceae	B49 HDI484A241
Vittelaria paradoxa	4/31	1.7	Sapotaceae	B226
Paramari excelsa	4/31	1.5	Rosaceae	B241HDI429A201
Oxytenanthera abyssinica	4/31	1.2	Andropogonaceae	B388
Cordyia pinnata	4/31	1.0	Caesalpinaceae	BIV350
				B70HDI446A304
Saba senegalensis	4/31	1.0	Apocynaceae	B103HDI161
Detarium microcarpum	4/31	1.0	Caesalpinaceae	BIV374
				B59HDI457A229

APPENDIX 2: SPECIES FOUND IN OPEN, LESS DENSE FORESTED OR WOODED SAVANNA AREAS (cont'd)

Species	Habitat Range	Abundance	Family	References
Annona sp.	3/31	1.7	Annonaceae	B242HDI51 A38
Hexalobus monopetalus	3/31	1.7	Annonaceae	B242HDI48 A38
Tamarindus indica	3/31	1.0	Caesalpinaceae	BIV430 B59 HDI477A226
Hymenocardia lyrata	3/31	1.0	Euphorbiaceae	B236HDI377A184
Gardenia ternifolia	3/31	1.0	Rubiaceae	B139HDI123A461
Syzygium guineensis	3/31	1.0	Myrtaceae	B111HDI240A88
Ceiba pentandra	2/31	1.5	Bombacaceae	B39 HDI335A169
Musanga sp.	2/31	1.5	Moraceae	HDI616
Lophira lanceolata	2/31	1.0	Ochnoceae	B242HDI231
Nauclea latifolia	2/31	1.0	Rubiaceae	B142HDI163
Adanasonia digitata	2/31	1.0	Bombacaceae	B39 HDI334A165
Afrarmosia laxiflora	1/31	3.0	Papilionaceae	BIV
Albizzia malacophylla	1/31	2.0	Mimosaceae	B74 HDI510A306 BIV
Anacardium occidentalis	1/31	2.0	Anacardiaceae	B48 HDI502A B233HDI727A393
Raphia gracilis	1/31	1.0	Cycadaceae	B354

APPENDIX 3: SPECIES FOUND IN GALLERY OR RIPARIAN FORESTS

Species	Habitat Range	Abundance	Family	References
Ficus sp.	7/12	2.4	Maraceae	B226HDI600A334
Combretum sp	5/12	3.4	Combretaceae	B239HDI264A90
Bauhinia thonningii	5/12	3.2	Caesalpinaceae	B HDI444A215
Khaya senegalensis	5/12	2.2	Meliaceae	B62 HDI698A377
Parkia biglobosa	5/12	1.8	Mimosaceae	B49 HDI487A249
Bombax costatum	5/12	1.8	Bombacaceae	B15 HDI334A170
Pterocarpus erinaceus	4/12	3.7	Papilionaceae	B13 HDI518A314
Terminalia sp.	4/12	2.5	Combretaceae	B241HDI277A123
Vitex sp.	4/12	2.2	Verbenaceae	B38 HDI445A500
Daniellia oliveri	4/12	1.7	Caesalpinaceae	B62 HDI463A235
Cola cordifolia	4/12	1.5	Sterculiaceae	B230HDI330A159
Borassus flabellifer	3/12	3.0	Cycadaceae	B355
Erythrophleum guineensis	3/12	2.7	Caesalpinaceae	B49 HDI484A241
Anogeissus leiocarpus	3/12	2.6	Combretaceae	B116HDI280A135
Afzelia africana	3/12	2.0	Caesalpinaceae	B63 HDI145A238
Acacia sp.	3/12	1.6	Mimosaceae	B44 HDI496A272
Ceiba pentandra	3/12	1.6	Bombacaceae	B39 HDI335A169
Cassia sp.	3/12	1.3	Caesalpinaceae	B54 HDI450A219
Adansonia digitata	3/12	1.0	Bombacaceae	B39 HDI334A165
Cordyla pinnata	2/12	2.5	Ceasalpinaceae	B70 HDI446A304
Lannea acida	2/12	2.5	Anacardiaceae	B16 HDI732A394
Spondias mombin	2/12	2.0	Anacardiaceae	B77 HDI728
Raphia gracilis	2/12	2.0	Cycadaceae	B354
Guiera senegalensis	2/12	2.0	Combretaceae	B120HDI762A90
Prosopis africana	2/12	1.5	Mimosaceae	B50 HDI732A394

APPENDIX 3: SPECIES FOUND IN GALLERY OR RIPARIAN FORESTS (cont'd)

Species	Habitat Range	Abundance	Family	References
Gardenia ternifolia	2/12	1.0	Rubiaceae	B139HDI123A461
Tamarindus indica	2/12	1.0	Caesalpinaceae	B59 HDI477A226
Salix sp.	1/12	3.0	Salicaceae	B239HDI588A326
Dichrostachys glomerata	1/12	3.0	Mimoseae	B3 HDI494A283
Myrianthus serratus	1/12	2.0	Moraceae	B214HDI616
Sarcocephlus esculentus	1/12	2.0	Rubiaceae	HDI163A477
Oxytenanthero abyssinica	1/12	2.0	Andropogonaceae	B388
Sterculia setigera	1/12	2.0	Sterculiaceae	B211HDI320A159
Saba senegalensis	1/12	2.0	Apocynaceae	B103HDI61
Alchornea cordifolia	1/12	2.0	Euphorbiaceae	B212HDI403A174
Mitragyna inermis	1/12	1.0	Rubiaceae	B148HDI161A474
Afrormosia laxiflora	1/12	1.0	Papilionaceae	B74 HDI51 A306
Carapa procera	1/12	1.0	Meliaceae	B63 HDI702A377
Detarium microcarpum	1/12	1.0	Caesalpinaceae	B59 HDI457A229
Moringa oleifera	1/12	1.0	Moringaceae	B48 HDI96
Anacardium occidentalis	1/12	1.0	Anacadiaceae	B233HDI727A393
Dialium guineensis	1/12	1.0	Caesalpinaceae	B73 HDI499A216
Diospyros mespiliformis	1/12	1.0	Ebenaceae	B244HDI12 A422
Ziziphus mauritiaca	1/12	1.0	Rhamnacear	B205HDI166A357
Syzygium guineensis	1/12	1.0	Myrtaceae	B111HDI240A88
Parinari excelsa	1/12	1.0	Rosaceae	B241HDI429A201
Landophia sp.	1/12	1.0	Apocyhaceae	B105HDI54
Elaeis guineensis	1/12	1.0	Cycadaceae	B354
Hibiscus asper	1/12	1.0	Malvaceae	B274HDI347
Cissus populnea	1/12	1.0	Ampelidaceae	B260HDI678
Celosia laxa	1/12	1.0	Amarantaceae	B334HDI147
Luffa cylindrica	1/12	1.0	Cucurbitaceae	HDI207

APPENDIX 4: LIST OF FOOD PLANTS AVAILABLE THROUGHOUT THE YEAR*

Month	Common Names	Scientific Name
January	Mam patto	Parinari excelsa
	Bentango	Ceiba pentadra
	Never Die	Moringa pherygosperma
	Tumburong	Ziziphus jijuba
	Talo	Detarium senegalensee
February	(Some of the same species continue being used)	
	Oil palm	Elaeis guineensis
March	Manankaso	Icarina senegalense
	Baobab	Adansonia digitata
	Wanko	Celtis integrifolia
	Mampato	Parinari excelsa
	Tumburong	Zizphus jijuba
April	Sito	
	Netto	Parkia biglobosa
	Sibo	Borassus aethiopum
	Keno	Parinari erinaceus
	Kunting-jawo	Sclerocarya birrea
	Bembol	Lannea velutina
	Soto	Ficus spp.
May	Tabo	Cola cordifolia
	Mo-kungo	Treculia africana
	Kaba	Landolphia florida
	Ko-sito	Dialium guineense
	Duto	Cordyla africana
	Timbingo	Tamarindus indica
June	Jambanduro	Cassia sieberiana
	Sunkungo	Anona senegalensis
July	(Wild yam season begins)	
August	Jajeo	Ameplocera amplectens
	Tongton-subo	(mushrooms)
	Kunto-fingo	Vitex barbatta
	Yellow plum	Spondias mombin
September	(Continuation of use of species in August)	

APPENDIX 4: LIST OF FOOD PLANTS AVAILABLE THROUGHOUT THE YEAR* (Cont'd)

Month	Common Names	Scientific Name
October	Talo Talo	Detarium senegalensis
November	Kunko	Diospyros mespiliformis
December	Bentango	Ceiba pentandra
	Never die	Moringa pterygosperma

Plants used as relishes, in soups, et.
Sito, baobab (leaves & fruits)/Adansonia digitata
Kuntcha Hibiscus sabdarrita

Boroboro (spinach)	Talinum triangulare
Kanjo (okra)	
Jakato (bitter tomatoe)	
Nyambo (cassava)	
Batata (sweet potato)	
Wulonkonno nyambo (bush yam)	
Wulonkonna duto (wild bush mango)	
Manankaso	Icacina senegalensis
Simbong (kutufing) (black plum)	
Sora	Leptadonia lancifolia
Sito	Borassus aethiopum
Netto	Parkia biglobosa
Jambanduro	Cassia sieberiana

*Source: Department of Agriculture, The Gambia; National Archives, Banjul.

APPENDIX 5: SPECIES COLLECTED IN THE GAMBIA RIVER BASIN

Name	Family	Local Name	Locality	Collect No.	Date
Pleraocarpus	Papilionaceae	Bani	Kouregnaki (Guinee)	3R	28-11-83
Cola laurifolia	Sterculiaceae	Bobori	Near Kouregnaki (Guinee)	3R	28-11-83
Prospis africana	Minosaceae	Tielin		3R	28-11-83
Guiera senegalensis	Combretaceae	Eloko	Near river & road (Guinee)	3R	28-11-83
Bauhinia Thonningii	Caesalpinaceae	Barkewi	Near river & road (Guinee)	3R	28-11-83
Mitragyna inermis	Rubiaceae	Koli	Kouregnaki River (Guinee)	3R	28-11-83
Spondias mombin	Anacardiaceae	Nynkon	Kouregnaki (Guinee)	3R	28-11-83
Myriantus serratus	Moraceae		Kouregnaki	3R	28-11-83
Sarcos cephalus sp	Rubiaceae	Bakoureh	By river bank	3R	28-11-83
Alchornea cordifolia	Euphorbiaceae		Near Kouregnaki (Guinee)	3R	28-11-83
Hexalobus monopelus	Annonaceae	Boyle	Boussoura (Guinee)	4R	28-11-83

APPENDIX 5: SPECIES COLLECTED IN THE GAMBIA RIVER BASIN (Cont'd)

Name	Family	Local Name	Locality	Collect No.	Date
Manilkara multinervis	Sapotaceae		Boussoura (Guinee)	4R	28-11-83
Hymenocardia lyrata	Euphorbiaceae	Pelitoropete	Kogou Fulbe (Guinee)	4/DC	28-11-83
Ficus iteophylla	Moraceae	Cekei	Kogou Fulbe (Guinee)	4/DC	29-11-83
Aphania senegalensis	Sapindaceae	Kouroudiendieng	Kogou Fulbe (Guinee)	4/DC	29-11-83
Cryptolepis	Asclepiadaceae		Kogou Fulbe (Guinee)	4/DC	29-11-83
Hibiscus asper	Malvaceae		Riverine Forest Kogou Fulbe	4/DC	29-11-83
Cissus populnea	Ampelidaceae		Riverrine Forest Kogou Fulbe	4/DC	29-11-83
Celosia laxa	Amaranthaceae		Riverine Forest Kogou Fulbe	4/DC	29-11-83
Daniellia oliveri	Caesalpiniaceae	Satan	Between River Boussoura	5/DC	29-11-83
Afroromosia laxiflora	Papilionaceae	Kokobe (Kuli-kuli)	Kuregnaki (Guinee)	5R	29-11-83

APPENDIX 5: SPECIES COLLECTED IN THE GAMBIA RIVER BASIN (Cont'd)

Name	Family	Local Name	Locality	Collect No.	Date
Paspalum sp.					12-83
Diospyros elliotii	Ebenacea		At Kogou Fulbe (Guinee)		12-83
Phragmites vulgaris					12-83
Combretum aculeatum	Combretaceae				12-83
Stereospermur kun-thiamum	Bignoniaceae	Golombi	Kogou Fulbe (Guinee)	2/DC	30-11-83
Albizzia zygia	Minosaceae	Maronaye	Kogou Fulbe (Guinee)	2/DC	30-11-83
Anogeissus leiocarpus	Combretaceae	Kodioly	Kogou Fulbe	2/DC	30-11-83
Gardenia ternifolia	Rubiaceae	Dinngahligorki	Kogou Fulbe (Guinee)	2/DC	30-11-83
Vitellaria paradoxa	Sapotaceae	Kare	Kogou Fulbe (Guinee)	2/DC	30-11-83
Oplismenus burmanuii	Garmineae		Climax Forest Kogou Fulbe	2/DC	30-11-83
Paullinia pinnata	Sapindaceae		Climax Forest Kogou Fulbe	2/DC	30-11-83

APPENDIX 5: SPECIES COLLECTED IN THE GAMBIA RIVER BASIN (Cont'd)

Name	Family	Local Name	Locality	Collect No.	Date
Mallotus oppositi-folius	Euphorbiaceae		Climax Forest	2/DC	30-11-83
Mallotus oppositi-folius	Euphorbiaceae	Kogou Fulbe	Climax Forest	2/DC	30-11-83
Mallotus oppositi-folius	Euphorbiaceae		Grass Flats oppo-site side from Kogou Fulbe Guinea	3/DC	30-11-83
Mallotus oppositi-folius	Euphorbiaceae		Grass Flats oppo-site side from Kogou Fulbe Guinea	3/DC	30-11-83
Andropogongayanus	Gramineae		Opposite side river from Kogu Fulbe Guinea	3/DC	30-11-83
Anogeissus leiocarpus	Combretaceae	Kodioly	Kogou Fulbe (Guinea)	3/DC	30-11-83
Endata africana	Mimosaceae	Fadouwadouhi	Kogou Fulbe (Guinea)	3/DC	30-11-83
Pterocarpus eirnaceus	Papilionaceae	Bani	Hill behird Kogou Fulbe (Guinea)	3/DC	30-11-83

APPENDIX 5: SPECIES COLLECTED IN THE GAMBIA RIVER BASIN (Cont'd)

Name	Family	Local Name	Locality	Collect No.	Date
Ostryoderris stuhl-manni	Papilionceae		Hill behind Kogou Fulbe (Guinea)	5/DC	30-11-83
Polygonum sp.	Polygonaceae		Guinea Bridge		1-12-83
Parinari	Papilionaceae		Guinee		1-12-83
Detarium micarocarpum	Ceaesalpiniaceae	Koukehi	Sambailo (Guinee)	9R	1-12-83
Pterocarpus luceus	Papilionaceae	Tiami	Oussou River	9R	1-12-83
Sarcocephalus escu-lentus	Rubiaceae	Bakourehi	Oussou River	9R	1-12-83
Moringa oleifera	Moringaceae	Niebedai	Oussou River	9R	1-12-83
Polygonum sp.	Poligonaceae		Guinee Bridge		4-12-83
Digitaria gayana	Garmineae		Guinee Bridge	11/7	12-83
Rotula aquatica	Boraginaceae		Guinee Bridge		12-83
Vetiveria fulvibarbis	Gramineae		Guinee Bridge		12-83
Cyperus esculantus	Cyperaceae		Guinee Bridge		12-83
Anogeissus leicarpus	Combretacea	Kokioli		33R	28-1-84

APPENDIX 5: SPECIES COLLECTED IN THE GAMBIA RIVER BASIN (Cont'd)

Name	Family	Local Name	Locality	Collect No.	Date
Diospyros amespili-formis	Ebenacea	Poupoui		36R	29-1-84
Detarium icrocarpum	Caesalpiniacea	Koukehi	Riverine area	36R	29-1-84
Sarcocephalus esculentus	Rubiaceae	Bakowrehi		36R	29-1-84
Lophira alata	Achnacaceae	Malanga	Oubadji (Senegal)	49R	24-2-84
Parinari macrophylla	Rosaceae	Neoudi	Oubadji	49R	24-2-84
Gymnosporia senegal-ensis	Clastraceae	Gielgotel (Pular)	Oubadji (Senegal)	49R	25-2-84
Diospyros mespilformis	Ebenaceae	Poupoui	Kekreti area (Senegal)		26-2-84
Guiera senegalensis	Combretaceae	Epako		56R	27-2-84
Hexalobus monopetalus	Annonaceae			56R	27-2-84
Cordyla pinnata	Papillioneae	Douki		59R	27-2-84
Herria insignis	Anacardiaceae	Bellbelgel	Linguekota (Senegal)		1-3-84
Lannea velutina	Anacardiaceae	Chuko		66R	2-3-84

APPENDIX 5: SPECIES COLLECTED IN THE GAMBIA RIVER BASIN (Cont'd)

Name	Family	Local Name	Locality	Collect No.	Date
Sarcocephalus exculentus	Rubiaceae		Kekreti reservoir (Senegal)		2-3-84
Ziziphus mauritiaca	Rhanmaceae	Diabi	Kedreti reservor		2-3-84
Diospyros mespiliformis	Ebenaceae	Kukuwo (madenka) poupoui (pular)	Kedreti reservoir		2-3-84
Corrdilla pinnata	Papilionaceae	Douki	Senegal	78R	28-3-84
Guiera senegalensis	Combretaceae	Elako	Senegal	78R	29-3-84
Maera angolensis	Capparidaceae	Bagu, Bagi, Boge	Senegal	78R	29-3-84
Cassia lora	Caeslpiniaceae	Oulo	Sine-Saloum (Senegal)	79R	29-3-84
Cozdia mixa	Borraginaceae	Daraman (wolof)	Sine-Saloum (Senegal)	80R	29-3-84
Calotropis procera	Asdepiadaceae			82R	30-3-84
Diopyzas mespili-	Ebenaceae	Poupoui	Senegal		30-3-84
Ceropegia spc	Asclepiadaceae		Bambali by Elephant Island		5-5-84
Acrostichum avreum	Fougertae	Bato manankaso	Elephant Island The Gambia		6-5-84

APPENDIX 5: SPECIES COLLECTED IN THE GAMBIA RIVER BASIN (Cont'd)

Name	Family	Local Name	Locality	Collect No.	Date
Drepanocarpus Lunatus	Papilionaceae	Ngassino	Elephant Island The Gambia		6-5-84
Acacia polyacantha	Mimosaceae		Elephant Island The Gambia		20-5-84
Aphania Senegalensis	Sopidaceae		Elephant Island The Gambia		20-5-84
Mitragyna inermis	Rubiaceae		Elephant Island The Gambia		20-5-84
Rhizopophoza har-risonu	Rhizophozaceae		Oyster Creek-Banjul area The Gambia		29-6-84
Avicemnia africana	Avicenniaceae		Oyster Creek-Banjul area The Gambia		29-6-84
Laguncularia race-mosa	Combretaceae		Oyster Creek-Banjul area The Gambia		29-6-84
Rhizophoza racemosa	Rhizophozaceae		Oyster Creek-Banjul area The Gambia		29-6-84
Nymphae spp.	Nympheaceae				30-7-34