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Organisation pour la Mise en Valeur du Fleuve Sénégal (O. M. V. S.)

ASSESSMENT OF ENVIRONMENTAL EFFECTS of Proposed Developments IN THE SENEGAL RIVER BASIN

Partial Report
for
Ornithology

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In association with

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Dakar Sénégal

ORNITHOLOGY

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CHAPTER A

INTRODUCTION

The prospective development of the Senegal River Valley potentially can affect avian communities in diverse ways have both beneficial and adverse results. Indeed, the environmental changes produced could introduce conditions that favor increase in some bird populations to the extent that these birds would then exert an adverse impact on the environment. Still other changes due to river developments could cause marked decreases in existing bird populations that now are valuable assets. Careful management of Senegal River resources could mitigate against adverse effects of development. The details of the various problems concerning bird populations in the Senegal River Valley will be described in the sections that follow.

CHAPTER B

OBJECTIVES, SCOPE, ORGANIZATION

B.1. Objectives of Report

The objectives of the ornithological phase of the overall study were to evaluate the present condition of bird populations in the Senegal River Valley, to appraise the existing relationships of birds to the terrestrial and aquatic environments there, and to predict the effect of proposed developments in the valley on the present avifauna.

B.2. Scope & Organization of Report

The approach to obtaining information concerning avian populations were as follows. Critical sites were visited to gain an overall prospective. In particular, surveys and enumerations of bird species, especially concerning waterbirds, were made at chosen sites along the Senegal River including Saint Louis, the Diama area, Parc Djoudj in Senegal and adjacent river delta sites in Mauritania, Rosso, Richard Toll and Lac de Guier, near Dogang, along the river to Matam and Bakel. Sites in Mali included Kayes and the Bafing River at Mahina, Manantali and Tondidji, and sites between these localities.

Basic information on the birds of Senegal was obtained from basic references on the birds of western Africa (Serle, Morel, and Hartwig, 1977; Mackworth-Praed and Grant, 1973, 1970; Dekeyser and Derivot, 1968, 1967, 1966; Bannerman, 1953). Especially useful, however, was the annotated list of birds of Senegal and Gambia by Morel (1972) which included avifauna information that focused on the Senegal River Valley in Senegal.

The bulk of the information obtained was accomplished through review of the literature on birds in the Senegal River Valley, and by discussions with key personnel in the Senegalese beaurocracy, plus information provided by personnel from other agencies involved in bird population problems in the valley. In particular in this regard recognition should be made to A. R. Dupuy, Director of National Parks in Senegal, G. J. Morel and B. Treca of the Office de la Recherche Scientifique et Technique Outre-Mer (O.R.S.T.O.M.) stationed at Richard Toll, R. Bruggers, bird control specialist with the Food and Agriculture Organization of the United National (FAO) in Senegal, I. Sylla at Djoudj National Bird Park, T. Roux of the Centre de Recherches sur la Biologie des Populations d'Oiseaux in Paris, M. J. Kundaeli of the International Union for Conservation of Nature and Natural Resources Headquartered in Switzerland, personnel of the Organization pour la Mise en Valeur du Fleuve Senegal (O.M.V.S.), the Eaux et Foret, and the United States Agency for International Development (U.S.A.I.D.) in Senegal.

In achieving the goals of the ornithological segment of the overall project, input from several other disciplines was encouraged when necessary. With regard to waterbird biology the data obtained from water quality scientists was useful. The findings of the ichthyologists were important in understanding the situation concerning picivorous waterbirds and in predicting the future of these populations.

In conducting savanna bird population censuses, whereever possible the census strips were located in Foret Classee sites, particularly in those savanna forest stand characteristics. Also there was considerable communication with agricultural interests in appraising the situation concerning dense populations of granivorous birds and their well known deprivations of grain crops. Discussions with the health team were useful in focusing on situations where birds serve as host reservoirs for disease agents that infect people and livestock.

During the period from August 1977 to June 1978 when the ornithological team visited Senegal, there was a severe drought, so the ornithologists were not afforded first hand experience with the effect of a rainy season. Thus they were not able to see the Senegal River delta wetlands at full water capacity. Consequently waterbird populations were low. Fortunately there is an excellent literature concerning waterbird populations inhabiting the Senegal delta (Roux, Maheo, and Tamisier 1978, 1976, Roux 1973, 1974, 1976; Dupuy 1971).

Other limitations to the study are that the ornithological team never was able to visit the wetlands of the Aftout es Sahel or Lac Rkiz, both areas in Mauritania. Also, the team was able to travel to the proposed Manantali Dam on the Bafing River in Mali only in May and consequently is unfamiliar with the avian situation there at other seasons, particularly during the important winter season when palearctic migrants would be present. Unfortunately, there is not a good literature concerning birds of the Bafing River.

The possible impacts on bird populations are basically due to four major aspects of proposed river developments: 1) construction and operation of the Diama Dam, 2) construction and operation of the Manantali Dam, 3) construction and operation of irrigated perimeters, and 4) development and operation of river navigation.

The ornithological report is organized with respect to the groups of birds most effected: 1) waterbird populations 2) savanna bird populations, 3) granivorous birds, and 4) protected bird species.

B.3. Method of Field Projects

Systematic bird censuses were conducted in savannah habitats adjacent to the Senegal River at various seasons at Diama, Richard Toll, Guidaker, Matam, Bakel in Senegal and near Manantali (at Serhoto) in Mali. The purpose of this was to gain a prospective on savannah bird populations to evaluate the effect of modification of these habitats following river valley

developments. The census technique used was the Forbes-Gross strip census method (Forbes 1907). Also, the strip censuses produced general information about crop pest birds in local environments, which was supplemented by observations of granivorous birds in corplands.

In the Parc Djoudj area special measurement of water quality of selected waterbird sites were made. The information obtained concerned aquatic temperature, pH, conductivity, alkalinity and dissolved oxygen levels in an attempt to characterize preferences in aquatic habitats expressed by waterbirds.

CHAPTER C

INVENTORY

C.1. General Distribution

The ornithological team encountered a total of 236 bird species from the edge of the Senegal River delta at St. Louis up the valley to the confluence of the Bafing and Bakoye Rivers, and up the Bafing to Tondidji. This list was compiled during field excurions in August and December 1977, and in May 1978. A list of this size in the time alloted represents an avifauna of moderate richness. The species seen are listed in Appendix A giving scientific names and corresponding French names for cross reference in French for the birds named in the text.

It should be emphasized that the list in Appendix A is not a complete species list of birds in the area. During a short field experience only the commoner species are found. So this list should not substitute for the more complete information found in the published annotated list of Morel (1972) based on over a decade of experience in the Senegal River Valley. Morel's data represents the most complete inventory available of the avifauna in the Senegal River Valley. The publication includes the rest of Senegal and also Gambia.

For purposes of the inventory, a survey of major families of birds found in the Senegal River region was made. The following pages summarize the habitat, food and status of these families.

C.1.1. Survey of Families

The family Podicipedidae is represented in Senegal by a single species, the Dabchick (Podiceps ruficollis) which frequents lakes, reservoirs, backwaters and rice fields. This resident species is widespread in West and Central Africa. Food consists of small fish, frogs, aquatic insects and water weeds obtained by diving.

Cormorants and darters (Phalacrocoracidae) are medium-sized water birds which dive under water to capture fish. Three species are residents of West Africa, are common and are found at lakes, rivers, swamps, rice fields and tidal estuaries. Pelican (Pelecanidae) also forage for fish but by flock synchronized dipping. They are widespread and breeding colony was observed in Parc Djoudj in December by the ornithology team.

The family Ardeidae (herons and egrets) is made up of wading, fish-eating birds and is well represented in the Senegal River region by 15 species. All are resident but many are augmented by migrant numbers during Palearctic winter. Larger herons also eat frogs, rats, mice, insects, reptiles, small birds and mammals. Breeding occurs in the Senegal River delta from July to October. Herons and egrets are usually solitary foragers but breed colonially. They are seen foraging in irrigation canals, rice fields, lakes, streams, marshes, swamps, and estuaries. Reef herons (Egretta gularis) are most often found in mangrove creeks, shores and islands, Cattle egrets (Ardeola ibis) are exceptions in that they feed on dry land by following cattle or large ungulates for insects they disturb. The Black-headed Heron (Ardea melanocephala) is most often found in grassy savannas or cultivated ground eating insects, rodents and reptiles.

Hammerkops (Scopus umbretta, family Scopidae) are widespread in West Africa, are solitary nesters and feeders, and forage for small fish, frogs, insects and tadpoles in swamps, rice fields, ponds, rivers and estuaries. This bird is probably the center of more legends than any other African bird, they are very tame and often are found in villages. Recorded breeding in Senegal is from November to March.

Storks (Ciconiidae), ibises and spoonbills (Threskiornithidae) and flamingos (Phoenicopteridae) are generally aquatic in habit. Adbim's Stork (Ciconia abdimii) is a dry season resident of savanna found in cultivated or open dry ground areas, foraging for locusts and other insects. It migrates south of the equator in October. Breeding in West Africa is mainly from March to July during the height of locust swarming season.

The White Stork (Ciconia ciconia) a European migrant, White-necked Stork (Ciconia episcopus), Saddlebill Stork (Ephippiorhynchus senegalensis) and the Wood Ibis (Ibis ibis) and the Sacred Ibis (Threskiornis aethiopica) frequent both wet and dry habitats foraging for fish, crabs, frogs, snails, reptiles, worms and insects such as locusts and grasshoppers. Breeding records for Senegal show the Wood Ibis and Sacred Ibis breed from November to March. The Maraboj Stork (Leptoptilos crumeniferus) is a scavenger in swamps, villages and open savanna. It has been noted in Mauritania destroying nests of Quelea spp., eating eggs and young. Spoonbills and flamingos forage on aquatic invertebrates, algae and small fish in fresh or brackish lakes and estuaries. The Lesser Flamingo (Phoeniconaias minor) has been recorded breeding on the lake south of Nouakchott, Mauritania in

Ducks and geese (Anatidae) are aquatic birds that require bodies of water for day-time resting, breeding or foraging. Table 1 shows habitat preferences, breeding status and foods for ducks and geese in the Senegal River region. The White-backed Duck, Spur-winged Goose and Egyptian Goose are noted as being unpalatable. The Spur-winged Goose is the most common and largest goose in Africa, and a major crop pest in many area.

TABLE 1 SPECIES OF DUCKS AND GEESE COMMONLY FOUND IN THE SENEGAL RIVER REGION WITH STATUS, HABITAT, FEEDING HABITS AND SOCIALITY.

Species	Status	Habitat	Feeding Habits	Sociality
Fulvous Tree-duck (Dendrocygna bicolor)	Resident nesting	lakes, marshes	nocturnal	gregarious
White-faced Tree-duck (D. viduata)	Common resident nesting (Senegal Sept-Oct)	lakes, marshes,	nocturnal	gregarious
Pintail (Anas acuta)	Nigrant non-breeding	lakes, swamps, flooded plains	nocturnal surface feeder damage crops in Nigeria	gregarious (often with garganey)
Garganey (Anas querquedula)	Common nigrant non-breeding	rice fields, marshes, shallow pools	damage rice in Nigeria	gregarious
Shoveler (Anas chypeata)	Nigrant non-breeding	marshes pools and lakes		single, pairs or small parties
Ferruginous Duck (Aythya nyroca)	Uncommon nigrant non-breeding	marshes and shallow lakes	diving duck	flocks in Nigeria
White-backed Duck (Thalassornis leuconotus)	Uncommon local resident nesting	swamps and lakes	diving duck	pairs or small groups
Egyptian Goose	Resident (Senegal July-Oct)	marshes, rice fields, flooded plains	eats youg grass and crops	pairs or flocks
Spur-winged Goose (Plectropterus gambensis)	Resident nesting (Senegal Sept-Oct)	swamps, rice fields, lake margins	damages ground nuts, sweet potatoes, noctural grassland & farmland	gregarious
Knob-billed Goose (Sarkidiornis melanota)	Resident nesting (Senegal Aug-Sept)	near open water swamps	feeds in marshes and croplands on water plants, insects, grass and grain	flocks
Pigmy Goose (Netapus auritus)	Resident nesting	deep-water lakes and lagoons	feeds by diving	pairs or small groups

The family Accipitridae is well represented in West Africa. Dekeyser and Derivot (1966) list 34 species which occur along the Senegal River. Vultures feed on carrion and fruit (Palm-Nut Vulture, Gypohierax angolensis), Harriers hunt small mammals or birds close to the ground (some are common in rice fields), Snake-Eagles eat mostly reptiles, Sparrowhawks and Goshawks generally eat small birds and large insects, Buzzards eat insects, lizards, and small mammals, various Eagles eat carrion, guinea-flow, monkeys, young domestic goats and sheep, small mammals and fish, and Kites eat insects, carrion, rodents, boats and trash. Most accipiters hunt solitarily but vultures commonly flock around carrion. Most of the accipiters in the Senegal region are found in savanna habitats, and breed beginning in October. Species of special note due to their relations to pest species include the Pallid Harrier (Circus macrocurus) and Montagu's Harrier (C. pygargus) and the Marsh Harrier (C. aeruginosus) which are common predators of rodents in rice fields of the Senegal River and Harrier Hawks (Polyboroides radiatus) which often raid weaver nests.

Falcons (Falconidae) are fast-flying predators preying on birds, bats, small mammals, and insects. Four species are resident breeders and two are migrants.

Falcons, quails and guinea-fowl (Phasianidae) are ground-foragers with relatively omnivorous diets including insects such as termites and seeds. Five species are resident in Senegal and Mali. Birds are commonly seen in small coveys of 5-6 in grass country or open bush. Guinea-fowl have more varied diets than Fancolins and Quail, eating insects, worms, molluscs, seeds crops, roots and bulbs.

Six species of rails (Rallidae) occur in the Senegal River region. One of these is a European migrant (the European Coot, Fulica atra), and one has a migratory race (Gallinula chloropus). Rails inhabit marshey borders of lakes, swamsp, backwaters and rice fields where there are reeds or floating vegetation. The European Coot is gregarious and commonly dives for molluscs, insects, worms and vegetable matter. The African Crake (Crex egregia) is more common in savanna areas and forest clearings. The Lily-trotter (Actophilornis africana, family Jacanidae) is a water bird with similar habits and habitats to rails.

The crowned Crane (Balearica pavonina) is found south of 17 degrees N in open country north of the forests, usually on wet plains, rice fields, grassy marshlands and in corp fields. Nesting is solitary but they form flocks in the non-bredding season of up to 100 birds. Diet is made up of reptiles, insects, (such as locusts), and grasshoppers and can do damage to young crops. Breeds in southern Mauritania in October.

Bustards (Otididae) are large terrestrial birds that inhabit dry open savanna or desert country. Five resident species are found in the Senegal-Mali area. Diet is mostly molluscs, small reptiles, locusts and small weed seeds. They breed from July to October in the area.

Two species of Thick-knees (Burhinidae) occur in the area. The Senegal Thick-knee (Burhinus senegalensis) is common along sandbands of large rivers. The Spotted Thick-knee (B.capensis) is fonder of bare sandy or stoney areas of savanna. Both breed from April to June and have nocturnal habits. They eat beetles, grasshoppers, molluscs, reptiles, frogs and mice.

Many species of plovers, sandpipers and snipe (charadriidae) are found in the Senegal River basin. European migrants compose 70% (28/40). The large proportion of migrants indicates a reliance of most species on insects and marine invertebrates in the diet that are not available during the Palearctic winter. Most shorebirds are small wading birds found along shores, marshes and mudflats, probing for invertebrates. They are frequently gregarious. Large plovers (Vanellus spp.) are found in dry northern savannas, commonly on bare open terrain or fields. The Spur-winged plover (Vanellus spinosus)frequents rice fields eating insects, molluscs, worms, and larval aquatic insects. The Ruff (Philomachus pugnax) is very common in winter on flooded plains and rice fields feeding largely on insects but it can do extensive damage to sprouting rice. Snipes may be found in rice fields and other swampy areas eating small worms and larval insects in the mud.

The family Gareolidae is a small African family. The Crocodile Bird (Pluvianus aegyptius) is common on inland sandy areas on large rivers. Sandbanks are required for breeding. Herodotus reported these birds enter the mounts of crocodiles to pick their teeth but no modern observer has witnessed it. Food consists of insects and small molluscs. Pratincoles (Glareola pratincola) are resident, augmented by Palearctic migrant populations in the winter. They frequent mud-flats, rice fields, deltas, lakes and rivers, and are predatory, eating large numbers of insects.

Gulls and terns (Laridae) feed mostly on fish. Species found in Senegal River area are mostly Europena migrants. Two species of gull and five species of terns commonly nest in colonies along the coasts of Mauritania and Senegal during May and June. Skimmers (Rhynchops flavirostris) are largely freshwater birds that fly low over the water snapping up small fish. Breeding records for Senegal are March; May and June in Mali.

Twelve species of doves and pigeons are found in the Senegal River area. Most of these feed on the ground on fallen seeds in savanna areas, on crop lands and around villages. Most are resident breeders. The European Turtle-Dove (Streptopelia turtur) occurs on rice fields of the Senegal River in large numbers from September to May. The only dove that regularly attacks cultivated crops is the Mourning Dove (S. decipiens). This bird occurs in small groups during the non-breeding season and attacks sorghum in ear and rice. Four species of doves were found in high desnity in savanna areas censused by the ornithological team: the Vinaceous Dove (S. vinacea) the Rose-grey

Dove (S. roseogrisea)the Laughing Dove (s. senegalensiss), and the Long-tailed Dove (Oena capensis). These species eat small seeds and grains. Two species of Fruit-Pigeons are found in the area. They are arboreal foragers, eating fruits of trees such as the wild fig. since doves and pigeons produce a milky substance to feed the young, breeding is less limited by wet-seasons and many species such as the Mourning Dove, Vinaceous Dove and Laughing Dove can breed the year-round.

The Senegal Parrot (Poicephalus senegalus) and the Senegal Long-Tailed Parrakeet (Psittacula krameri) represent the Psittaciformes in the area. Fruits, millet, maize, groundnuts, and sorghum are eaten by these species. The Parrakeet occurs in large flocks and is considered a crop pest when not breeding (Senegal Feb-March). It was not observed in large numbers by the ornithological team.

The Cuckoos and coucals (Cuculidae) are carnivorous birds, foraging for caterpillars, large insects (like locusts), and small vertebrates. Cuckoos are nest parasites. The Diarie Cuckoo (Chrysococcyx caprius) commonly parasitzes weavers species. Coucals are not parasitic. Three resident nesting species are found in the Senegal-Mali-Mauritania region. Their habitats and breeding seasons are varied.

Owls (Strigiformes) are nocturnal birds of prey that feed on rodents, other small mammals and birds. The Barn Owl (Tyto alba) sometimes is a cosmopolitan species and is found in varied habitats.

Seven Owl species are found resident in savanna lands in the region. Caprimulgidae (nightjars) is a nocturnal or crepuscular insectivorous family that is active at night and in evening. Four species occur in this area.

The Long-Tailed Nightjar (Caprimulgus climacurus) is a common bird observed in moist savanna areas.

Swifts (Apodidae) are diurnal or evening foragers for aerial insects. Most breed near villages and are colonial. The Ussher's Spine-Tailed Swift (Chaetura ussheri) is only found in pairs. Two species are Palearctic migrants, five are breeders.

Mousebirds (Coliidae) are fruit eaters that move about the savanna in small parties. The Blue-naped mousebird (Colius macrourus) occurs in the Senegal River region with breeding records from December-March and July-September. They eat seeds, berries, soft fruits, buds, flowers and small bird nestlings.

Several species of Kingfishers (Alcedinidae) occur over the region. Three species are fish-eaters and four are mainly insectivorous. Pied Kingfishers (Ceryle rudis), a fisher, frequents rice fields, lakes marshes and lagoons and was very abundant in Parc Djoudj during the team visit. Bee-eaters (Meropidae), rollers (Coraciidae) and hoopoes (Upupidae) are closely related to Kingfishers and are all insectivorous in food

habits. The European Bee-eater (Merops apiaster), the European Roller (Coracias garrulus) and the European race of the Hoopoe (Upupa epops) are passage migrants (spring and fall) and occassional winter visitors. The remaining thirteen or so species rest in the Senegal River region. Bee-eaters usually rest in large colonies in Senegal commonly from March to July during locust swarming time in stream banks. Rollers and hoopoes rest in tree cavities.

Hornbills (Bucerotidae) are mostly arboreal and fruit-eating. They are found in forest or wooded savanna, and have highly specialized resting habits requiring large tree cavities. Usually the incubating female is walled in the cavity by the male until the young fledge and they are fed by the male through a small hole. Five species of hornbills are found in the region, including the turkey-sized Ground Hornbill (Bucowers abyssinicus). Small hornbills such as the Grey Hornbill (Tockus nasutus) and Red-billed Hornbill (T. erythrorhynchus) eat large insects like locusts as well as fruits and berries in season. They generally breed from August to November.

Barbets (capitonidae) are small to medium-sized aboreal fruit and insect-eating birds found in forests and savannas. Three resident species are commonly found in Senegal and Mali. Nests are placed in excavated holes in dead branches or trees.

Two Species of Honey-guides (Indicatroidae) occur in the area. The Black-throated Honey-guide (Indicator indicator) prefers open woodlands and is a nest parasite on many species of bee-eaters, rollers, hoopoes and wood peckers. The Lesser Honey-guide is found in forests and savanna and parasitzes Barbet nests. Both feed on beeswax and insects; the Black-throated Honey-guide has a well known behavoir of guiding animals or man to bee nests so that it will be broken-up for the honey and the bird can feast on the wax.

Woodpeckers (Picidae) are arboreal species that drill into tree bark for insects and larvae. They usually nest in excavated holes in dead branches or trunks of dead trees. Some nest in ant-hills. Five species reside and nest in savanna forest habitats in the region.

The remaining birds are in the order Passeriformes - the perching birds. These are mostly small insectivorous or seed-eating birds; many species are migratory. Most of these species nest in trees, bushes or on the ground. Table 2 summarizes general habits, food and statuses for families occurring in the Senegal River region.

Most families are not granivorous in food habits. Potential crop pests that eat seeds and are in large flocks are mostly in two families - Ploceidae and Estrildidae. Table 3 lists the most important species of these families, their foods, breeding season, habits and habitats.

One hundred and forty-five species of the family Ploceidae are known in Western Africa. They are found in all types of country. Many are colonial nesters, covering savanna trees with hundreds of pendulous insects to the yound after the rainy season begins and eat seeds during

Table 2. Major families of the order Passeriformes found in the Senegal River Region with species, number, status, habits, and foods.

COMMON NAME	FAMILY	NO. SPECIES	NO. SPECIES RESIDENT	HABITS, HABITAT	FOODS
Larks	Alaudidae	3	3 resident	solitary, nest on ground	insects & small seeds
Swallows	Hirundinidae	10	8 resident	in flocks, varied nesting	aerial insects
Pipits	Motacillidae	6	2 resident	winter flocks, varied nesting	insects
Shrikes	Laniidae	8	7 resident	solitary, nest in trees	mainly arboreal insects, small bird
Orioles	Oriolidae	2	0 resident	shy, solitary	caterpillers, insects & fruit
Drongos	Dicruridae	1	1 resident	--------	insects
Starlings	Sturnidae	6	6 resident	nest in hole in tree	fruits, millet, insects, berries
Crows	Corvidae	2	2 resident	common around villages	omnivorous
Bulbuls	Pycnonotidae	1	1 resident	solitary, in gardens	insects, fruit
Thrushes	Turdidae	20	8 resident	single or in pairs	ground omnivores
Babblers	Timaliidae	2	2 resident	pairs or small groups	terrestrial insects, some fruits
Warblers	Sylviidae	35	15 resident	small parties	insects
Flycatchers	Muscicapidae	11	4 resident	pairs, small groups	insects
Sunbirds	Nectariniidae	4	resident	small groups or flocks	insects, nectar
Bunting	Emberizidae	3	African migrants	pairs or small groups	insects, small seeds
Canaries	Fringillidae	2	resident	winter flocks	seeds, millet, tree buds & flowers
Weavers	Ploceidae	many	mostly resident	winter flocks	seeds, insects
Weaver-Finches	Estrildidae	10	are resident	winter flocks	seeds, insects

TABLE 3. IMPORTANT SPECIES OF THE FAMILIES PLOCEIDAE AND ESTRILDIDAE IN THE SENEGAL RIVER REGION WITH THEIR FOODS, BREEDING SEASON AND HABITS.

Common Name	Latin Name	Foods	Breeding	Habits, Habitats
PLOCEIDAE				
Village Weaver	*Ploceus cucullatus*	seeds flowers	Senegal Aug-Sept	100's of pairs in colonies near villages
Vitelline Masked Weaver	*P. velatus*	wild foods	Senegal & Mali July-Sept	Nests singly or in small colonies in wild remote thorn scrub
Black-headed Weaver	*P. melanocephalus*	seeds insects	Senegal & Mali July-Sept	Colonies are found near rivers, lakes swamps
Spectacled Weaver	*P. nigricollis*	insects berries	Senegal May-Aug	Solitary, in riparian woodland
Slender-billed Weaver	*P. luteolus*	insects	Senegal July-Oct	Small groups of nests usually associated with wasps, not gregarious
Black-faced Dioch	*Quelea quelea*	seeds grain	Senegal Aug-Oct	Breeds in large colonies in remote thorn scrub, very mobile flocks of millions
Red-headed Quelea	*Q. erythrops*	seeds grain	irregular breeding	Flocks in grass habitats, can be a rice pest
Yellow-crowned Bishop	*Euplectes afer*	grass seeds insects	Senegal & Mali Aug-Sept	Flocks in winter with Quelea spp., found in swampy grassland, rice fields
Red Bishop	*E. orix*	seeds grain	Senegal Aug-Nov	Grassy areas, corn crop pest in some areas large winter flocks
Buffalo Weaver	*Bubalornis albirostris*	seeds	Senegal Aug-Oct	Colonial nest of thorns with individual nests inside covering thorn tree forage in small groups (10-12) on ground
Grey-headed Weaver	*Passer griseus*	seeds grain	Senegal July-Sept	"House sparrow" in villages, large flocks in winter

Golden Sparrow	P. luteus	seeds insects	June-Sept	Breeds in colonies in steppe country, roving flocks move to fields in winter
Bush-Sparrow	Petronia dentata	seeds insects	Nov-March	Occurs in trees and fallow land looking for seeds and insects in small groups
Scaly-fronted Weaver	Sporopipes frontalis	seeds	Oct-Feb	Arid savanna thickets and thorn scrub, gregarious in winter, rarely around villages
Pin-tailed Whydah	Vidua macroura	seeds	Senegal July-Aug	Nest parasites on Waxbills, Cisticolas form small flocks in cultivated areas
Senegal Indigo Finch	V. chalybeata	seeds	Senegal Sept-?	Nest parasite on Senegal Fire-Finch common on farmland
Broad-tailed Paradise Shydah	V. orientalis	seeds	Aug-Dec	Nest parasite on Pytilia spp., small ground feeding flocks in open grass savanna
ESTRILDIDAE				
Cut-throat Weaver	Amadina fasciata	seeds	Mali Sept-Nov, March	Dry open country and cultivated fields join Quelea spp. in winter flocks
Melba Finch	Pytilia melba	seeds	Aug-Sept	Dry thron scrub savanna, local pairs and small groups
Black-rumped Waxbill	Estrilda troglodytes	seeds	July-Aug	Northern arid savanna occasionally in large flocks, nests on ground
Red-cheeked Cordon-Bleu	E. bengala	ground seeds	Senegal Aug-Nov	Small flocks, open woodland and villages
Senegal Fire-Finch	Lagonosticta senegala	seeds	Senegal Sept-May	Dry savanna and around villages, very tame
Quail-Finch	Ortygospiza atricollis	seeds	?	Swampy savanna grasslands, small groups in winter feed on seeds, crops
Warbling Silverbill	Lonchura malabarica	seeds	Senegal Oct-Nov & April-May	Northern dry savanna, gregarious, tame, near villages. build nest in old weaver nests
Bronze Mannikin	L. cucullata	grass seeds and millet	?	Savanna, rice fields, near towns, nest colonially flocks in winter

the dry season when large flocks may become agriculture pests. Many occur in roving flocks which travel for many miles. More discussion of the weavers and weaver finches will be given in the section on Granivorous Birds.

C.2. Four Major Groups

Four major groups of birds that represent special areas of impact were denoted and are discussed in detail in the following section

C.2.1 Waterbird Populations

Due to drought conditions, waterbird populations were far below normal levels at wetland sites in the Senegal River delta in December, 1977, but still, water bird numbers and variety were impressive. Lac de Guiers remained full but the wetlands in Djoudj National Bird Park were strikingly dry. In the Mauritanian delta country, the Diaouling depression was rapidly disappearing, the Tianbrank depression had dried up, and the shoreline of the Keur Massene lagoon was receding. During the August 1977 field session, most of the delta wetlands were in the process of filling from the annual rise of the Senegal River, which did not last long enough to provide water in sufficient quantities to sustain normally high waterbird populations through the winter.

Roux and his co-workers have provided past inventories of waterfowl populations in the Senegal River Valley emphasizing the delta (Roux, Mahao and Tamisier 1976: Roux 1973) including an in-depth summary of the ecology of the three dominant species of ducks in the Senegal River Valley (Roux, Mahao and Tamisier, 1978). To summarize these findings; Anas querquedula (garganey), Anas acuta (pintail), and Dendrocygna viduata (white-faced tree-duck), in that order of abundance, constitute 90% of the waterfowl population in the valley. A. querquedula, a palearctic migrant, is the first to arrive, in September during the rising inumdation stage of the Senegal River, Therefore, it utilizes the abundant wetlands spread out over the whole valley in Senegal and Mauritania. A. acuta, another palearctic migrant, and D. viduata, a resident of Africa, arrive in numbers during the time of receding waters and thus concentrate in the Djoudj depression. By then A. querquedula also has largely retreated to Djoudj. Depending on the year, A. querquedula has varied from 23,000 to 142,000 individuals, A. acuta from 3,000 to 110,000, and D. viduata from 4,300 to 43,000. By mid-winter each year, Djoudj Park normally contains 90% of the waterbirds wintering in the delta. Table 4, taken from Roux (1973), lists numbers of various ducks and waterbirds found in Senegal during an aerial survey.

The Djoudj depression became a haven for waterbirds in 1963 when a system of dikes was built that prevented the inundation of many delta wetlands surrounding Djoudj in Senegal and permitted agricultural developments (Roux 1974). Much waterbird habitat was destroyed. The same developments allowed the retention of waters in the Djoudj basin longer than normally to the benefit of waterbirds.

TABLE 4. NUMBERS OF WATER BIRDS COUNTED IN THE SENEGAL DELTA.
14-18 January 1972 (Rounded Totals) (From Roux, 1974)

	Djoudj National Park	Confluence of Lampsar & Djeuss	Mauritanian delta	Lake Guier	Other areas	Total
Teal						
Anas crecca	500					500
Garganey						
Anas querquedula	95,000	38,000	240	1,620	1,600	135,000
Wigeon						
Anas penelope	1					1
Pintail						
Anas acuta	26,000	200	28,700	830	320	55,000
Shoveler						
Anas clypeata	2,000	40	215	30	29	2,300
Pochard						
Aythya ferina	420					420
Ferruginous Duck						
Aythya nyroca	230					230
Fulvous Whistling Duck						
Dendrocygna bicolor	400					400
White-faced Whistling Duck						
Dendrocygna viduata	35,000	6,300	500	510	680	43,000
Egyptian Goose						
Alopochen aegyptiaca	250					250
Spur-winged Goose						
Plectropterus gambensis	750			410	11	1,170
Comb Duck						
Sarkidiornis melanotos	650				40	690
African Pygmy Goose						
Nettapus auritus	4	4		60	39	110
SUBTOTAL	160,000	45,000	30,000	3,500	2,700	240,000
White Pelican						
Pelecanus onocrotalus	8,000		530		10	8,500
Pink-backed Pelican						
Pelecanus rutescens	110				160	270
White Stork						
Ciconia ciconia	7		7			14
Black Stork						
Ciconia nigra	2				14	16
Glossy Ibis						
Plegadis falcinellus	150	900	70	30		1,150
Spoonbill						
Platalea leucorodia	750		100		100	950

TABLE 4 NUMBERS OF WATER BIRDS COUNTED IN THE SENEGAL DELTA. 14-18 January 1972 (Rounded Totals) (From Roux, 1974) (Cont'd.)

	Djoudj National Park	Confluence of Lampsar & Djeuss	Mauritanian delta	Lake Guier	Other areas	Total
Greater Flamingo *Phoenicopterus ruber*	170		4,350		150	4,700
Crowned Crane *Balearica pavonina*	260		3	15		280
Black-tailed Godwit *Limosa limosa*	4,500	1,500	1,500	1,800	1,200	10,500
Ruff *Philomachus pugnax*	500,000	1,600		700	1,400	500,000
Avocet *Recurvirostra avosetta*	1		2,230		850	3,100

The waterfowl use the open water, lily pond areas, rivers and shorelines for daytime resting areas, which prevents predation. At night they fly to feeding grounds in marshes and other areas of aquatic emergent vegetation having water levels of less than a meter in depth. Native grasses in seed, covered by the inundation, are favorite feeding sites. Rice and other agricultural crops are presently little used by waterfowl.

Bird banding records show that the population of A. querquedula in Djoudj arrives from a vast area extending from Europe into Siberia. The Djoudj population represents a significant concentration of this widely distributed but not very numerous European duck and is a critican area along with the Interior Niger Delta in Mali, in the survival of this species (Roux 1974). In drought years in the Senegal River Delta a scarcity in aquatic environments forces A. querquedula to move elsewhere, but mortality is very high, and population levels take several years to return to normal even though subsequent years in Senegal may be wet enough (Roux, Maheo and Tamisier, 1976c). This factor highlights the importance of the Senegal River to the survival of this species.

Djoudj is not so critical to the other two abundant ducks there. A. acuta is a world wide species and overwinters widely in other areas. d. viduata is a widely distributed resident duck in Africa, although it does exhibit seasonal movements and concentrations and becomes unusually abundant in the Djoudj basin in winter.

The Djoudj area and the other wetlands up river complement each other in adequacy for waterbird utilization (Morel, pers. comm. 1977). The first birds to arrive come at the beginning of the expected period of annual rise and inundation by the Senegal River. The middle valley receives maximum flooding first, at the end of September, while the delta maximum flooding is delayed about one month. The time of water recession occurs in October in the middle valley, in November in the delta (Roux, Maheo, Tamisier 1978). Therefore, when the first waterbirds arrive, the Djoudj depression is still rather dry from the effects of the dry season, but up river, wetlands have been revitalized for waterbird use. Later, when waters have receded up river, the Djoudj basin is filled and waterbirds can concentrate there. Thus, both delta wetlands and inundated lands farther up river, including Lac de Guiers and other lakes, contribute to the overall ecological needs of the waterbirds. The diagram in Roux et al. (1978) shows that the Senegal River Valley has approximately 7,000 km^2 of wetlands at the peak of the river rise but that this normally shrinks to around 1100 km^2 by mid-winter.

Considering all species, the numbers and diversity of waterbirds in winter in Djoudj National Park normally is spectacular. Roux (1974) states that "more than a million birds, among them 200,000 palearctic ducks and the major part of the West African population of Pelecanus onocrotalus (white pelican), find refuge there." He lists 69 species of palearctic waterbirds wintering in tropical West Africa. In the short field survey at various seasons conducted by the ornthological

team, 78 species of waterbirds were encountered, comprising both wintering migrants and African birds (Appendix A). This included 6 kinds of pelicaniforms (anhings, cormorants and pelicans), 21 kinds of ciconuforms (herons, storks, ibises, etc.), 10 kinds of waterfowl (Anatidae), 24 kinds of shorebirds (plovers, sandpipers, etc.), 8 gulls and terns, among others. The greatest populations occurred in the Senegal River delt, but nevertheless, waterbird populations were well represented up river except in the Manantali area of the Bafing River where waterbirds were scarce, at least in May 1978 when the ornithological team was there.

C.2.2. Savanna Birds

There is an appreciable acreage of native savanna in areas slated for future reservoir and agricultural developments in the Senegal River project. The inventory of bird populations in the savanna habitats thus relates to the impact that the removal of this habitat due to project developments will have on the avifauna in the Senegal River region.

The most complete inventory of the status of savanna birds in the area is contained in the publication by G. J. Morel titled "Liste Commentee des Oiseaux du Senegal et de la Gambie." The bird list (Appendix A) compiled by the present ornithological team during travels along the Senegal River complements the Morel findings.

Field studies to determine population values for savanna birds were conducted in this study and are discussed in Section D.

The savanna bird population levels in the Senegal River Valley greatly exceeded the approximately 230 birds per 40.5 hectares which was the yearly average for several years found in the nearby Ferlo region away from the river (Morel and Morel, in press). Still, the Morels found granivorous birds were in abundance there. So, the possible presence of seeds cannot be the whole reason for high bird populations in savannas. Availability of water must also be important, since it is readily available in savanna habitat near the Senegal River where bird populations were very high. The water factor is discussed by the Morels who found that the height of the drought forced many bird species out of the isolated Ferlo country to areas with accessible sources of water.

C.2.3. Granivorous Birds

Because of the abundance of grasses and other plants that produce copious numbers of seeds in the savannas of Africa, an abundance of seed eating (granivorous) birds occupy this habitat. Because the Senegal River is in the savanna vegetational zone, the region is characterized by a preponderance of granivorous avian species in terrestrial habitats. This avifauna includes Quelea quelea (black-faced dioch) which is an notorious pest of grain crops in Africa. Quelea quelea was found by the ornithological team in the Senegal River Valley. Past surveys show that Quelea quelea has a widespread distribution in both nesting and roosting aggregations particularly in the Senegal Delta, but also in the middle Senegal River Valley. However, this destructive

species seems to be replaced by the closely related Quelea erythrops (red-headed dioch) in western Mali (Bertoli 1972).

Although Quelea quelea has exerted a tremendously harmful effect on grain crops in African savanna lands, particularly in the Sahel type savannas, the species has been declining in the last decade in the Sahelian Senegal River Valley. This decrease is attributed to a combination of factors over the period, including severe droughts, increased livestock grazing and other human agricultural developments that have reduced savanna habitat for Quelea, plus direct control methods. Although the Quelea problem seems fairly controlled and thus is not as great now in the Senegal River Valley as it once was, Quelea populations still do some local damage, and the possibility for increased damage in the future is immense, considering the plans for augmenting grain production through irrigation.

A number of other species of birds occurring in the Senegal River Valley also have been implicated in grain crop damage but not to the same extent as has Quelea. These include several members of the genus Ploceus (weavers), the genera Euplectes (bishops) and Passer, especially Passer luteus (golden sparrow), a relative newcomer to the Senegal River area. Dove species particularly in the Genus Streptopelia, especially Streptopelia decipiens (mourning dove) have damaged grain crops. Waterbirds such as the shorebirds Philomachus pugnax (ruff) and Limisa limosa (block-tailed godwit) have frequented rice fields, but mainly after harvest (Treca 1975), and the waterfowl Dendrocygna viduata (white-faced tree duck), Anas querquedula (Garganey), and Plectropterus gambensis (spur-winged goose) have been implicated too, but to a minor degree (Morel and Treca, pers. comm. 1977). Although Passer luteus has become very abundant in the Senegal River area in recent years, its food habits consists mostly of insects and weed seeds (Morel and Morel 1976, Buggers and Bortoli 1976).

C.2.4. Protected Birds

The game statutes for Senegal and Mali include a number of avian species found in the Senegal River Valley that are fully and partially protected. (The game statuates for Mauritania were not obtained despite attempts to do so.) Also, of the species that occur along the Senegal River, Ciconia ciconia (white stork) enjoys full protection and all egrets, large bustards, cranes and flamingos have partial protection under the Convention Africaine pour la Conservation et l'Amenagement de la Faune et de son Habitat. This African agreement for the conservation of wildlife and wildlife habitat has been joined by Mali but the status of Senegal and Mauritania with respect to the Convention was not ascertained. In addition, the Convention on International Trade in Endangered Species of Wild Fauna and Flora includes seven avian species from the Senegal River area that are listed in Appendix II of the Convention. None of the nations along the Senegal River had ratified this Convention as of February 1977. No species of bird named in the international list of Endangered and Threatened Wildlife and Plants under the United States Endangered Species Act occurs along the Senegal River. Finally, at least

Senegal has ratified the Ramsar Convention, which is an international agreement for the conservation of wetlands and waterfowl. In so doing, the government of Senegal designated two wetland sites totaling 23,000 hectares to be protected and preserved for waterfowl conservation. These are Park Djoudj and a nearby Delta Sec area near Ross-Bethio.

The species of birds found along the Senegal River that are listed in Appendix II of the convention on international trade of endangered species are as follows: Balearica regulorum (crowned crane), all eagles in the genera Aguila and Haliaetus, all harrier hawks in the genus Circus, Pandion haliaetus (osprey), Otus scops (scops owl) and Platalea leucorodia (European spoonbill). Of the above, only Otus scops was not found by the ornithological team, but Morel (1972) lists it as a wintering bird near Richard Toll. Appendix II contains the species that although not presently threatened with extinction may become so if their trade is not subject to strict regulation. Appendix II also includes some more common species that simply are, in appearance, so similar to a related endangered species that the commoner species must be regulated merely to protect the endangered one. Appendix I in the Convention contains the species that are directly threatened with extinction and thus are strictly protected. None of these species in Appendix I occur along the Senegal River.

Ciconia ciconia was discussed above as a Senegal River species that is strictly protected under the African conservation convention. Morel (1972) found it wintering only at the rice perimeters near Richrd-Toll. The ornithological team found it also at Parc Djoudj in winter. In addition, Ciconia nigra (block stork) was found recently wintering in the Senegal River delta of Mauritania (Roux and Dupuy 1972).

Insight concerning the protected species of birds named in the game laws that occur along the Senegal River can be gained by comparing the lists in the game statuates from Senegal and Mali with the bird list in Appendix A and with Morel's (1972) annotated list. For example, 44 species found in Appendix A are on the list of completely protected birds in the Senegalese game statuates. Perusal of Morel's (1972) list would add more protected species. These birds are mostly birds of prey and large waterbirds. The partially protected Balearica paronia (crowned crane) is particularly abundant in the Senegal River Delta. This a very significant area for this species.

CHAPTER D

FIELD PROJECT RESULTS

D.1. Water Quality

In attempting to determine specific relationships between water bird distribution and environmental characteristics of aquatic habitats, the ornithological team conducted water quality analyses in the Parc Djoudj, Lac de Guiers and St. Louis areas of the Senegal River delta.

The physical factors sampled were, conductivity, water temperature, alkalinity, pH, and dissolved oxygen. The sampling sites were scattered along the Senegal River from St. Louis (including the Atlantic Ocean there) to Richard Toll, along the Djoudj River to the Djoudj basin, and at Lac de Guiers.

The findings are summarized in Tables 1 through 4 in Appendix B. Tables 1 and 2 show the number of each avian species seen at the sampling stations during August the December respectively in 1977, and Tables 3 and 4 show the physical factors at these sites in these two months. Tables 3 and 4 also include the total number of bird species seen and total number of birds counted at each site.

There were no obvious trends in bird distribution relative to changes in pH, dissolved oxygen or alkalinity. The number of bird species and total bird populations was higher in August when water temperatures were high and conductivities were low, than in December when temperatures were lower and conductivities much higher. These changes in physical factors and bird species and densities are probably associated with the season change from August to December, rather than showing any direct cause and effect relationship. It simply is warmer in August and high waters from the Senegal River dilute saline conditions more than in December when the migrating influx of birds from the palearctic region arrives. Within each season there were no conspicuous relationships between varying physical factors and avifauna characteristics. However, it is possible that salinity and temperature affect food sources (e.g. fish, aquatic invertebrates).

D.2. Savanna Census

In addition, the ornithological team completed the first detailed bird population censuses ever conducted in the savanna habitats along the river. The results (Table 1 and appendix C) showed that there is an extraordinarily high bird population in the savannah despite only moderate species numbers and diversity. The census tracts at Diama, Richard Toll, Guidakar and Matam in Senegal were all in the Sahel savanna zone and bird populations there ranged from 437 individuals per

40.5 hectares in August at Diama to 3991 at Matam in December (Table 5). The average bird population for eight censuses over the four Sahelian sites, once in August 1977, once in December 1977, was 1616 birds. This is exceptionally high compared to bird populations found elsewhere in the world. The high population trend continued at the Bakel, Senegal, site in Sudan savannah where there were 866 birds per 40.5 hectares, and 683 in Guinea savanna near Manantali, Mali.

These high population levels are attributable to what must be a high density of seeds persisting in the soil during dry parts of the year. The presence of this copious seed supply is conspicuous once the rains arrive and the dry denuded land turns green quickly due to sprouting seeds. This sudden simultaneous sprouting and consequent sudden disappearance of a vast seed food suuply in fact produces a stressful period for granivorous birds (Lack 1966). It is an obvious time for bird deprivation of agricultural grains where irrigated grain crops are available.

Indeed the percentages of granivorous birds in the populations censused was extremely high (Table 6) thus supporting the idea that the high populations were due to the great availability of seeds which supported large numbers of seed eating birds. Percentages of granivores ranged from 31% at Matam in August to 94% at another site there in December. The median percentage of the 10 census plots is in the low 60's and the averages is 58.4%. Thus over half the birds were granviores whereas in most avian communities well under half the population are seed eaters.

TABLE 5. AVIAN POPULATION LEVELS AT VARIOUS SAVANNA SITES IN SENEGAL AND MALI

BIRDS PER 40.5 HECTARES (SPECIES)

LOCATION*	AUGUST		DECEMBER		MAY	
MAKA-DIAMA	437	(16)	718	(19)		
RICHARD TOLL	2169	(27)	810	(20)		
GUIDAKAR	2772	(31)	1460	(25)		
MATAM	567	(14)	3991	(18)		
BAKEL					866	(20)
SERHOTO					683	(26)

*Serhoto near Manantali is in Mali, the other sites are in Senegal

CHAPTER E

ENVIRONMENTAL IMPACTS

E. Environmental Impacts

E.1. Diama Impoundment Area

E.1.1. Negative Impacts

E.1.1.1. Carnivorous Water Birds

Carnivorous birds such as herons, egrets and pelicans will be affected directly as the impoundment affects fish species. The Fisheries Report indicates changes in salinity and the construction of the Diama Dam will result in a loss of many fish species in the Senegal River. Loss of estuary fishes, with an associated decrease in overall productivity, will result in decreases in fish-eating bird populations. Water birds that utilize the Parc Djoudj will be unaffected by this impact since recharge of Lac Djoudj is mostly fresh water. Relatively little usage of the Senegal River channel by these species decreases the economic importance of this impact.

If dikes surrounding Parc Djoudj are not constructed and/or maintained, over-flooding within the park will alter much of the existing habitat for the park's many bird species. Optimal foraging areas for many species are maintained by controlled inundation and drainage over seasonal periods. Loss of this control would have severe effects on species such as the Pink-backed Pelican (*Pelecanus rufescens*) and the White Pelican (*P. onocrotalus*), which breed in the park.

After the impoundment fills and agricultural irrigation begins, removal of water from the lake may reduce available habitat around the lake perimeter for these species. However, the overall benefits from creation of new habitats will offset this negative impact.

E.1.1.2. Ducks and Geese

The negative impacts expected from the Diama impoundment would be associated with the possible uncontrolled flooding of the Parc Djoudj. If dikes are not maintained, the primary foraging areas (wild grass seeds in the park) would be lost, resulting in a drastic decrease in the Main-

tenance of park habitats is critical for the survival of this species, since Djoudj represents one of two jamor wintering grounds for the Garganey (Roux 1974).

E.1.1.3. Savanna Birds (Insectivorous)

Inundation of 235-square kilometers of savanna habitat will result in a complete loss of habitat to savanna birds. We estimate that with population levels of 192 birds per square kilometer (based on our most conservative census value), a minimum of 256,620 total birds will be lost. These birds will move into surrounding savanna areas, but this number represents a near-total loss, since competition with existing capacity populations of birds will result in a decrease in total population numbers in these areas. Because the area of inundation will not be a loss of a critical habitat (savanna areas will be left), and considering the short-term effect, this impact is considered of relatively minor economic importance. However, mitigating measures are necessary to prevent future total destruction of savanna habitat near the river. Morel (in press) has pointed out the importance of available water to savanna species. Mitigating measures would have to consider habitat replacement in areas near the river.

Over the long term, development of the savanna areas along the Senegal River for farmland will further decrease habitat for species of savanna birds. Specific requirements for savanna species are not known, however it appears from the observations of the ornithological team that grazing disturbance over the middle and lower Senegal River region of savanna forests is not detrimental to birds since population census totals and species diversity are among the highest ever recorded worldwide.

Alteration in quality of savanna will also affect avian populations. Loss of 1065 hectares of gonakie forest will reduce the quality of savanna habitat for birds. Complete loss of vegetation as a result of deforestation will remove sananna habitat entirely. By definition, trees represent the difference in savanna and desert habitat in Senegal. The high avian productivity observed for savanna areas studied is not true for deserts. If the entire ecosystem of the area is to be preserved (for humans as well as birds), it is necessary to maintain, manage and control usage of the savanna vegetation (see Forestry Report). Reforestation measures, if protected, should mitigate some of these losses.

E.1.1.4. Granivorous Birds

Loss of savanna due to inundation will be a short term detrimental impact to these species, even through the source of most of the granivorous

bird species populations is the savanna habitat. Further development of savanna lands for agriculture will mean a further decrease in habitat. However, this will be relatively unimportant considering the large positive impact of increased food availability in the grain fields to be developed.

The overall effect will be an increase in granivorous bird populations. Different species are expected to respond in various ways some, such as the pest birds, will rapidly increase in population densities, while others may decrease, depending on specific requirements and various control methods implemented.

E.1.1.5 Protected Bird Species

Uncontrolled inundation of Djoudj could endanger habitat and resource availability for several species, including the Crowned Crane (Balearica regulorum), White Stork (Ciconia ciconia), European spoonbill (Platalea leucorodia), Osprey (Pandion haliaetus), West African River Eagle (Haliaetus vocifer), Marsh Harrier (Circus aeruginosus), Montagu's Harrier (Circus pygargus), and the Greater Flamingo (Phoenicopterus ruber).

E.1.2. Positive Impacts

E.1.2.1. Carnivorous Water Birds

Creation of a large shallow-water impoundment along with resulting marshy perimeters, as well as maintenance of water in Lac R'Kiz and Aftout es Sahel in Mauritania, will increase considerably the available habitats for egrets, herons, pelicans, storks and ibises. Populations of these species, now mostly concentrated in Parc Djoudj, will increase due to the increase in habitats for feeding and nesting. Protection of these species and habitats will be necessary if new populations are to be maintained.

If dike systems are controlled successfully, maintenance of water levels in the Diama impoundment, Mauritanian lakes, and the Djoudj area will insure available habitat to species during drought years. This will prevent the present level of losses of birds in exceptionally dry years and should be a large positive impact immediately a well as long term.

Expected increases in sedimentation within the impoundment area should result in an overall increase in productivity, resulting in increased water plants, marsh grasses, fish, manatees, and other aquatic organisms. This "bloom" in biota will also be reflected in increased bird populations, especially fish-eating birds.

Fluctuation of water levels within the impoundment will be beneficial to fish-eating species, due to concentrations of fish and larval frogs in shallow pools during periods of lowered levels. Migrant shorebirds will also be expected to utilize the uncovered mudflats during low water periods.

E.1.2.2. Ducks and Geese

An immediate, as well as long term, advantageous impact resulting from impoundment will be the large increase in available resting habitat. This will be in the form of open water for ducks and geese. Migratory ducks (Garganey, Pintail and Shoveler) will utilize the lake during winter seasons. Resident species such as the Knob-billed Goose and Pigmy Goose will utilize the habitat year-round. Marshy habitats along the lake's edge will provide breeding habitats for these resident species.

Creation of a marshy periphery around the impoundment will result in an increase in feeding and breeding habitats for these species, especially if later development of these wetlands is limited.

With increased agricultural development, long term increases in feed habitat will benefit these species to the extent they may become economic pests. The White-faced Tree-duck (Dendrocygna viduata) and the Spur-winged Coose (Plectropterus gambensis) have been implicated in rice field damage.

With control of water levels in Parc Djoudj, beneficial effects will result from better management possibilities for natural grain (native grasses) development. This would be an immediate as well as long term impact. Presently, drought years reduce seed production in the park, resulting in decreased populations of ducks and geese. More efficient control of seed production would result in fewer losses of garganey, pintails, shovelers and white-faced tree ducks which winter in the park in large numbers. Increases in population numbers of more rare species such as the Pochard (Aythya ferina), Ferruginous Duck (Aythya nyroca), Egyptian Goose (Alopochen aegyptiaca) and Comb Duck (Sarkidiornis melanotos) could also be expected.

E.1.2.3. Savanna Birds

Most species of savanna birds will be favorably impacted by the Diama project. An overall increase in productivity due to higher water table levels in the savanna areas near the lake, increases in numbers of insect prey both in the savanna and in the crop fields, as well as increased water availability (irrigation ditches and lake) will result in increased populations of these species. Disturbance due to grazing of the savanna as observed by the ornithological team does not appear to have detrimental effects on these birds. The presence of insectivorous birds is highly advantageous to human interests in terms of insect control. Loss of significant numbers of these species would result in severe insect pest problems.

E.1.2.4. Granivorous Birds

Increases in productivity of savannah areas, due to higher water table levels, would also favorably impact granivorous birds in these areas as seed production increased. This effect is considered minor compared to positive impacts of agricultural development.

E.1.2.5. Protected Bird Species

Creation of the Diama impoundment, filling of Lac R'Kiz and Aftout es Sahel in Mauritania, and control of water levels in Djoudj will positively affect many of the protected species. Most of the species listed in the previous section as protected bird species are fish-eaters. The frog populations are also a major source of food for the Crowned Crane, White Stork, and the egrets and herons. As forg populations would also be expected to increase in the impoundment areas (see Mammals and Herpotology Report), and fish populations become established (Fisheries Report), so well their predators. Flamingos would be expected to increase in numbers especially in the saline lakes in Mauritania as invertebrate productivity increased with constant water releases. Protection from poaching (not just adults but eggs, young) will be necessary to maintain these new populations. Nest predation increases from crocodiles, monitor lizards would be minor, however, disturbance (river traffic, human use of perimeters) would greatly lessen the postive effects of this impact around the Diama impoundment.

E.2. Agricultural Development

E.2.1. Negative Impacts

The principal impact of development on bird populations will be loss of natural vegetation converted to irrigated perimeters. This is estimated to be about 155,000 hectares of presently unfarmed natural lands lost to development of fields (mostly heavily used unclassified savanna forest). Present livestock and human disturbance within these forests do not appear to have limited avian usage of the savanna. Total removal of vegetation and replacement with croplands, however, will seriously impact on many species. Responses of individual species cannot be assessed due to lack of sufficient life history information. In general, some granivorous species will be expected to increase by utilization of crops. Insectivorous savanna birds will be more heavily impacted by habitat loss with resulting population decreases.

Widespread usage of pesticides in croplands could impact insectivorous species by removing food sources and by concentration of pesticide residues in the body tissues of the birds themselves, resulting in high mortality rates. Since some utilization of wild birds for human food occurs in villages, this could also be hazardous for human health. Educated consideration of available pest control measures should lessen the effect of this impact.

Extensive usage of pesticides would most likely be a negative impact on top level predators such as the Eagle, Harriers, and Osprey. Concentrations of pesticide residues can cause population decreases due to egg shell thinning, as has been demonstrated in species in the United States, such as the Peregrin Falcon. Fish-eating species may also be affected from agricultural runoff pollution of the river and contamination of fishes. Proper control of pesticide usage should lessen this possible impact.

E.2.2. Positive Impacts

As agricultural development of the area proceeds, an increase in available water in irrigation ditches will be utilized by many bird species. Coucals, diochs, marsh hens and other species were observed around irrigation ditches in the sugar cane fields at Richard Toll. If fishes (e.g. Tilapia spp.) and frogs (Dicroglossus occipitalis) populate these pools, carnivorous water birds will be expected to utilize these food sources.

Development of agricultural areas and irrigation practices will lead to a large increase in population sizes of granivorous bird species, such as diochs and golden sparrows. This long term positive impact for the bird species will be seen as a negative human impact as species reach pest proportions. The magnitude of this impact on agricultural economics could be tremendous, as has been demonstrated in many other African nations. As the area develops, loss of surrounding savanna habitat and natural foods will augment the pressures on grain crops. Responses of individual species to these pressures is hard to predict. Presently known pest species include the Black-faced Dioch (Quelea quelea), Bishops (Euplectes spp.), the Blue-eared Glossy-starling (Lamprotornis chalybaeus), the Morning Dove (Streptopelia decipiens), the Long-tailed parrakeet (Psitaccula krameri), and several species of Weavers (Ploceus cucullatus, capitalis, Passer luteus, P. griseus and Bubalornis albirostris). These species all occur in the Diama area in relatively low densities at present. It is possible that other species that have not been encountered as pests could opportunistically utilize the new crop sources as well, and develop into pest numbers. On the other hand, many granivorous birds of the savanna habitats will remain in these habitats, utilizing the tremendous natural seed resources available.

E.3. Manantali Impoundment Area

E.3.1. Negative Impacts

E.3.1.1. Water Birds

No major negative impacts to water birds are foreseen for the Manantali inundation area, since few water birds (virtually no ducks or geese, and few carnivorous water birds) were observed during the site visit of the ornithological team. Other members of the project reported that very few water birds had been seen on previous trips to the Manantali area. The absence of large bodies of open water seem to preclude the existence of any large densities of water birds in the area.

However, during periods of low water level (dry season), many egrets, herons and shorebirds utilize the shallows and mudflats down river from the proposed damsite. If the low flow regulation as proposed maintains moderate water levels in the river channel, these seasonal habitats, and the birds, would be lost. Alternation of high and low levels of flow during the dry season would lessen this impact since sandbars and mudflats

would be periodically uncovered. The River and Estuary report indicates that sedimentation areas will occur between Bafoulabe and Bakel. This should increase the productivity of the area and presumably produce additional habitats (more mudflats).

Specific habitats for some species will be lost due to inundation. For example, Cocodile Birds (Pluvianus algyptius) will be lost, due to inundation of rocky and sandy shores along the Bafing River.

E.3.1.2. Savannah Birds

Relatively minor negative impacts are predicted for savanna bird populations due to the Manantali impoundment. Loss of Sudan savanna habitat and those birds in the area of inundation will be permanent, but relatively inimportant to total population levels and economically minor. In view of the importance of protecting remaining savanna habitat from development, mitigating measures are necessary.

E.3.1.3. Granivorous Birds

The same relatively inimportant negative effect (loss of habitat) will occur for granivorous birds as listed for savanna birds.

E.3.1.4. Protected Species

No information is available to determine the amount of usage of the Manantali area by individual species. Egret habitat along the river down-stream from the dam will be lost if high flow levels are maintained. Information on other species such as hawks and eagles in the area is not available, but there are no major impacts foreseen.

E.3.2. Positive Impacts

E.3.2.1. Water Birds

Increase in water habitats after construction of the dam will benefit all groups of water birds, which are presently few in numbers in the area. The large open-water impoundment should attract ducks and geese. Additionally, shallow marshy perimeters would be suitable habitat for species of egrets, herons and possibly cranes. Degree of utilization of these areas by birds will depend on a suitable resource base (i.e. fish, frogs and grass seeds). A large grassy perimeter with fluctuating water levels could, in the long term analysis, create areas, like in Parc Djoudj, as a major attraction for bird species.

E.3.2.2. Savannah Birds

No foreseeable positive impacts are recognized for savannah birds.

E.3.2.3. Granivorous Birds

With the gradual development of grassy areas around the impoundment, granivorous birds would benefit. As these increases in population sizes

affect any developed croplands, the impact could become economically important to man. Since no large scale farming or grain crops are planned for the region, this economic impact will be minor. One should also consider that providing granivorous birds with alternatives to crops, such as natural grassy areas, result in a reduced impact on agricultural crops.

E.3.2.4. Protected Species

Development of grassy periphery areas around the lake will increase available habitat for egrets and cranes. Utilization of these areas will depend on food abundance (fish and frog populations), as well as other specific habitat parameters that are presently unknown. Ornithological information for this region is scarce, and field experience of the ornithological team did not disclose use of the area by protected species. It is possible that a large lake could be an attraction to species not presently found in the area, but this impact is difficult to assess.

E.4. Lake Guier

A distinction between impacts of Diama impoundment and effects on Lake Guier is necessary. Favorable impacts for water birds at Lake Guier are immediate, although not of great magnitude (modest increases in population sizes of species already present). Creation of the Diama impoundment will take a considerable period to become productive enough to support many species of water birds. For example, fish-eating birds may not utilize the Diama impoundment for many years. Therefore, most of the favorable aspects of Diama will be long term. However, the projected magnitude of the increases in water bird populations will be much higher in the Diama area since there are very few species utilizing the river channel at present.

E.4.1. Nagative Impacts

As lake levels increase and perimeters expand, no long term major negative impacts on bird species are expected.

E.4.2. Positive Impacts

Increased surface area and perimeter habitats will benefit all water birds including those that are protected species.

E.5. River Navigation

E.5.1. Negative Impacts

The proposed entry channel, permanent lagoon and associated port development at St. Louis will have only a detrimental impact on bird populations. Species of marine birds utilizing the Langue de Barbarie National Park will be disturbed by construction activities, dredging and oil or chemical spills associated with port traffic.

Table 7 lists species of marine birds utilizing the Park. Two species of gulls and four species of terms, representing some 12,720 birds, breed in the 2000-hectare area of the park located 25 kilometers south of Saint-Louis.

Development and maintenance of the river channel will negatively impact waterbird usage of the river basin. Disturbance from river traffic and dredging operations will also impact these species unfavorably. These impacts are relatively minor down-river from Matam where bird utilization along the river is minimal. Larger populations of water birds were censused upriver from Matam at several sites. Fairly dense populations of herons, egrets, shorebirds were observed using the floodplain, mudflats and sandbars of the river especially upriver from Bakel.

Habitat losses will occur for terrestrial bird species (savanna birds) due to dredge spoil disposal operations along the edges of the river. However, the Rivers and Estuary Report indicates that the land will quickly revegetate after deposition so that the impacts would be temporary and of minor impact to savanna bird populations as a whole.

E.5.2. Positive Impacts

No positive impacts on birds are predicted from development of river navigation.

E.6. Summary of Impacts

Three impacts to birds of major economic importance are anticipated:
(1) impacts to Parc Djoudj (positive and/or negative),
(2) habitat loss in savanna areas due to inundation and agricultural development, and
(3) positive impact on granivorous birds and waterfowl.

Parc Djoudj is a valuable source of income for Senegal (100,000,000 CFA/yr by 1980) as well as reserve for the future enjoyment of the Senealese and worldwide peoples. Loss of this park would be irreplaceable and represent a substantial income loss in the future. As more and more wild areas are developed over Africa, tourist pressure on existing animal parks will increase. Development and protection of this national resource is, therefore, extremely important. The Diama dam, Manantali dam and resulting low flow augmentation should have a favorable impact on management control in Djoudj. Protection of the dikes and gates around the park will be necessary to assure these positive impacts.

Habitat will be lost due to inundation and agricultural development for most species of savanna birds. The great diversity of types of birds utilizing the natural savanna areas and their many economic and beneficial impacts on man and the biotic environment necessitate mitigation to prevent their eventual total loss. For example, amny species are critical in controlling locust and other insect populations, and many are utilized as food by villagers. The Sahel savanna is also a major wintering area for many species of European and African migrants.

TABLE 7. BIRD UTILIZATION OF THE LANGUE DE BARBARIE NATIONAL PARK.

Common English Name	Latin Name	French Name	Status
Lesser Flamingo	Phoenicopterus minor	Flamant nain	Rare
Greater Flamingo	P. ruber roseus	Flamant rose	Common
Slender-billed Gull	Larus genei	Goeland railleur	2500 pairs
Grey-headed Gull	L. cirrhocephalus	Mouette a tete grise	3000 pairs
White Pelican	Pelecanus onocrotalus	Pelican blanc	300-400 individuals
Pink-backed Pelican	P. rufescens	Pelican gris	Common
Caspian Tern	Sterna caspia	Sterne caspienne	200 pairs
Gull-billed Tern	S. nilotica	Sterne hansel	60 pairs
Little Tern	S. albifrons	Sterne naine	100 pairs
Royal Tern	S. maxima	Sterne royal	500 pairs

The positive impact on granivorous birds to be initiated by agricultural development of grain crops will become a negative economic impact for man. Crops lost to pest species represent a considerable economic loss over all Africa.

CHAPTER F

MITIGATION ALTERNATIVES

F. Mitigation Alternatives

The previously discussed, major economic impacts will be considered in the following pages. All possible mitigating alternatives considered will be listed. Then, in the next CHAPTER, these will then be evaluated.

F.1. Djoudj Impact

The prevent any negative impacts in Djoudj, dikes could be constructed and maintained.

To increase or assure water level management capabilities within the park, water gates could be repaired and maintained. If necessary, new gates should be constructed.

To assure proper technological implementation of procedures involving Djoudj, a wet land ecologist could be hired to assess in more detail the impacts and measures to be considered.

To prevent losses to specific species (such as protected species), research programs could be initiated in the park to study life histories to these species.

Other park areas could be established to provide habitat alternatives to species within the park.

The no-mitigating measures alternative could be considered.

F.2. Habitat Loss in Savanna Areas

Most of the mitigation alternatives mentioned in the Mammology and Herpetology report are applicable to impacts on bird species as well. These include:

Equivalent sized areas of habitat similar to those which will be lost could be established near each of the proposed impoundments. At Manantali this would require that 123 kilometers of fringe forest along the Bafing River be set aside as a wildlife preserve.

Existing national parks (e.g. Djoudj National Bird Park) could be expanded and new national parks could be established. This would provide areas of complete protection for wildlife and would permit habitat management, thus optimizing conditions for several important species.

Wildlife specialists could survey the areas to be affected to obtain data on population levels and carrying capacities for important species. This would provide quantitative information to be used in assessing impacts and designing appropriate mitigation measures.

Preforestation and forestation of protected areas around the new impoundments and along the Senegal River could be initiated. These areas would improve savanna forest habitat quality for bird species as well as other wildlife. Establishing alternative habitats from crop fields can also be instrumental in helping control possible pest species.

The no-mitigating measures alternative could be considered.

F.3. Pest Bird Control

Although impacts to granivorous bird species are favorable, it is necessary to consider mitigating actions to control the resulting economic impacts on field crops. Presently, bird pests exert heavy pressures on grain crops in Senegal. For example, as indicated in the Agriculture Report, millet grain losses are presently greater than 50%. These losses are mostly attributed to granivorous savanna birds.

Major mitigating alternatives to the pest bird problem include:

1. The birds could be killed at night-time roosting aggregations using explosives or spraying with pesticides.

2. Systematic destruction of nesting colonies near crops could be implemented.

3. Harvesting African species of ducks that become over-abundant.

4. Birds could be frightened away from fields using people, cannons, etc.

5. Fields could be covered with nets.

6. Watering sites could be poisoned.

7. Seed dressing or crop dressing repellents such as Curb, Mesurol, Methiocarb could be used.

8. Major rice harvests could be timed to occur when potential pests are absent.

9. Rice crops could be alternated with non-grain crops.

Timing of mitigation measures is very important in this agricultural-savanna system. Figure 1 summarizes major seasonal relationships to be considered. It can be readily seen that migrant ducks, for instance, presently only impact rice at the early stages and are not present during harvest. It also appears that species such as Quelea quelea are

major impact forces on present rice harvest in April when they are at maximal flock sizes, but will be breeding in remote savanna areas during the second rice harvest once double-cropping in implemented. Thus, the major rice predators (ducks vs. rice birds) will differ during the two seasons.

Detailed studies of particular species' seasonal habitats are necessary to determine the exact pressures. However, it appears that at least two different problems will exist and should be dealt with using different control methods.

Predation on mature rice at harvest time is at present limited to local species due to harvest dates prior to migrant arrivals. Migrants (Ruffs and ducks) are present in Senegal for October to March. A second rice crop produced during this period would be subject to predation by these species. A second crop might also provide a more stable food supply for some granivorous savanna birds which can breed whenever sufficient water and seeds are available.

Harvesting the rice in September, if possible, would minimize predation by migrant ruffs and ducks, and many species of savanna breeding weavers such as Quelea quelea, bishops and others (see table 3 and figure 1). Other species not controlled by this method, such as Village Weavers, are more locally breeding, and their colonies are more easily found and destroyed.

Predation on sprouting rice sown in irrigated fields is attributed to palearctic migrant Ruffs (Philomachus pugnax) and White-faced tree ducks (Dendrocygna viduata). Methiocarb repellent has been shown to be effective against these and other bird species (Bruggers and Ruelle, 1977) when applied to pre-germinated rice seeds.

Current agricultural production of tomato crops in irrigated perimeters during the dry season is desirable to prevent even larger predation rates on rice by birds.

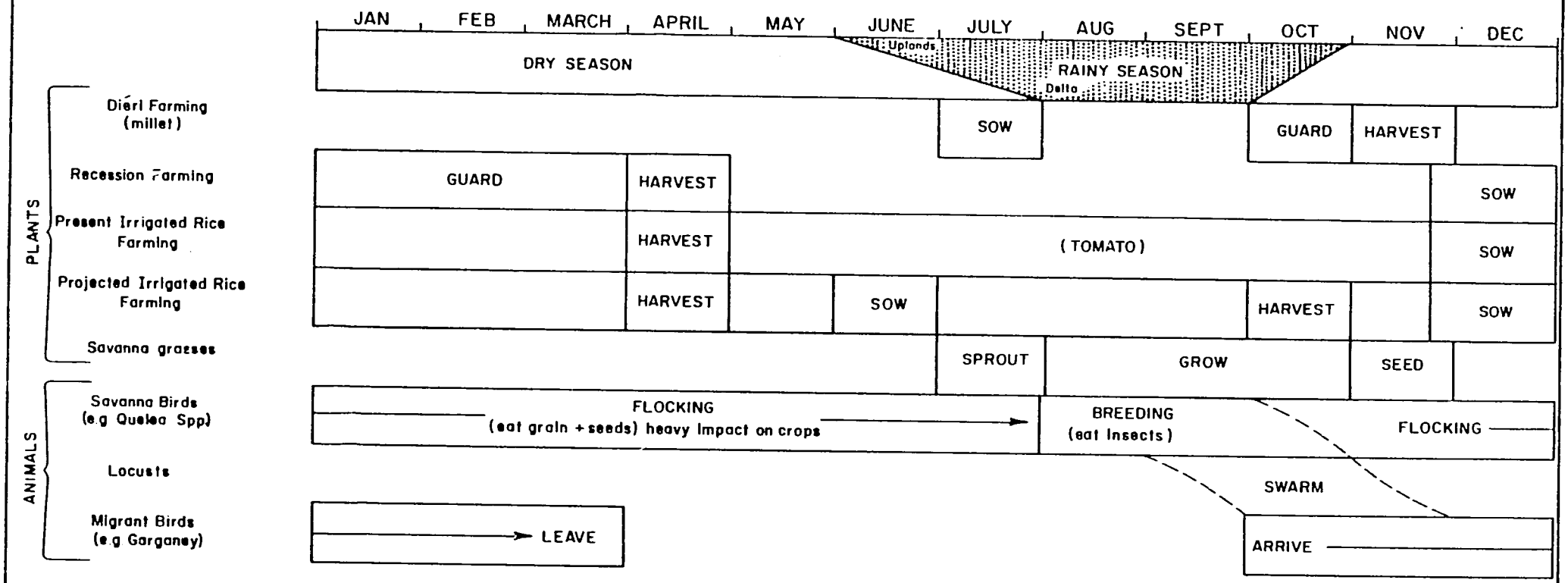
Normal population control on savanna birds occurs during the dry season when food (wild seed) availability is low. Providing a second rice harvest could allow bird populations to increase every year, more and more, virtually unlimited. As long as one period per year has low food availability, (they do not eat tomatoes), material control could be maintained for species such as the Golden Sparrow, while maintaining productivity in the fields.

Staggered harvest times in differnet areas should also be prevented to prevent a constant food source being available to these birds.

Since many flocks are highly mobile, they can move from field to field up the river destroying crops. Synchronized harvest times all along the river valley would minimize the impact of flocks (they can only be one place at a time).

Figure: 1

SCHEDULE OF EVENTS: AGRICULTURAL, CLIMATOLOGICAL AND AVIFAUNAL



In summary, synchronizing harvests followed by periods of low food (rice) availabilities would have quite an unfavorable impact on pest bird population levels.

CHAPTER G

EVALUATION OF MITIGATION MEASURES

G. Evaluation of Alternatives

G.1. Djoudj

Dike repair, maintenance and gate replacement is a technically feasible and warrented mitigative measure. With the higher water levels in the Diama impoundment, an adequate dike and gate system is necessary to control water levels that are necessary to maintain present habitat quality within the park. Placement of additional dikes around the park would further protect the area from irrigated perimeter influences. Total costs, as estimated in the Mammalogy and Herpetology Report, are 458,880,000 CFA.

A monitoring project that involves the hiring of a wetlands ecologist is feasible and recommended. The temproary appointment of the consultant would be for purposes of assessing water level impacts on present species in the park, recommending management techniques, and training park officials in the technology necessary to maintain and increase wetlands productivity in the park. Costs of the project include:

--Labor

Wetlands ecologist salary	7,350,000 CFA per year
2 Conservation Officers[1]	1,800,000 CFA per year
2 Support Staff[1]	720,000 CFA per year

--Direct Costs

Field meals and lodging	2,000 CFA per day per person
Car (Land Rover)	3,000,000 CFA
Boat (Motorized)	425,000 CFA
Maintenance and Miscellaneous	65,000 per month
Transportation and baggage for ecologist and dependents	2,000,000 CFA
Per diem for ecologist	3,830,000 CFA per year

[1]could be existing Parc Djoudj personnel

Research programs to study protected species could easily be initiated easily at the park. Surveys of population densities, as well as African River Eagle and Pink-backed Pelican would greatly increase the information known about these species, their habitats and food requirements, breeding requirements and present pre-impoundment population status. The studies should also assess the value of the parks as reservoirs for species found outside the park. Cooperative exchange between park officials, international wildlife organizations, O.R.S.T.O.M. and university research institutions could minimize costs of such research.

Creation of new park areas, as discussed in the Mammalogy and Herpetology Report, would be an effective method of assuring habitat availability to species in Djoudj. Land adjacent to Djoudj in Senegal and 30,000 hectares of land west of Djoudj in Mauritania are not within the planned areas of development and are recommended for national park status. The proposed park enlargement will also act as a buffer zone between park animals and nomadic herding peroples west of the river and will help reduce the impact of illegal burning of grasslands which presently occurs within the park. Figure 2 shows the area of proposed enlargement in Senegal for Djoudj.

An increase in park conservation officers will be needed to patrol enlarged park boundaries. An increase in size of the park will not be beneficial if adequate enforcement of wildlife laws and park regulations are not maintained. Costs would depend on numbers of persons hired (at 900,000 CFAF per person per year).

Nonimplementation of mitigating measures is an unsatisfactory alternative. Low costs of preventative measures (dike and gate repair and maintenance) and magnitude of possible adverse impacts (destruction of major habitat areas in Djoudj for 3,000,000 birds that visit the park annually, as well as loss of national income of 100,000,000 CFA due to visitors to the park) indicate that this approach is unsatisfactory.

G.2. Habitat Losses in Savanna Areas

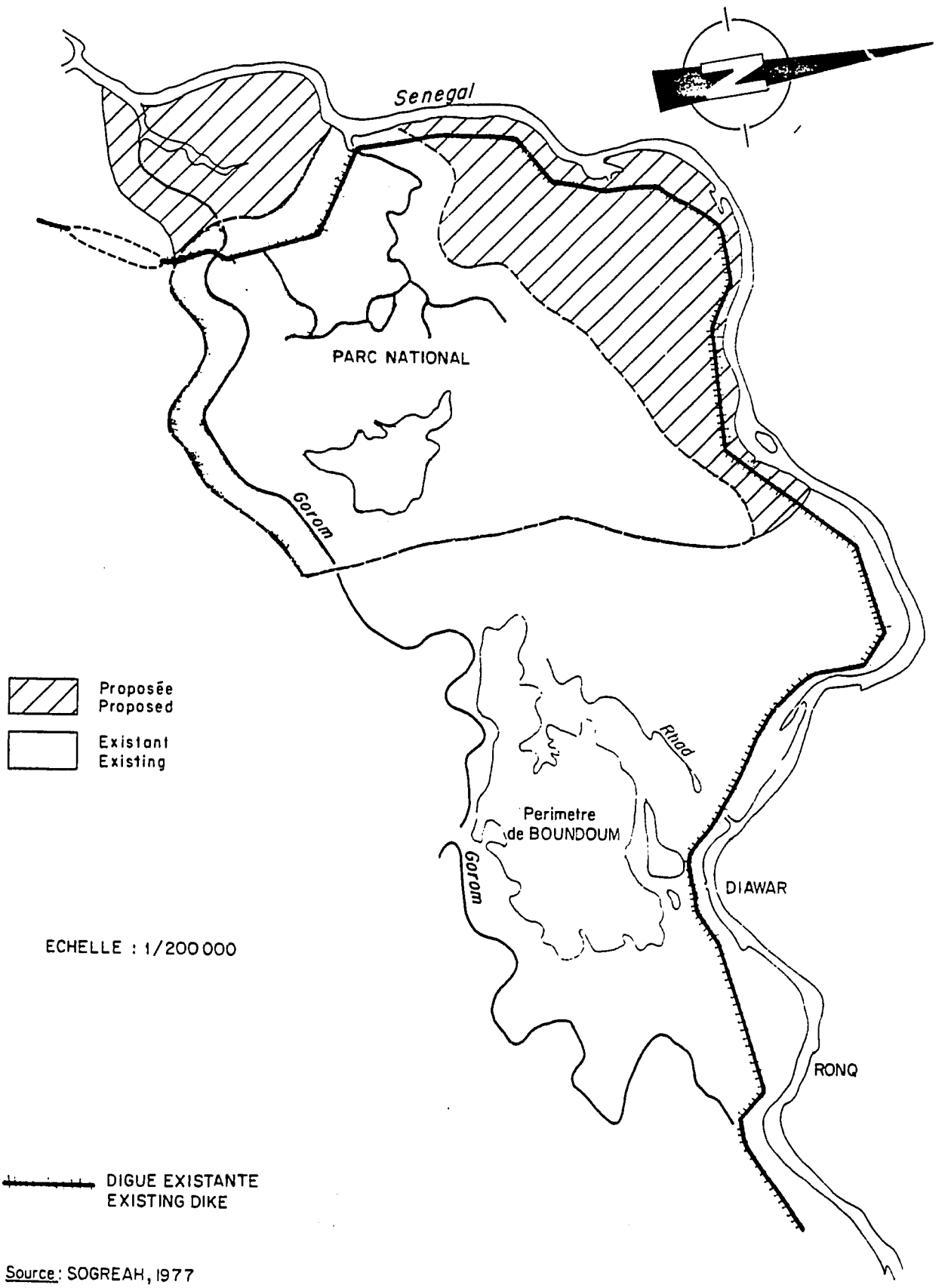
Setting aside equivalent sized areas of similar habitat is not practical due to lack of suitable areas available, without large-scale resettlement projects for villages.

Expanding existing parks and designating new national parks as discussed in the evaluation section on Djoudj are also the mitigating factors for this impact. In addition, establishment of a new park (40,000 hectares) along the Bafing River in Mali in areas not planned for development will protect present habitat and improve habitat quality for species in that area. Since little is known at present about birds in this area, it is important to protect wildlife and avian habitats as the surrounding area develops in the future. The park could easily be acquired, would not require resettlement of large numbers of people, and management of the park presents no technical problems. Advantages of this action include revenue from the new park for the state of Mali and the tremendous increase in information on avifauna of the area. Development of this area into an active national park would require a detailed study.

A quantitative survey of areas of savanna would provide a more detailed assessment of avian population sizes than this report could determine. Our estimates of population sizes are extremely high, indicating that the savanna ecosystem is, in fact, a very productive one, when compared to other areas of the world. This is not immediately apparent. Morel and Morel (personal communcation, 1978), working for O.R.S.T.O.M., are presently studying on the diets of many savanna species.

Figure: 2

CARTE DU PARC NATIONAL DE DJOUDJ
MAP OF THE DJOUDJ NATIONAL PARK



Source: SOGREAH, 1977

This work, in association with quantitative surveys of bird populations in the savanna areas, would provide much useful information necessary to evaluate problems, such as graniorous pests, seasonal savanna productivity and insectivorous bird population dynamics. The strip census method used by the ornithological team requires few materials (two binoculars, two compasses, notebook and pencil), can be done by two persons and is not difficult or time consuming. Costs of this project would be minimal, including equipment, training of two field persons, and their salaries for a period perhaps of two years.

Planting of tree seedlings could be easily initiated and administrated by the National Park service for areas that are within parks and by Eaux et Forets in other regions. Costs would depend on extent of planned plantings.

The final alternative, no mitigating measures, is not warrented considering the ease with which some of the alternatives can be implemented and the severity of impacts on wildlife.

G.3. Pest Bird Control

Killing the birds on night-time roosts is only possible for species that roost in large numbers, such as Quelea species. This is not a recommended large-scale project due to difficulty in locating roosts and destruction of considerable amounts of habitat necessary to affect population numbers of the birds. Destruction of one roost would simply move the remaining birds to another location. Since many of these birds roost in remote areas, the amount of time spent looking for roost areas would be prohibitive. Additionally, movement of equipment required to destroy a roost would not be possible in most areas of limited access. Only local roosts near irrigated perimeters would be accessible, and the detrimental effects to human health from using pesticides and explosives would probably not warrent the action. Further study of the effects and evaluation of this technique is warrented and could augment other mitigating procedures in local cases of severe pest control problems.

Systematic destruction of nesting colonies near crops is probably more effective than destroying roosting sites, since total productivity is being targeted and controlled. Destroying concentrations of young birds is more effective in controlling population growth than removal of adults. This method would only be effective on birds nesting near fields and would not have an impact on other species, such as Quelea spp., which tend to nest in remote areas. Study of particular methods to be used (i.e. explosives, shooting, burning) would have to be conducted to evaluate the impact on populations of target birds, cost of implementation and effectiveness before any large-scale project could be initiated.

Control measures proposed above apply to granivorous savanna species, which reside and breed in the affected areas. Migrant waterfowl and ruffs are presently not rice pests during harvest periods due to absenteeism.

If double cropping in the irrigated perimeters develops as proposed, the migrant species could become pests. Management techniques that would be implanted within Djoudj in order to produce sufficient overwintering grass seed crops may well prevent such occurrence. Migrant population numbers are probably limited in their northern breeding ranges (Europe) by breeding success and hunting, with the result that population numbers in Africa would not be predicted to change due to rice agriculture. Resident species of ducks and geese, however, will probably increase. These would be the target species should their populations produce pest pressures on rice production. If such a situation developed, strictly controlled harvesting in such a situation might be possible. Methods such as cannon netting or shooting would be preferable to poisoning since the birds could provide a needed source of protein for people.

Present control methods involve guarding fields (mostly by children) during the day by farmers. This method requires large numbers of man-hours and effectiveness depends on constant surveillence. This effort is not effective when very large flocks invade a field. Use of nois-makers and cannons have been shown to be non-effective in many cases. The birds simply become used to the sounds.

Costs of a large-scale project to cover fields with netting are prohibitive. Also, they would not exclude insects and insect populations no longer controlled by birds would cause more crop damage.

Poisoning of watering sites is a nonselective procedure that would be detrimental to other species, such as insectivorous birds and would therefore be ecologically unsound. Effects on other species including wildlife, man or domestic animals utilizing the water source could also be detrimental and cannot be assessed at this time.

Seed repellents have been used successfully in Senegal (Bruggers and Ruelle, 1977) for prevention of predation on freshly sown rice. In areas where early predation is a problem, this alternative seems advisable. Costs of such projects are not available at this time but the Sahel Food Crop Protection Center near Dakar and the Food and Agriculture Organization of the United Nations (FAO) will be able to provide information on current research progress, availability and recommended usage of present control methods.

Timing of major harvest periods to coincide with low population periods of migrants or during breeding seasons of granivorous savanna species would limit losses of grain to pest bird species and would instrumental in control of population sizes in the case of the savanna species (not ducks, as pointed out earlier). Studies to determine the feasibility of such actions are beyond the scope of this evaluation, but it is suggested that studies of this nature be considered.

The attractiveness of alternating food crops as is presently practiced with rice and tomatoes in some areas of the delta, appears

to be incompatible with programmed double cropping plans for rice culture (Agriculture Report). The economic and technological costs of such a program precludes this measure.

CHAPTER H

PLAN OF ACTION

Proposed mitigation measures can be summarized into plans of action for two major impacts. Protection of Parc Djoudj and mitigation of savanna habitat losses can be integrated into one plan, and minimization of grain loss to pest birds discussed in the second plan. These two programs are discussed in the following pages.

H.1. Plan of Action to Mitigate Habitat Losses and Impacts on Djoudj

The most effective way to combine and administrate the proposed mitigating factors would be the following program:

1. A single member of the environmental staff of O.M.V.S. should be appointed to organize and implement the program. This official should be the same person as suggested in the Mammoalogy and Herpotology Report.

2. Prospective lands for addition to existing parks and for creation of new national parks should be designated around Djoudj, in Mauritania and in Mali as soon as possible. A committee of national park service members of the O.M.V.S. countries should be included in the planning stages.

3. Following land aquisition, new park conservation officers should be trained and organization of staff members in new parks should begin.

4. The O.M.V.S. official would be responsible for implementing dike and gate repair in Djoudj, monitoring potential problems in the breeding colony. At the Langue de Barbarie National Park, maintaining a dike maintenance program for the park, research programs on existing birds in the park by park personnel.

5. The wetlands ecology program proposed for Djoudj should be initiated as soon as possible to assess water level impacts before construction of the Diama dam begins. This program compliments the proposed manatee research program (Mammals and Herpetology Report) and should proceed in conjunction with it.

6. A research program to assess savanna avian ecology and population numbers should be initiated soon, but it is not as critical to the initiation of the project as the preceeding steps. Perhaps after consultation with appropriate international agencies (such as O.R.S.T.O.M.) implementation of the plan would be immediate depending present research activities.

H.2. Plan of Action to Control Pest Birds

The control of the granivorous bird problem in all of Africa requires international cooperation in large-scaled studies and implementation of control methods. Since many species are wide ranging, control in one area may not remedy the problem and more birds may invade the area from other regions. The pest problem is analogous to locust outbreaks, which are still uncontrolled over much of Africa.

The first part of the plan of action, therefore, is to organize an action program to be administered under an O.M.V.S. official who would identify pest problems. Such a study would identify problems to be dealt with in the program and predict specific areas of concern.

A second part of this overall program of pest control would be communication with appropriate organizations working in pest control (such as FAO). The most recent and recommended measures for control can then be evaluated and applied to the specific problems encountered in the O.M.V.S. member countries as they arise.

The third step would be initiation of appropriate control methods for specific problems. The Quelea impact may be minimized by synchronized harvesting of rice during September while the Quelea are breeding in remote savanna areas. Ruff and Tree-duck predation on sprouting rice can be controlled by application of methiocarb. Programs to remove nesting colonies of weavers near rice fields will control local problems.

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APPENDIX A

COMPLETE LIST OF BIRDS SEEN IN SENEGAL AND MALI IN AUGUST, DECEMBER AND MAY, 1977 and 1978

Order:	Podicipediformes	
Family:	Podicipedidae	
	Podiceps ruficollis	Grèbe Castagneux
Order:	Pelecaniformes	
Family:	Phalacrocora cidae	
	Anhinga rufa	Anhinga d'Afrique
	Phalacrocorax africanus	Cormoran Africain
	Phalacrocorax carbo	Grand Cormoran
Family:	Pelecanidae	
	Pelecanus rufescens	Pélican Gris
	Pelecanus onocrotalus	Pélican Blanc
Family:	Sulidae	
	Sula bassana	
Order:	Ciconiiformes	
Family:	Ardeidae	
	Ardea cinerea	Héron Cendré
	Ardea melanocephala	Héron Mélanocéphale
	Ardea purpurea	Héron Pourpré
	Ardeola ralloides	Héron Crabier
	Ardeola ibis	Héron Garde-boeufs
	Butorides striatus	Héron à Dos Vert
	Egretta alba	Grande Aigrette
	Egretta garzetta	Aigrette Garzette

	Egretta intermedia	Aigrette Intermédiaire
	Egretta gularis	Aigrette Dimorphe
	Nycticorax nycticorax	Heron Bihoreau
Family:	Scopidae	
	Scopus umbretta	Ombrette
Family:	Ciconiidae	
	Ciconia ciconia	Cigogne Blanche
	Ciconia abdimii	Cigogne d'Abdim
	Ciconia episcopus	Cigogne Episcopale
	Ibis ibis	Tantale Ibis
	Leptoptiles crumeniferus	Marabout
Family:	Threskiornithidae	
	Threskiornis aethiopica	Ibis Sacré
	Plegadis falcinellus	Ibis Falcinelle
	Platalea alba	Spatule d'Afrique
	Platalea leucorodia	Spatule Blanche
Family:	Phoenicopteridae	
	Phoenicopterus ruber	Flamant Rose
Order:	Anseriformes	
Family:	Anatidae	
	Dendrocygna bicolor	Dendrocygne Fauve
	Dendrocygne viduata	Dendrocygne Veuf
	Alopochen aegyptiaca	Oie d'Egypte
	Plectropterus gambensis	Canard Armé
	Sarkidiornis melanota	Canard Casgué
	Nettapus auritus	Sarcelle à Oreillons
	Anas acuta	Pilet
	Anas guorguedula	Sarcelle d'Eté
	Anas penelope	
	Anas clypeata	Souchet
	Aythya nyroca	Fuligule Nyroca

Order:	Falconiformes	
Family:	Accipitridae	
	Gyps ruppellii	Vautour de Ruppell
	Gyps bengalensis	Gyps Africain
	Neophron monachus	Percnoptère Brun
	Neophron percnopterus	Percnoptère d'Egypte
	Circus macrourus	Busard Pâle
	Circus pygargus	Busard cendré
	Circus aeruginosus	Busard des Roseaux
	Terathopius ecaudatus	Bateleur
	Circaetus gallicus	Circaète Jean-le-Blanc
	Circaetus cinereus	Circaète Brun
	Accipiter badius	Epervier Shikra
	Melierax metabates	Autour Chanteur
	Melierax gabar	Autour Gabar
	Butastur rufipennis	Busard des Sauterelles
	Buteo auguralis	Buse à Queue Rousse
	Lophaerus occipitalis	Aigle Huppard
	Polemaetus bellicosus	Aigle Martial
	Aquila rapax	Aigle Ravisseur
	Aquila wahlbergi	Aigle de Wahlberg
	Haliaetus vocifer	Aigle Pêcheur
	Milvus migrans	Milan Noir
	Elanus caeruleus	Elanion Blanc
	Elanus riocourii	Naucler d'Afrique
	Pandion haliaetus	Balbuzard Pêcheur
Family:	Falconidae	
	Falco biarmicus	Faucon Lanier
	Falco chicguera	Faucon à Cou Roux
	Falco tinnunculus	Crércerelle

Order:	Galliformes	
Family:	Phasianidae	
	Francolinus albogularis	Francolin à Gorge Blanche
	Francolinus bicalcaratus	Francolin Commun
Order:	Gruiformes	
Family:	Gruidae	
	Balearica pavonina	Grue Couronnée
Family:	Rallidae	
	Gallinula chloropus	Poule d'Eau
	Porphyrio porphyrio	Poule sultane
	Fulica atra	Foulque Macroule
Family:	Otididae	
	Otis arabs	Grande Outarde Arabe
Family:	Jacanidae	
	Actophilormis africana	Jacana
Order:	Charadriiformes	
Family:	Burhinidae	
	Burhinus senegalensis	Oedicnème du Sénégal
Family:	Charadriidae	
	Vanellus spinosus	Vanneau Armé
	Vanellus tectus	Vanneau à Tête Noire
	Vanellus lugubris	Vanneau Terne
	Vanellus senegallus	Vanneau Caronculé
	Charadrius alexandrinus	Gravelo à Collier Interrompu
	Charadrius hiaticula	Grand Gravelot
	Charadrius pecuarius	Pluvier Pâtre
	Pluvialis squatarola	Pluvier Argenté
	Himantopus himantopus	Echasse Blanche
	Limosa limosa	Barge à Queue Noire
	Numenius arquata	Courlis Cendré

	Tringa nebularia	Chevalier Aboyeur
	Tringa stagnatilis	Chevalier Stagnatile
	Tringa ochropus	Chevalier Cul-blanc
	Tringa hypoleucos	Chevalier Guignette
	Tringa totanus	Chevalier Gambtete
	Tringa erythropus	Chevalier Arlequin
	Gallinago gallinago	Bécassine des Marais
	Arenaria interpres	Tournepierre à Collier
	Calidris ferruginea	Bécasseau Cocorli
	Calidris minuta	Bécasseau Minute
	Calidris alba	Bécasseau Sanderling
	Philomachus pugnax	Chevalier Combattant
	Rostratula benghalensis	Rhynchée
	Recurvirostra avosetta	
Family:	Glareolidae	
	Pluvianus algyptius	Pluvian d'Egypte
	Cursorius cursor	Courvite Isabelle
	Glareola pratincola	Glaréole à Collier
Family:	Laridae	
	Larus cirrhocephalus	Mouette à Tête Grise
	Larus ridibundus	Mouette Rieuse
	Larus argentatus	Goéland Argenté
	Rynchops flavirostris	Bec-en-Ciseau

	Sterna nilotica	Sterne Hansel
	Sterna caspia	Sterne Caspienne
	Sterna nigra	Guifette Noire
	Sterna leucoptera	Guifette Leucoptère
	Sterna maxima	Sterne Royale
Order:	Columbiformes	
Family:	Pteroclididae	
	Pterocles exustus	Ganga Sénégalais
Family:	Columbidae	
	Columba livia	Pigeon
	Columba guinea	Pigeon de Guinée
	Streptopelia decipiens	Tourterelle Pleureuse
	Streptopelia vinacea	Tourterelle Vineuse
	Streptopelia roseogrisea	Tourterelle Rieuse
	Streptopelia senegalensis	Tourterelle Maillée
	Oena capenses	Tourterelle du Cap
	Turtur afer	Emerauldine à Bec Rouge
	Turtur abyssinica	Emerauldine à Bec Noir
	Turtur waalia	Pigeon à Epaulettes Violettes
Order:	Psittaciformes	
Family:	Psittacidae	
	Poicephalus senegalus	Youyou
	Psittacula krameri	Perruche à Collier

Order:	Cuculiformes	
Family:	Musophagidae	
	Crinifer piscator	Touraco Gris
Family:	Cuculidae	
	Clamator jacobinus	Coucou Jacobin
	Chrysococcyx klaas	Coucou de Klaas
	Chrysococcyx caprius	Coucou Didric
	Centropus senegalensis	Coucal du Sénégal
Order:	Strigiformes	
Family:	Tytonidae	
	Tyto alba	Effraie Africaine
Order:	Caprinulgiformes	
Family:	Caprimulgidae	
	Caprimulgus eximius	Engoulevent Doré
	Caprimulgus climacurus	Engoulevent à Longue Queue
Order:	Apodiformes	
Family:	Apodidae	
	Apus apus	Martinet Noir
	Apus affinis	Martinet à Dos Blanc
	Cypsiurus sarvus	Marinet des Palmiers
Order:	Coliiformes	
Family:	Coliidae	
	Colius macrourus	Coliou Huppé

Order:	Coraciiformes	
Family:	Alcedinidae	
	Ceryle rudis	Martin-pêcheur Pie
	Halcyon senegalensis	Martin-chasseur du Sénégal
Family:	Meropidae	
	Merops superciliosus	Guêpier de Perse
	Merops orientalis	Petit Guêpier vert
	Merops nubicus	Guêpier Ecarlate
	Merops albicollis	Guêpier à Gorge Blanche
Family:	Coraccidae	
	Coracias abyssinica	Rollier d'Abyssinie
	Coracias naevia	Rollier Varié
	Coracias cyanogaster	Rollier à Ventre Bleu
	Eurystomus glaucurus	Rolle Africain
Family:	Upupidae	
	Upupa epops	Huppe Pasciée
	Phoeniculus purpureus	Moqueur
	Phoeniculus aterrimus	Petit Moqueur Noir
Family	Bucerotidae	
	Tockus nasutus	Petit Calao à Bec Noir
	Tockus erythrorhynchus	Petit Calao à Bec Rouge
	Bucorvus abyssinicus	Grand Calao d'Abyssinie

Order:	Piciformes	
Family:	Capitonidae	
	Lybius dubius	Barbican à Poitrine Rouge
	Lybius vieilloti	Barbu de Vieillot
Family:	Picidae	
	Campethera punctuligera	Pic à Taches Noires
	Dendropicos elachus	Petit Pic Gris
	Mesopicos goertae	Pic Gris
Order:	Passeriformes	
Family:	Alaudidae	
	Mirofra javanica	Alouette Chanteuse
	Eremopterix leucotis	Alouette-Moineau à Oreillons Blancs
	Eremopterix nigriceps	Alouette-Moineau à front Blanc
Family:	Hirundinidae	
	Riparia paludicola	Hirondelle Paludicole
	Riparia riparia	Hirondelle de Rivage
	Hirundo rustica	Hirondelle de Cheminée
	Hirundo daurica	Hirondelle Rousseline
	Delichon urbica	Hirondelle de Fenêtre
Family:	Motacillidae	
	Motacilla flava	Bergeronnette Printanière
	Motacilla alba	Bergeronnette Grise
	Anthus trivialis	Pipit des Arbres

Family:	Laniidae	
	Tchagra senegala	Téléphone Tchagra
	Laniarius ferrugineus	Gonolek à Ventre Blanc
	Laniarius barbarus	Gonolek de Barbarie
	Corvinella corvina	Corvinelle
	Lanius excubitor	Pie-grièche Grise
	Lanius senator	Pie-grièche à Tête Rousse
	Prionops plumata	Bagadais Casqué
Family:	Oriolidae	
	Oriolus auratus	Loriot Doré
Family:	Dicruridae	
	Dicrurus adsimilis	Drongo Brilliant
Family:	Sturnidae	
	Onychognathus moris	Etourneau Roupenne d'Alexander
	Lamprotornis purpureus	Merle Métallique Pourpré
	Lamprotornis chalybaeus	Merle Métallique Commun
	Lamprotornis caudatus	Merle Métallique à Longue Queue
	Spreo pulcher	Etourneau à Ventre Roux
	Buphagus africanus	Pique-boeuf à Bec Jaune
Family:	Corvidae	
	Ptilostonus afer	Piac-piac
	Corvus albus	Corbeau Pie

Family:	Pycnonotidae	
	Pynonotus barbatus	Bulbul Commun
Family:	Turdidae	
	Saxicola rubetra	Traquet Tarier
	Oenanthe oenanthe	Traquet Motteux
	Phoenicurus phoenicurus	Rouge-queue à Front Blanc
	Cercotrichas podobe	Merle Podobé
	Cercotrichas galactotes	Agrobate Rubigineux
	Turdus pelios	Grive Kurrichane
Family:	Timaliidae	
	Turdoides plebejus	Cratérope Brun
Family:	Sylviidae	
	Hippolais polyglotta	Hypolais Polyglotte
	Hippolais pallida	Hypolais Pâle
	Sylvia communis	Fauvette Grisette
	Sylvia cantillans	Fauvette Passerinette
	Phylloscopus collybita	Pouillot Véloce
	Cisticola juncidis	Cisticole des Joncs
	Prinia subflava	Fauvette-roitelet Commune
	Camaroptera brachyura	Camaroptere à Tête Grise
	Eremomela pusilla	Erémomèle à Dos Vert
	Eremomela icteropvgialis	Erémomèle Gris-Jaune

Family:	Muscicapidae	
	Muscicapa aquatica	Gobe-mouches des Marais
	Melaenornis edolioides	Gobe-mouches Drongo
	Batis senegalensis	Gobe-mouches Soyeux du Sénégal
Family:	Nectarinidae	
	Anthreptes platura	Petit Soui-nanga à Longue Queue
	Nectarinia senegalensis	Soui-manga à Poitrine Rouge
	Nectarinia pulchella	Soui-manga à Longue Queue
	Nectarinia spp.	
Family:	Emberizidae	
	Emberiza tahapisi	Bruant Cannelle
Family:	Fringillidae	
	Serinus mozambicus	Serin du Mozambique
	Serinus leucopygius	Chanteur d'Afrique
Family:	Ploceidae	
	Ploceus cucullatus	Tisserin Gendarme
	Ploceus luteolus	Tisserin Minulle
	Ploceus melanocephalus	Tisserin à Tête Noire
	Ploceus spp.	
	Quelea quelea	Travailleur à Bec Rouge
	Euplectes afer	Vorabé
	Euplecter orix	Ignicolore
	Euplectes spp.	

	Bubalornis albirostris	Alecto à Bec Blanc
	Plocepasser superciliosus	Moineau-tisserin
	Passer griseus	Moineau Gris
	Passer luteus	Moineau Doré
	Vidua chalybeata	Combassou du Sénégal
	Vidua orientalis	Veuve à Collier d'Or
Family:	Estrildidae	
	Amadina fasciata	Cou-coupé
	Estrilda bengala	Cordon Bleu
	Lagonosticta senegala	Amarante Commun
	Lonchura malabarica	Bec d'Argent

APPENDIX B

Table 1.

Location of Sample Sites and Birds Seen During August Aquatic Study.

SAMPLE	LOCATION	SPECIES	N°
1 (23)	Djoudj watergate channal Senegal River side	Phalocrocorax carbo	2
		Ardea cinerea	1
		Ceryl rudis	4
2	Djoudj watergate channal Senegal River side	Ardea cinerea	1
		Egretta garzetta	1
3	Djoudj watergate channal Senegal River side	None	
4 (26)	Djoudj watergate channal Senegal River side	Sterna nilotica	2
5 (25)	Djoudj watergate channal Senegal River side	Phalocrocorax carbo	1
		Anhinga rufa	1
		Egretta garzetta	1
6 (24)	Senegal River at Djoudj	Sterna nilotica	2
7	Djoudj watergate channal Djoudj Lake side	Phalocrocorax carbo	3
		Ardea cinerea	1
8	Djoudj watergate channal Djoudj Lake side	None	
9	Djoudj watergate channal Djoudj Lake side	Vanellus spinosus	1
		Calidris minuta	2
		Tringa totanus	3
		Burhinus senegalensis	3
10 (22)	Djoudj watergate channal Djoudj Lake side	Phalocrocorax carbo	3
		Charadrius alexandrinus	1
		Ceryl rudis	1

Table 1. (continued)

Location of Sample Sites and Birds Seen During August

Aquatic Study.

SAMPLE	LOCATION	SPECIES	N°
11 (27)	Lac de Guiers	Egretta alba	3
		Egretta intermedia	18
		Egretta garzetta	6
		Haliaetus vocifer	1
		Himantopus himantopus	1
		Vanellus spinosus	1
		Tringa totanus	1
		Calidris minuta	4
		Burhinus senegalensis	1
12 (28)	Canal between Lac de Guiers and Richard Toll	Egretta intermedia	1
		Egretta garzetta	1
		Ceryl rudis	1
13	Canal between Lac de Guiers and Richard toll	None	
14 (29)	Canal between Lac de Guiers and Richard Toll, 5 km from Lake	None	
15 (30)	Senegal River at Richard Toll	None	

Table 2.

Locations of Sample Sites and Birds Seen During December Aquatic Study.

SAMPLE	LOCATION	SPECIES	N°
16	Estuary at Saint-Louis	Phalocrocorax carbo	6
		Phalocrocorax africanus	30
		Egretta alba	1
		Egretta gularis	1
		Ardea cinerea	1
		Tringa hypoleucos	2
		Tringa nebulosa	1
		Pandion haliaetus	1
		Sterna caspia	2
		Larus cirrhocephalus	4
17	Atlantic Ocean at Saint-Louis	Calidris alba	8
		Charadrius alexandrinus	1
		Sterna nilotica	1
		Larus fuscus	2
		Larus ridibundus	6
18	Lake Djoudj	Ardea cinerea	1
		Egretta alba	1
		Plegadis falcinellus	4
		Phoenicopterus ruber	7
		Anas querquedula	40
		Anas clypeata	100
		Himantopus himantopus	1
19	Djoudj channal Djoudj Lake side	Phalocrocorax africanus	3
		Phalocrocorax carbo	15
		Ardea purpurea	1
		Fulica atra	6
		Sterna caspia	1
20	Djoudj channal Djoudj Lake side	Pelecanus onocrotelus	40
		Phalocrocorax carbo	60
		Phalocrocorax africanus	10
		Anhinga rufa	1
		Ardea cinerea	1
		Anas querquedula	2
		Anas clypeata	15

Table 2 Cont'd.

Locations of Sample Sites and Birds Seen During December

Aquatic Study

SAMPLE	LOCATION	SPECIES	N°
21	Djoudj channal Djoudj Lake side	Pelecanus onocrotalus	45
		Phalocrocorax carbo	2
		Ardea cinerea	1
22 (10)	Djoudj channal Djoudj Lake side	Pelecanus onocrotalus	30
		Phalocrocorax carbo	3
		Phalocrocorax africanus	4
		Ardea cinerea	1
		Egretta garzetta	3
		Dendrocygna bicolor	6
		Dendrocygna viduata	350
		Larus ridibundus	1
		Vanellus spinosus	2
		Tringa hypoleucos	1
		Tringa nebularia	2
23 (1)	Djoudj watergate channal Senegal River side	Phalocrocorax carbo	1
		Ardea cinerea	1
		Vanellus spinosus	1
		Burhinus senegalensis	25
		Tringa hypoleucos	2
		Ceryl rudis	1
24 (6)	Senegal River at Djoudj	Ardea cinerea	1
		Egretta garzetta	1
		Tringa nebularia	1
25 (5)	Djoudj watergate channal Senegal River side	Ardea cinerea	1
		Ceryl rudis	1
26 (4)	Djoudj watergate channal Senegal River side	Egretta garzetta	1
		Tringa nebularia	3
		Tringa totanus	1
		Circus aeruginosus	1

Locations of Sample Sites and Birds Seen During December Aquatic Study.

SAMPLE	LOCATION	SPECIES	N°
27 (11)	Lac de Guiers	Egretta garzetta	1
		Plectropterus gambensis	1
		Dendrocygna viduata	120
		Gallinula chloropus	1
		Vanellus spinosus	2
		Limosa limosa	2
		Tringa totanus	
28 (12)	Canal between Lac de Guiers and Richard Toll	None	
29 (14)	Canal between Lac de Guiers and Richard Toll, 5 km from Lake	Sterna nilotica	6
		Tringa hypoleucos	1
30 (15)	Senegal River at Richard Toll	Tringa hypoleucos	1

TABLE 3. WATER QUALITY MEASUREMENTS

FOR AUGUST AQUATIC STUDY

Sample Number	Birds: Number of Species	Birds: Number of Individuals	Conductivity (micromhos)	Temperature (C°)	Alkalinity (grains/gal.)	PH	Dissolved Oxygen (p.p.m.)
1	3	7	90	28	9	8,0	7,4
2	2	2	220	29,5	10	8,0	8,0
3	0	0	100	28	12	9,2	9,0
4	1	2	130	29	10	8,2	7,0
5	3	3	160	29	10	7,8	7,2
6	1	2	100	29	10	7,6	5,8
7	2	4	100	30	11	9,6	8,0
8	0	0	120	31,5	11	7,9	7,8
9	4	9	130	34	11	8,0	6,6
10	3	5	100	29	9	8,0	7,4
11	9	36	190	31	8	9,0	7,0
12	3	3	80	29	6	7,6	5,6
13	0	0	80	29	7	7,5	7,0
14	0	0	80	29	5	7,4	7,4
15	0	0	100	28	8	7,3	5,6
Average	2,07	4,87	118,67	29,5	9,13	8,1	7,1

TABLE 4. WATER QUALITY MEASUREMENTS
FOR DECEMBER AQUATIC STUDY

Sample Number	Birds: Number of Species	Birds: Number of Individuals	Conductivity (micromhos)	Temperature (C°)	Alkalinity (grains/gal.)	PH	Dissolved Oxygen (p.p.m.)
16	10	49	24.000	21	14	9,0	8,0
17	5	18	50.000	19	21	9,0	6,0
18	7	154	3.200	18	17	9,0	7,6
19	5	26	3.100	19	18	8,1	7,4
20	7	129	1.700	20	12	9,0	9,0
21	3	48	1.200	20	11	7,9	7,8
22	12	404	1.300	20	9	8,1	7,2
23	6	31	6.000	20	6	7,6	7,6
24	3	3	3.600	21	6	9,0	7,2
25	2	2	5.700	21	10	9,0	7,0
26	5	7	5.600	21	5	7,8	7,0
27	7	128	370	21	11	8,5	8,6
28	0	0	50	21	7	7,7	7,0
29	2	7	60	19	8	7,6	6,6
30	1	1	60	20,5	5	7,4	7,6
Average	5,00	67,13	7062.67	20,1	10,67	8,3	7,4

Appendix C, Savanna Bird Populations

NUMBER OF INDIVIDUALS

	MAKA-DIAMA		RICHARD TOLL		GUIDAKAR		MATAM		BAKEL	MANANTALI
	Aug.	Dec.	Aug.	Dec.	Aug.	Dec.	Aug.	Dec.	May	May
Milvus migrans		1	2	1						
Falco tinnunculus								1		
Francolinus bicalcaratus										2
Vanellus spinosus	2	5			11	3				
Vanellus tectus			3	8	15	2	2			
Pterocles exustus					8				10	
Streptopelia decipiens	1		2							
Streptopelia vinacea			6		3	4	2	64	11	10
Streptopelia roseogrisea	1		21	6	9	20	3	31		
Streptopelia senegalensis	4	4	9	13	3	21	2	3	2	
Cena Capensis	2	6			2	2	1	12	1	3
Turtur afer										7
Turtur abissynica	10	9	2		6	1	1			
Treron waalia										13

Appendix C, Savanna Bird Populations (cont'd)

	NUMBER OF INDIVIDUALS									
	MAKA-DIAMA		RICHARD TOLL		GUIDAKAR		MATAM		BAKEL	MANANTALI
	Aug.	Dec.	Aug.	Dec.	Aug.	Dec.	Aug.	Dec.	May	May
Lybius vieilloti				1						
Campethera punctuligera			1						2	1
Dendropicos elachus			1							
Eremopterix leucotis								2		
Riparia riparia										2
Hirundo rustica					18					3
Motacilla flava				3						
Motacilla alba				1		1				
Tchagra senegala	2					1				4
Laniarius ferrugineus		2								
Laniarius barbarus					1	1				
Corvinella corvina										1
Lanius senator								2		
Dicrurus adsimilis				1	2					
Onychognathus morio										1
Lamprotornis chalybaeus	2	4	7	1	78	8	3			
Lamprotornis caudatus				5	1	10	20		2	

Appendix C. Savanna Bird Populations (cont'd)

	NUMBER OF INDIVIDUALS									
	MAKA-DIAMA		RICHARD TOLL		GUIDAKAR		MATAM		BAKEL	MANANTALI
	Aug.	Dec.	Aug.	Dec.	Aug.	Dec.	Aug.	Dec.	May	May
Total individuals	41	78	166	62	438	155	49	749	92	108
Census area (hectares)	3.8	4.4	3.1	3.1	6.4	4.3	3.5	7.6	4.3	6.4
Total per 40.5 hectares	437	718	2169	810	2772	1460	567	3991	886	683
Total species	16	19	27	20	31	25	14	18	20	26
Added species outside census	9	3	10	9	3	2	4	9	0	5
Diversity (H')	2.455	2.242	2.804	2.663	2.460	2.653	2.117	1.166	2.572	2.898