

**WATTLED CRANES, WATERBIRDS, AND WETLAND CONSERVATION IN THE
ZAMBEZI DELTA, MOZAMBIQUE¹**

Carlos Manuel Bento
Researcher
Museu de Natural Historia, Travessia do Zambeze 104
Maputo, Mozambique
Ph: 258-1-491145
Fax: 258-1-490879
Email: bento@natural.uem.mz

Richard David Beilfuss
Africa Program Director
International Crane Foundation
PO Box 447
Baraboo, Wisconsin, USA 53913
Ph: 1-608-356-9462 x131
Fax: 1-608-356-9465
Email: rich@savingcranes.org

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**WORKING PAPERS OF THE
PROGRAM FOR THE SUSTAINABLE MANAGEMENT OF
CAHORA BASSA DAM AND THE LOWER ZAMBEZI VALLEY**

1. **Wattled Cranes, waterbirds, and wetland conservation in the Zambezi Delta, Mozambique (Bento and Beilfuss 2000)**
2. Patterns of hydrological change in the Zambezi Delta, Mozambique (Beilfuss and dos Santos 2001)
3. Patterns of vegetation change in the Zambezi Delta, Mozambique (Beilfuss, Moore, Dutton, and Bento 2001)
4. Prescribed flooding and restoration potential in the Zambezi Delta, Mozambique (Beilfuss 2001)
5. The status and prospects of Wattled Cranes in the Marromeu Complex of the Zambezi Delta (Bento, Beilfuss, and Hockey 2002)
6. The impact of hydrological changes on subsistence production systems and socio-cultural values in the lower Zambezi Valley (Beilfuss, Chilundo, Isaacman, and Mulwafu 2002)

1. INTRODUCTION

The Museum of Natural History in Maputo was approached by the Biodiversity Foundation for Africa to conduct a waterbird survey and review data on the actual status, occurrence, numbers and ecology of waterbirds in the Zambezi Delta. The delta is internationally renowned for its species richness and productivity, and provides breeding, feeding and wintering grounds for many species of national and international concern. It supports at least twelve distinct vegetation communities, ranging from papyrus swamps to *Borassus* palm savanna to dry forest. The delta is also vital to the Mozambican economy, providing a lucrative shrimp fishery, sugar production, transportation and many natural resources. Both the ecology and the economy of the Zambezi Delta are intricately linked to the flooding cycles of the Zambezi River.

Unfortunately, historical information on the diversity and abundance of waterbirds in the Zambezi Delta prior to 1990 is limited to a few observations recorded during aerial wildlife surveys, and anecdotal accounts from ecologists working in the study area. Maugham (1910) compiled a list of bird species observed during his travels up the Zambezi from Chinde. His observations include a large number of waterbirds, including the Grey Crowned Crane (*Balearica regulorum*), Saddlebilled Stork (*Ephippiorhynchus senegalensis*), White Pelican (*Pelicanus onocrotalus*) and a variety of egrets and herons. There is only cursory information on waterbird abundance from riverside observations, however, and several questionable species records (e.g. the Blue Crane, endemic to South Africa and Namibia, is listed, perhaps mistakenly for the Wattled Crane) (Bento & Beilfuss 1999).

Early aerial surveys of the Marromeu Buffalo Reserve and surrounding Coutadas or hunting areas (Tinley 1969, Tinley & Sousa Dias 1973) carefully recorded the distribution and abundance of mammal species but did not record waterbird observations, with the exception of large flocks of cattle egrets in association with buffalo herds. According to ecologist Paul Dutton (pers. comm. 1999), waterbird populations were so abundant in the 1960s and 1970s that even cursory counts could not be conducted in conjunction with mammal surveys. The Marromeu floodplains were abundant in waterfowl and fish-eating birds such as White Pelicans and Pink-backed Pelicans (*Pelecanus rufescens*) and several species of storks. Dutton participated in the final surveys of the delta following the large flooding event of March 1978 and prior to the advent of civil war, but no observations of bird species were reported (Tello & Dutton 1979).

During the height of civil war in Mozambique from 1980-1990, there were no wildlife surveys in the Zambezi Delta with the exception of a limited and inconclusive survey by Chambal (1989). There is thus no information on waterbird diversity or abundance for the first fifteen years after closure of Cabora Bassa Dam in 1975. The incredible decimation of wildlife populations during this period (Anderson *et al.* 1990), however, suggests that large edible waterbird species were likely to have been heavily persecuted during this period (Bento & Beilfuss 1999).

The present study provides information which could be used as support for the wise use of the natural resources of the delta, while maintaining its biological diversity.

1.2 Objectives

The principal objectives of the study were to: (a) compile annotated checklists of waterbirds from various representative sites in the Zambezi Delta; (b) present a report giving techniques used and evaluating the findings; and (c) indicating particular species or sites of interest.

As we were involved in a similar study looking at potential impacts of dam construction (described in Bento & Beilfuss 1999), many of the findings and sections are common to both reports.

2. STUDY AREA

The Zambezi Delta covers an area of about 18,000 km² from its apex at Chupanga to its 120 km front with the Indian Ocean coast from Quelimane southwest to Machesse. There are two distinct climatic seasons, a summer rainy season (approximately November to April), during which the climate is subhumid and hot, and a dry winter period (May to October), during which the climate is subarid and warm. The mean annual rainfall increases from 1000 mm near Chupanga to about 1200 mm at the coast, but there is considerable variation in its inter-annual and seasonal distribution. Evaporation is high, and

for only a few months of the rainy season does rainfall approach or equal potential evapotranspiration. The most important influence on the hydrology of the delta is the seasonal floodwaters of the Zambezi River and its distributor channels, and perennial runoff from streams draining the Cheringoma plateau from the west.

Twelve distinct vegetation communities are recognised in the delta (Timberlake , pers. comm.), including *Borassus* palm savanna, *Acacia* savanna, open dry grassland, wet open grassland, evergreen forest, riverine forest, swamp grassland, papyrus swamp, ridge vegetation, mangrove forest, dune scrub and foreshore vegetation. The grasslands, mangrove and evergreen forests are the most important habitats for waterbirds. The vast grasslands of the delta are composed of a complex mosaic of sedge and grass species related to subtle differences in soil moisture and chemistry. Extensive mangroves and associated mudflats occur along much of the delta coastline. These communities are maintained by seasonal flooding from the Zambezi River.

3. METHODOLOGY

The species list has been compiled from observations made over 1995, 1996, 1997 (Beilfuss & Allan 1996) and from observations made in 1998 and 1999. Three methods have been used: (a) aerial surveys, (b) ground surveys (in coutadas 11, 10), and (c) boat surveys from Marromeu to Chinde along the Zambezi River in 1998 and 1999. We also include a checklist from observations made over 10 days in the Marromeu coastal area.

The aerial survey covered the entire Marromeu Buffalo Reserve and surrounding coutada floodplains ("the Marromeu Complex") with 4 km-width transects running parallel to the coastline in an attempt to generate a complete count of large birds species in the area. During the survey, the team also noted large breeding colonies of White Pelicans, egrets and several species of storks. All species noted during the ground and boat surveys were noted.

For the terrestrial survey, more than four hours were spent each day for five days recording waterfowl on the Coutada 10 and 11 floodplains. Various species were not possible to identify owing to difficulties such as grass height and accessibility. Such species as Crake's Rail's and Flufftails were not recorded due to difficulties in walking over the floodplain to flush them.

Four boat surveys along the Zambezi (from Marromeu to Chinde) were carried out in October 1998 and July 1999, with recording from mid-morning to mid-afternoon. During these surveys several expected species were not noted, possibly owing to the extent of the area surveyed and limited vision with binoculars. At Pambane on Chinde island in July 1999 we surveyed several small channels among the mangroves for 3.5 hours using a small canoe. Possibly many waterbird species were missing from our observations owing to the difficulties of walking in this habitat.

For questionable bird calls, a recorded tape cassette (Common Birds Calls of Southern Africa) was used for confirmation.

4. SPECIES ACCOUNTS

Each species account provides follows the Robert's number, the English and scientific names, and details on status and numbers. South Africa Red Data Book status is also mentioned. A list of species seen at each locality is given in Table 5.3.1.

Table 5.3.1. Lists of waterbird species seen at various localities in the Zambezi Delta.

Locality 1: Nhamagote Lake (Coutada 11), 18°25'.08 S / 35°33'.70 E, 20 June 1999

Locality 2: Nhamagote Lake (Coutada 11), 18°15'.30 S / 35°42'.49 E, 21 June 1999

Locality 3: Inhagoia, Nhapacue River (Coutada 11), floodplain, 18°33'.87 S / 35°39'.21 E, 26 & 28 June 1999

Locality 4: Missocossa River (Coutada 10), floodplain, 18°43'.43 S / 35°42'.45 E, 26 & 30 June 1999.

Species	Locality			
	1	2	3	4
Dabchick <i>Tachybaptus ruficollis</i>		X		
White Pelican <i>Pelecanus rufescens</i>				X
Reed Cormorant <i>Phalacrocorax africanus</i>			X	
Darter <i>Anhinga melanogaster</i>				X
Blackheaded Heron <i>Ardea melanocephala</i>			X	X
Goliath Heron <i>Ardea goliath</i>			X	X
Purple Heron <i>Ardea purpurea</i>	X			X
Great White Egret <i>Casmerodius albus</i>			X	X
Yellowbilled Egret <i>Egretta intermedia</i>	X		X	X
Cattle Egret <i>Bubulcus ibis</i>			X	
Squacco Heron <i>Ardeola ralloides</i>			X	X
Rufousbellied Heron <i>Butorides rufiventris</i>			X	
Little Bittern <i>Ixobrychus sturmii</i>				X
Hamerkop <i>Scopus umbretta</i>			X	X
Woolynecked Stork <i>Ciconia episcopus</i>	X		X	
Openbilled Stork <i>Anastomus lamelligerus</i>			X	
Saddlebilled Stork <i>Ephippiorhynchus senegalensis</i>			X	X
Marabou Stork <i>Leptoptilos crumeniferus</i>				X
Yellowbilled Stork <i>Mycteria ibis</i>			X	
Sacred Ibis <i>Threskiornis aethiopicus</i>			X	
Hadedda Ibis <i>Bostrychia hagedash</i>			X	X
African Spoonbill <i>Platalea alba</i>				X
Whitefaced Duck <i>Dendrocygna viduata</i>				X
Duck <i>Anas hottentota</i>	X			
Pygmy Goose <i>Nettapus auritus</i>	X			
Spurwinged Goose <i>Plectropterus gambensis</i>			X	X
Bateleur <i>Terathopius ecaudatus</i>			X	
Palmnut Vulture <i>Gypophierax angolensis</i>			X	
African Fish Eagle <i>Haliaeetus vocifer</i>			X	X

Wattled Crane <i>Bugeranus carunculatus</i>				X
Crowned Crane <i>Balearica regulorum</i>				X
Lesser Gallinule <i>Porphyryula alleni</i>	X			
Lesser Moorhen <i>Gallinula angulata</i>		X		
African Jacana <i>Actophilornis africanus</i>	X	X		X
Lesser Jacana <i>Microparra capensis</i>	X			X
Blacksmith Plover <i>Vanellus armatus</i>			X	
Whitecrowned Plover <i>Vanellus albiceps</i>			X	X
Longtoed Plover <i>Vanellus crassirostris</i>			X	
Great Snipe <i>Gallinago media</i>				X
Blackwinged Stilt <i>Himantopus himantopus</i>				X
Pied Kingfisher <i>Ceryle rudis</i>			X	X
Malachite Kingfisher <i>Alcedo cristata</i>	X			X

49. White Pelican *Pelecanus onocrotalus*

Common resident and breeds in the delta. Nests in large, conspicuous colonies in the coastal mangrove and are very sensitive to disturbance (Dennis & Tarboton 1993). Dutton observed large numbers of this species feeding in the Zambezi Delta floodplains during the 1960s and 1970s. In recent years they have abandoned the dry floodplains of the Zambezi Delta and now feed on Lake Urema of Gorongosa National Park, but they continue to roost and breed in the coastal parts of the delta. The aerial surveys of March 1995, July 1996 and May 1997 show local movements into the delta (Beilfuss & Allan 1996). The White Pelican is listed in the South African Red Data Book as Rare (Brook 1984).

50. Pinkbacked Pelican *Pelecanus rufescens*

Uncommon resident and breeds in the delta. Dutton observed large numbers of this species feeding on the Zambezi floodplains during the 1960s and 1970s. In the recent years they have abandoned the dry floodplains of the Zambezi Delta and now feed in Lake Urema of Gorongosa National Park, but they continue to roost and breed in the coastal delta. A flock of up to 55 birds was recorded on sandbanks in the Zambezi close to Luabo during the boat survey in July 1999. The aerial surveys of March 1995, July 1996 and May 1997 show local movements into the delta (Beilfuss & Allan 1996). The Pinkbacked Pelican is listed in the South African Red Data Book as Rare (Brook 1984).

55. Whitebreasted Cormorant *Phalacrocorax carbo*

This species is common and resident in the delta, and has been seen flying along the Zambezi and at the coast in Chinde. Normally, single birds were seen, but flocks ranging from 20 to 30 individuals were recorded roosting on tidal sandbanks along the main channel of the Zambezi.

58. Reed Cormorant *Phalacrocorax africanus*

At least three large breeding colonies of this species were recorded on the Marromeu floodplain in reedbeds along small rivers. It is a common and resident bird and feeds in ponds and calm rivers in the delta.

60. Darter *Anhinga melanogaster*

During the boat survey from Marromeu to Chinde (October 1998) this species was very common in areas along the Zambezi influenced by the tide. Up to 700 birds were counted. Few individuals were recorded during the July 1999 boat survey, suggesting migratory movements to elsewhere in southern Africa (probably to the breeding grounds).

62. Grey Heron *Ardea cinerea*

Normally, solitary birds were recorded on coastal and inland shallow waters, also on floodplain pans and lagoons. In coastal areas during high tide they roost on mangroves.

63. Blackheaded Heron *Ardea melanocephala*

Few birds were recorded on open grassland floodplains feeding on fish and frogs.

64. Goliath Heron *Ardea goliath*

Common resident and breeds on the Zambezi floodplain. It often occurs singly, even in the breeding season. It is widespread in river reedbeds on the floodplain.

65. Purple Heron *Ardea purpurea*

Occurs solitary and is a common resident. Breeds in areas with dense reedbeds and other aquatic vegetation on the floodplain and along the Zambezi.

66. Great White Egret *Egretta alba*

A common and resident species in the Zambezi Delta. Breeds in dense reedbeds and papyrus vegetation. Several colonies (up to 80 pairs) were recorded along floodplain streams covered by vegetation. For most records they were associated with other egret species feeding on fish or frogs in ponds and large lagoons (some in woodlands).

67. Little Egret *Egretta garzetta*

Common resident species of the delta breeding in reedbeds. Feeds along small streams, perching in mangrove branches, and on shores of inland and marine waters. Large colonies (up to 100 individuals) of roosting birds were recorded at Pambane (Chinde) in mangroves during high tide.

68. Yellowbilled Egret *Egretta intermedia*

Common resident usually associated with other egrets in the breeding and feeding grounds on the floodplain, ponds and lagoons of the delta. In the mixed flocks of Little Egret, Great Egret and Cattle Egret (flock size 257 birds) in Coutada 11 (Inhagoia), 65 Yellowbilled Egrets were counted.

69. Black Egret *Egretta ardesiaca*

Although this species is considered common in the tropics (Maclean 1993), only two birds were observed during the May 1997 aerial survey.

71. Cattle Egret *Bubulcus ibis*

Common and resident in the delta. During the 1995, 1996 and 1997 aerial surveys, thousands of Cattle Egrets were recorded associated with buffalo and elephant herds (Beilfuss & Allan 1996).

72. Squacco Heron *Ardeola ralloides*

Very common resident in the delta. Is usually associated with reed or papyrus vegetation. They are easily mistaken for Little Egrets during the aerial surveys.

74. Greenbacked Heron *Butorides striatus*

Usually solitary at the Zambezi estuary, along mangroves and in the intertidal mud flats at Pambane and Chinde. Feeds on crustaceans.

76. Blackcrowned Night Heron *Nycticorax nycticorax*

Few birds were recorded on the Zambezi floodplain and large lagoons in the woodland area. A bird ringed in Romania was recovered in Mozambique (Maclean 1993), which suggests that some non-breeding Palearctic migrants reach Mozambique and the delta.

81. Hamerkop *Scopus umbretta*

Usually solitary along the Zambezi and on the floodplains. During the March 1995 aerial survey, two birds were recorded (Beilfuss & Allan 1996). During the boat survey (Marromeu-Chinde) in 1998, eight birds were counted.

84. Black Stork *Ciconia nigra*

Uncommon on the Zambezi floodplain. Six birds were recorded during the March 1995 aerial survey (Beilfuss & Allan 1996). This species is listed in the South African Red Data Book as Rare (Brook 1984). Breeds in mountainous regions (Maclean 1993).

85. Abdim's Stork *Ciconia abdimii*

Uncommon non-breeding intra-African migrant. A flock of 30 birds were recorded on the Zambezi floodplain during the March 1995 aerial survey (Beilfuss & Allan 1996).

86. Woollynecked Stork *Ciconia episcopus*

Uncommon resident bird on the Zambezi floodplain and inter-tidal area. A flock of 12 birds were recorded during the boat survey. On the floodplain they are usually seen following fires to feed on insects. Only 6 and 3 birds were recorded during the 1995 and 1996 aerial surveys, respectively, and 69 birds in 1997 (Beilfuss & Allan 1996). This species is listed in the South African Red Data Book as Rare (Brook 1984).

87. Openbilled Stork *Anastomus lamelligerus*

Common and resident in the Zambezi Delta. Large numbers concentrate in sandbars feeding on freshwater snails and mussels in the lower Zambezi during the dry season (Beilfuss & Bento 1997). They feed in the shallow freshwater lakes in the coastal mangrove zone during the wet season (Bento 1999). During the 1995, 1996 and 1997 aerial surveys, 1896, 1500 and 534 birds, respectively, were recorded on the floodplain. During the boat surveys from Marromeu to Chinde along the Zambezi thousands of birds were counted. This species is listed in the South African Red Data Book as Rare (Brook 1984).

88. Saddlebilled Stork *Ephippiorhynchus senegalensis*

Common resident and breeds on the Zambezi floodplain and large lagoons in the woodlands. Usually they were observed in pairs, or a pair with chick. Sometimes flocks ranging from 4 to 7 birds were observed on the floodplain. During the 1995, 1996 and 1997 aerial surveys, 36, 7 and 31 birds, respectively, were recorded (Beilfuss & Allan 1996). This suggests local movement of the species in the delta. This species is listed in the South African Red Data Book as Rare (Brook 1984).

89. Marabou Stork *Leptoptilos crumeniferus*

Locally common and resident in the delta. Mostly in pairs on the floodplain, but were also seen gregarious in coutadas 11 and 14 around carcasses of mammals during the hunting season. During the aerial surveys of the Marromeu Complex, 52 birds were recorded in 1995 and 56 in 1997. Local people often confuse this species with the Wattled Crane. This species is listed in the South African Red Data Book and is considered a rare and vagrant species in South Africa (Brook 1984).

90. Yellowbilled Stork *Mycteria ibis*

Common resident and breeds in the delta. Approximately 500-1000 pairs were observed in a large breeding colony (Beilfuss & Bento 1997). Out of the breeding season, the species is widespread all over the floodplain and perched on trees in small flocks ranging from 2 to 5 birds. It is also common to see solitary birds feeding in the lagoons. In the 1995, 1996 and 1997 aerial surveys, 41, 14 and 96 individuals, respectively, were recorded. This species is listed in the South African Red Data Book as Rare (Brook 1984).

91. Sacred Ibis *Threskionis aethiopicus*

Common resident and usually seen in association with flocks of egrets in the southwest part of the floodplain during the ground survey. Hundreds of breeding pairs have been recorded in the Marromeu Complex (Beilfuss & Bento 1997). After the breeding season, the species is widespread within the delta and other areas. During the 1995, 1996 and 1997 aerial surveys, 35, 40 and 14 birds were observed.

93. Glossy Ibis *Plegadis falcinellus*

This species is common in the delta, usually observed in the wet grassland. Feeding flocks were associated with Spurwinged Goose in the Marromeu Complex. During the aerial surveys 73 birds were recorded in 1995, and 244 in 1997.

94. Hadedda Ibis *Bostrychia hagedash*

Very common and resident in the delta, often gregarious in groups of 2 to 7 birds. During the ground survey in Coutada 10, up to 900 birds were seen early in the morning travelling from roosting trees in woodland to the feeding grounds in the grassland area.

95. African Spoonbill *Platalea alba*

Common resident and breeds in the delta. Hundreds of breeding pairs have been recorded in the Marromeu Complex. During the aerial survey only 10 birds were recorded in 1997. This species might be underestimated because it can be easily mistaken with egrets from the air. A flock of up to 25 birds was observed during the boat survey from Marromeu to Chinde in July 1999. A few feeding birds were recorded on the floodplain in Coutada 10 in July 1999.

96. Greater Flamingo *Phoenicopterus ruber*

Common in the coastal areas of the delta. A flock of up to 900 flamingos was recorded during the inter-tidal survey at Chinde in October 1998 and in July 1999. More than 300 birds were recorded during the ground survey in Pambane near Chinde. 100 birds were counted during the boat survey (October 1998) from Marromeu to Chinde in a big lagoon along the main Zambezi River (around 6 km from Chinde). During the aerial survey flamingos were not recorded because the flights did not cover the inter-tidal area. Fortunately, in 1999 we flew the inter-tidal area and a flock of around 1000 birds were observed.

97. Lesser Flamingo *Phoeniconaias minor*

Common in the coastal areas of the delta, normally associated with Greater Flamingos. More than 150 birds were counted in Chinde District. The population of Lesser Flamingos might be underestimated because of the difficulty in distinguishing the Greater from Lesser Flamingo when they are far away.

99. Whitefaced Duck *Dendrocygna viduata*

Common resident of the Zambezi floodplain. During the 1995, 1996 and 1997 aerial surveys, 57, 400 and 58 birds, respectively, were counted on the floodplain (Beilfuss & Bento 1997). Usually they are associated with small floodplain lagoons together with Fulvous Duck and Spurwinged Goose. Hundreds of Whiteface Duck were counted during the boat survey along the Zambezi River from Marromeu to Chinde in July 1999. The flocks range from 20 to 60 birds. More birds were recorded on the floodplain behind the mangroves (Bento 1999).

100. Fulvous Duck *Dendrocygna bicolor*

Common resident in the delta. During the 1995, 1996 and 1997 aerial surveys, 4, 15 and 230 birds, respectively, were counted on the floodplain (Beilfuss & Bento 1997). These numbers might be underestimated owing to difficulties in differentiating this species from Whitefaced Duck.

101. Whitebacked Duck *Thalassornis leuconotus*

Uncommon resident in the small lagoons protected by mangroves on the way to Pambane (Chinde). Six dispersed pairs were recorded feeding during the ground survey.

102. Egyptian Goose *Alopochen aegyptiacus*

Common and resident in the small lagoons on the Zambezi floodplains. During the aerial surveys only one individual was recorded due to difficulties in identifying the bird from the air. During the Marromeu-Chinde boat survey a group of 11 birds were recorded crossing the main river channel from the south to north banks.

108. Redbilled Teal *Anas erythrorhyncha*

Two birds were recorded during the November 1997 aerial survey. It is probable that the population was underestimated owing to difficulties in distinguishing the bird from the air. Three pairs were counted in Pembane (Chinde) along the small lagoons behind the mangroves.

114. Pygmy Goose *Nettapus auritus*

It is a common and resident bird in the Zambezi Delta. Was only recorded from the ground survey in small floodplains lagoons and lagoons behind the Mangroves in Chinde. A total of 30 birds were recorded, usually in small flocks ranges from 2 to 4 birds (always in pairs). This species belongs to South African Red Data Book and is consider a rare species (Brook 1984).

116. Spurwinged Goose *Plectropterus gambensis*

A common and resident on the Zambezi floodplains including the riverine areas along the Zambezi River. During the aerial surveys made over the Marromeu Complex in 1995, 1996 and 1997, 101, 14 and 172 birds, respectively, were observed. Along the Zambezi sandbanks, flocks ranging from 10-50 were observed.

113. Southern Pochard *Netta erythrophthalma*

Two pairs of this birds were observed diving in small lagoon on the Coutada 11 floodplain during the 1999 ground survey.

115. Knobilled Duck *Sarkidiornis melanotos*

A common waterbird in the delta, nevertheless it disappears in certain seasons. During the aerial surveys 7 birds were counted in March 1995, and 3 in May 1997 (Beilfuss & Allan 1996).

146. Bateleur *Terathopius ecaudatus*

Common and resident on the Zambezi floodplain. Feeds on catfish in almost dry small lagoons. During the ground survey 15 birds were counted in Coutada 10. This species is listed in the South African Red Data Book as Vulnerable (Brook 1984).

147. Palmnut Vulture *Gypohierax angolensis*

Common on the floodplain boundary. A flock of 11 birds were recorded on palm trees in Coutada 10 during the ground survey. This species is listed in the South African Red Data Book as Rare (Brook 1984).

148. African Fish Eagle *Haliaeetus vocifer*

Common in the delta, particularly on the floodplain and by large lagoons where trees are available to perch on. In the coastal areas (Chinde) they are also common and perch on the mangroves. On large highly productive lakes in coutadas 11 and 10, more then two pairs of African Fish Eagle were counted.

165. African Marsh Harrier *Circus ranivorus*

Common resident usually observed on the floodplain. During the ground survey 17 birds were counted within a range of 4 km on the Coutada 11 floodplain.

207. Wattled Crane *Bugeranus carunculatus*

Common and resident on the Zambezi floodplain. During the 1995, 1996 and 1997 aerial surveys, 156, 60 and 179 birds, respectively, were recorded (Beilfuss & Allan 1998). Usually they are seen in pairs, or pair with a chick during the breeding season. This species is sensitive to human disturbance and its presence is used by the Maputo Museum and International Crane Foundation as an indicator for habitat changes in the delta. This species is listed in South African Red Data Book as Endangered (Brook 1984).

209. Crowned Crane *Balearica regulorum*

Common and resident o the Zambazi floodplain, normally on dry grassland. Usually they occur in pairs and are very territorial. During aerial surveys 25, 44 and 50 birds were counted in 1995, 1996 and 1997, respectively.

210. African Rail *Rallus caerulescens*
Common resident on medium and large lagoons in the woodland area and floodplains of the delta. During the ground survey 13 birds were counted, but the population is underestimated because the species is often hidden. They were more often heard than seen.
213. Black Crake *Amaurornis flavirostris*
Common resident on medium and large lagoons in the woodland area and on floodplains. The best time to count them was early in the morning before sunrise. During the ground survey 105 birds were counted in two lagoons in Coutada 11.
240. African Jacana *Actophilornis africanus*
Common resident in the lagoons and pans of the Zambezi floodplain. None of these birds were counted from the air during the aerial survey owing to their small size. From the ground a total of 1000 birds were counted in Coutadas 10 and 11.
241. Lesser Jacana *Microparra capensis*
The Lesser Jacana is common in areas where there is a less human disturbance, including fishing. On the floodplain 35 birds were counted, although this number might be an underestimate owing to its small size. This species is listed in the South African Red Data Book as Rare (Brook 1984).
246. Whitefronted Plover *Charadrius marginatus*
Common resident in the coastal area on sand along the inter-tidal zones. In Chinde we counted 175 birds in 1998, and 670 birds in 1999. Usually they are in flocks of up to 7 but less than 30 individuals. They are gregarious at high tide and the flock size ranges from 100-250.
249. Threebanded Plover *Charadrius tricollaris*
Common resident in the coastal areas, with a few records on ponds on the floodplain. During the ground survey at Chinde, 23 birds were counted at low tide. The numbers are probably an underestimate.
254. Grey Plover *Pluvialis squatarola*
Common non-breeding Palaearctic migrant species. More than 350 birds were counted at Chinde from Pembane to Villa do Chinde. They are widespread in the inter-tidal area during low tide.
258. Blacksmith Plover *Vanellus armatus*
Common resident on small ponds in the floodplain. Usually in pairs or small flocks ranging from 3 to 5 birds. Also seen in burned grassland.
259. Whitecrowned Plover *Vanellus albiceps*
This species is associated with the larger river floodplains. On the road along the Zambezi towards Malingapanse 12 birds were recorded, and 25 on the Coutada 11 floodplain. This species is listed in the South African Red Data Book as Rare (Brook 1984).
260. Wattled Plover *Vanellus senegallus*
Common resident on the Zambezi floodplain. More than 70 birds were recorded during the ground survey on the coutada 10 and 11 floodplain. During the 1997 aerial survey 13 birds were counted.
261. Longtoed Plover *Vanellus crassirostris*
Common resident of the Zambezi floodplain. During the ground survey 6 pairs were counted and one pair in the lake near the Mungari Camp. During the 1995, 1996 and 1997 aerial surveys, 21, 3 and 4 birds were counted.
264. Common Sandpiper *Actitis hypoleucos*
Common non-breeding Palaearctic migrant. Solitary individuals were recorded along the Zambezi and streams in the floodplain and pans. Total count during the ground survey was 75 birds.

270. Greenshank *Tringa nebularia*

Common non-breeding Palaearctic migrant. Usually seen in the inter-tidal area in Chinde and sometimes in the estuary along branches of the Zambezi. In Chinde 560 birds were counted.

272. Curlew Sandpiper *Calidris ferruginea*

Common non-breeding Palaearctic migrant. Mainly occurs on mudflats. In Chinde 1050 birds were counted. Usually they feed in flocks ranging from 15 to 50 mixed with Sanderlings.

281. Sanderling *Calidris alba*

Common non-breeding Palaearctic migrant, observed in the inter-tidal area. A flock of 750 birds were counted in Chinde during high tide.

290. Whimbrel *Numenius phaeopus*

Common non-breeding Palaearctic migrant. The numbers are very high during the summer in the inter-tidal area and on muddy flats in mangroves. More than 900 birds were recorded in the coastal area of Chinde. Few birds overwinter in the delta in flocks ranging from 5 to 7 birds.

295. Blackwinged Stilt *Himantopus himantopus*

Common resident and breeds on the Zambezi floodplains. Flocks range from 2 to 6 birds. During the aerial survey in 1997 four birds were recorded from the air.

298. Water Dikkop *Burhinus vermiculatus*

Common resident in the delta, particularly along the small meanders in the mangrove. During the night we heard calling from the pans. Up to 25 birds were recorded by walking along the river edge to the mangroves in Pambane. A few birds were noted doing the short flight to the grassland close nearby.

304. Redwinged Pratincole *Glareola pratincola*

A migrant species common at certain times of the year in the delta. During the 1998 boat survey 25 birds were counted roosting on the sandbanks along the Zambezi, while during the 1999 boat survey more than 2000 birds were observed feeding in the air along the river from the area called Bento to Luabo. This species is sensitive to water regime changes. It is listed in the South African Red Data Book as Rare (Brook 1984).

315. Greyheaded Gull *Larus cirrocephalus*

A common species especially in the coastal and estuarine area. Three birds were recorded during the aerial surveys in 1995, and 23 in 1997 (Beilfuss & Bento 1997). During the boat survey from Marromeu to Chinde up to 70 birds were counted. Usually this species is associated with fishery activities and follows fishermen's boats.

343. African Skimmer *Rynchops flavirostris*

Common intra-African migrant bird along the Zambezi and Pungue rivers. During aerial surveys 10 birds were counted in 1997, but none were seen during the boat surveys from Marromeu to Chinde. In South Africa this bird is considered Threatened.

324. Swift Tern *Sterna bergii*

Few individuals (around 10) were observed along the Chinde coastline fishing. It is considered common and resident.

332. Sooty Tern *Sterna fuscata*

Common resident in the delta coastal area. More than 10,000 birds were counted in Puga-Puga Island (Nampula-Angoche), where this species breeds. The presence of the Sooty Tern in the Zambezi Delta suggests that the species moves south after the breeding season.

322. Caspian Tern *Hydroprogne caspia*

A flock of 13 birds were recorded in the Zambezi estuary during the inter-tidal waterbird survey along the Chinde coastline. This species is listed in the South African Red Data Book as Rare (Brook 1984).

338. Whiskered Tern *Chlidonias hybridus*

Common along the coastline of the Zambezi Delta. This species is nomadic and moves according to rainfall (Maclean 1993). A few flocks ranging from 5 to 7 birds were recorded on the floodplain along the Zambezi.

428. Pied Kingfisher *Ceryle rudis*

Common resident all over the Zambezi Delta. During the boat survey from Marromeu to Chinde 55 birds were recorded. From the ground survey in coutadas 10 and 11, 17 birds were recorded. Two birds were counted from the air in 1997. They usually breed along the Zambezi.

429. Giant Kingfisher *Megaceryle maxima*

During the whole trip by boat (October 1998) from Marromeu to Chinde only 3 birds were counted. In following year, on the similar boat survey (July 1999), none were recorded.

431. Malachite Kingfisher *Alcedo cristata*

A total of 12 birds were recorded during the ground survey in coutadas 10 and 11 on floodplain ponds and small streams.

434. Mangrove Kingfisher *Halcyon senegaloides*

Common resident and breeds in the delta mangroves. During the ground survey (October 1998) 100 birds were counted at Chinde. This species is listed in the South African Red Data Book as Vulnerable (Brook 1984).

5. STATUS OF WATERBIRDS IN THE ZAMBEZI DELTA

A total of 73 species of waterbirds were observed during the aerial and ground surveys (Table 5.3.2). The aerial survey counts in March 1995 gave 33 waterbird species totalling approximately 5905 individuals. Counts of July 1996 gave 4399 individuals of 25 waterbird species, and 14,960 individuals of 42 waterbird species in May 1997. Aerial counts in 1998 and 1999 focussed on accurate counts of the species of international concern and did not record total counts for the more abundant species such as egrets and herons.

The combined surveys reveal that the Zambezi Delta supports numerous Vulnerable and Threatened species of Global Concern, including the Wattled Crane, Grey Crowned Crane, African Skimmer (*Rynchops flavirostris*), White Pelican, Pinkbacked Pelican, Woollynecked Stork (*Ciconia episcopus*), Openbilled Stork (*Anastomus lamelligerus*), Saddlebilled Stork, Yellowbellied Stork (*Mycteria ibis*), Black Stork (*Ciconia nigra*), Redwinged Pratincole (*Glareola pratincola*) and Caspian Tern (*Sterna caspia*). The delta supports colonies of thousands of pairs of White Pelicans among the coastal mangroves in the southeastern Marromeu Complex, one of the largest breeding colonies recorded in Southern Africa (Goodman 1992a, Beilfuss & Allan 1996). Three immense breeding colonies of storks and herons were also observed during the summer surveys on the central Marromeu floodplains. The largest colony supports hundreds of pairs of Openbilled Stork, Yellowbellied Stork, Sacred Ibis (*Threskiornis aethiopicus*), African Spoonbill (*Platalea alba*) and three species of egrets (*Egretta* spp). Large breeding colonies of Reed Cormorant (*Phalacrocorax africanus*), Squacco Heron (*Ardeola ralloides*), Grey Heron (*Ardea cinerea*) and Blackheaded Heron (*Ardea melanocephala*) were also recorded (Beilfuss & Bento 1997). Large groups of migrant Abdim's Storks (*Ciconia abdimii*) utilize the delta grasslands in the summer.

During the boat surveys from Marromeu to Chinde, thousands of Openbilled Stork (in groups ranging from 200-1000 individuals) were recorded in association with Glossy Ibis (*Plegadis falcinellus*) and Sacred Ibis on small sandbank islands along the main channel of the Zambezi. Large numbers of Reed Cormorants, African Darters (*Anhinga melanogaster*), Lesser Flamingoes (*Phoenicopterus minor*), Goliath Herons (*Ardea goliath*), Purple Herons (*Ardea purpurea*), African Spoonbills, White Pelicans, Pinkbacked Pelicans, Spur Winged Geese (*Plectropterus gambensis*), Sandwich Terns (*Sterna sandvicensis*) and Redwinged Pratincoles were observed. Many of these species were under-represented in the aerial surveys because of their small size or similarity to other species (for example, the

comparison of aerial and boat surveys of Lake Urema, Gorongosa National Park in Beilfuss *et al.* 1998). This is especially true for several duck species, including Whitefaced Ducks (*Dendrocygna viduata*) and Fulvous Ducks (*D. bicolor*), that typically did not flush during aerial surveys and could not be accurately counted.

Whimbrels (*Numenius phaeopus*), Greenshank (*Tringa nebularia*), Grey Plovers (*Pluvialis squatarola*), Curlew Sandpipers (*Calidris ferruginea*), Sanderlings (*C. alba*) and other migratory shorebirds were common on the coast near Chinde. A large flock of Lesser Flamingos was also observed. Whitebreasted Cormorants (*Phalacrocorax carbo*), Mangrove Kingfishers (*Halcyon senegaloides*) and Pygmy Kingfishers (*Ispidina picta*) were widespread in the coastal mangroves.

6. IMPACT OF WATER RESOURCES DEVELOPMENT ON THE ZAMBEZI DELTA

Over the past half-century, water resources development projects have greatly altered the hydrology of the Zambezi Delta. Prior to the construction of Kariba Dam on the middle Zambezi River, peak floods inundated a mosaic of habitats in the 18,000 km² Zambezi Delta – flooding an area at times comparable in size to the Okavango Delta in Botswana (White 1993, Coppinger & Williams 1994). Maximum flow in the lower Zambezi occurred in March-April, several months after maximum precipitation in the upper and middle Zambezi basin. Low-lying floodplains were inundated with floodwaters for up to nine months of the year, and many areas were saturated throughout the dry season (SWECO 1983). With the closing of Kariba, the third largest dam in Africa, in 1959, approximately 54% of the total Zambezi runoff became regulated. The vast Lake Kariba reservoir now captures the transient minor flood (known locally as "gumbura") generated by local rainfall in the middle Zambezi catchment, and effectively reduces and regularizes the major annual inundation ("murorwe") from the upper Zambezi catchment area (Davies 1986). These hydrological impacts are further exacerbated by the damming of the Kafue River, the most important Zambezi tributary below Kariba Dam. More than 90% of the total Zambezi catchment runoff is now controlled by Kariba and Itzhi Tezhi Dams (RPT 1979, SWECO 1983).

Table 5.3.2. Waterbird species numbers observed in the Zambezi Delta (categories Common and Uncommon follow Maclean 1993).

	no. species
Total waterbird species observed	73
Common species	45
Uncommon species	8
Rare species	20
Breeding species (confirmed)	28
South Africa Red Data Book species	17
Endangered species, breeding (confirmed)	11
Non-breeding palaeartic species	7

Despite these changes in the Zambezi's hydrological regime, the sheer volume of floodwaters reaching the lower Zambezi continued to seasonally inundate the floodplains of the delta until the construction of the massive Cabora Bassa dam in 1975. With the closing of Cabora Bassa, the last vestiges of the ancient floodcycles of the Zambezi River have been nearly eliminated. Only four significant tributaries enter the Zambezi below Cabora Bassa dam, and of those, only the Shire River is perennial. Flooding events in the Zambezi Delta, when they occur, are now dependent upon local rainfall within the lower Zambezi sub-catchment, or unplanned (possibly catastrophic) water releases from Kariba Dam (RPT 1979). The timing, magnitude, duration and sediment deposition of these floods now differ greatly from natural flooding conditions (Suschka & Napika 1990, Beilfuss & Davies 1999).

These hydrological changes are further exacerbated by the construction of dykes along the lower Zambezi to protect the Sena Sugar plantations at Marromeu and Luabo. Dykes were set at the elevation of the 1924 flood peak and prevent floods of less than 12,000 m³/s from inundating the Marromeu floodplains (Bolton 1983). Prior to that time, floods of 5000 m³/s or more inundated the Marromeu Complex on an annual basis (RPT 1979). The railway line constructed between Marromeu to

Inhaminga, and the road between Marromeu and Chupanga further impede drainage through several important distributor channels in the northwestern portion of the delta or Solane depression. The cumulative impact of these developments is a dramatic reduction in flooding on the south bank of the Zambezi during moderate flood years. The north bank sector of the delta has also undergone considerable drying since the 1960s, and is much drier than the south bank sector (Tinley 1994).

Over the past 23 years, overbank flooding of the Zambezi Delta has occurred only a few times, and the western portion of the Marromeu Complex is now fed primarily by silt-free runoff from local rainfall on the Cheringoma Plateau. Anderson *et al.* (1990) observed that the complex is much drier at the end of the dry season than under natural conditions, with a reduction in wetland and open water areas, infestation of stagnant waterways with exotic vegetation, and intrusion of saltwater. Beilfuss & Allan (1996) observed the lower Zambezi River more than 2 m below bankful discharge in the delta during the period when peak floods historically occurred. The desiccation of the floodplain opened the area to aggressive poaching of wildlife species with a more than 90% reduction in buffalo, zebra, waterbuck, reedbuck, hippo and other important grazing species (Anderson *et al.* 1990). Grassland fires now consume more than 90% of the Zambezi Delta grasslands during the dry season.

Prior to the closing of Cahora Bassa dam, Tinley (1975) and Davies *et al.* (1975) predicted that the hydrological changes imposed by the dam would result in reduced fisheries productivity, reduced silt deposition and nutrient availability, salt water intrusion, replacement of wetland vegetation by dryland species, failure of vegetation to recover from grazing, and disrupted or mis-timed reproductive patterns for wildlife species. A few years later, Bernacsek and Lopez (1984) lamented:

“It is clear that in the case of Cahora Bassa there was no serious attempt to ecologically optimize the dam prior to construction... furthermore, after dam closure, proposals put forward by the ecological assessment team were not implemented and there has been no regular monitoring of the dam’s downstream effects during its lifespan. As a result, Cahora Bassa has the dubious distinction of being the least studied and possibly least environmentally acceptable major dam project in Africa.”

In recent years, several studies have been initiated to assess aspects of these potential changes on the ecology of the Zambezi Delta (e.g. GERFFA's Gorongosa-Marromeu Mountain to Mangrove Project, GEMA's Mangrove Assessment Project, the International Crane Foundation–Museu de Historia Natural Zambezi Delta restoration project, and the IUCN Zambezi Basin Wetlands Conservation and Resource Utilisation Project). Among the most significant and obvious changes observed over the past 40 years are the mass invasion of young *Borassus* palms into the open grassy floodplain, and the invasion of *Acacia* woodland into the older palm savanna associations. These changes are to be further quantified (Beilfuss & Dutton, in press), but clearly have important implications for the waterbirds of the Zambezi Delta.

7. IMPACT OF HYDROLOGICAL AND ECOLOGICAL CHANGES ON WATERBIRDS

Although we lack historical data on the abundance and distribution of most waterbirds in the Zambezi Delta, it is clear that water resources development on the Zambezi River is resulting in widespread changes in the quantity and quality of many key waterbird habitats. These changes are especially significant for the many species that either depend on natural flooding cycles to meet their reproductive requirements (e.g. Wattled Cranes), depend on natural low flow periods in the Zambezi River for breeding (e.g. African Skimmer) or feeding (e.g. Openbilled Stork), or depend on the annual recruitment of fish prey in the delta floodplains (e.g. pelicans, many storks). Case studies of these species are presented below.

If present trends continue, species requiring vast expanses of open floodplain, seasonally flooded marshland or brackish mangrove are also vulnerable to the further dessication of the delta. At present, very few waterbird species occur in the northwestern portion of the south bank of the delta where the combined effects of dams and dykes are most marked. There are also very few waterbirds in the drier north bank portion of the Zambezi Delta. The great majority of waterbirds are clumped in the southeast corner of the Delta where seasonal runoff from the Cheringoma escarpment still inundates the

floodplains on an annual basis. There is very limited waterbird utilization of the active and abandoned agricultural and livestock grazing fields around Marromeu and Luabo villages. This may be due, in part, to local hunting pressures.

These changes to important waterbird habitats are exacerbated by other ecological changes in the delta, particularly the decrease in grazing species (e.g. buffalo, waterbuck, zebra) and wallowing species (e.g. hippo), and the increased frequency of grassland fires. Further expansion of the Sena Sugar Estates into reclaimed wetland areas also threatens disturbance-sensitive waterbird species.

8. SPECIES OF SPECIAL CONCERN

8.1 Wattled Crane

The Wattled Crane (*Bugeranus carunculatus*) is a Globally Endangered resident of sub-Saharan Africa, with a total population estimated at no more than 13,000-15,000 birds (Urban 1996). The vast majority (more than 95%) of the population occurs in south-central Africa in the floodplains and dambos of the Zambezi, lower Zaire and Okavango River basins.

Goodman (1992b) estimated there were 2570 Wattled Cranes in the Marromeu floodplain during September 1990, one of the largest populations of Wattled Cranes ever reported. The birds were observed in pairs across the floodplain, although family groups were not reported. Repeating these survey routes during March 1995, we observed 156 Wattled Cranes in the Marromeu floodplain, including 58 pairs (74%) on territories. Only two observations were made of Wattled Cranes on nests, and no juveniles were observed in the population. Surveys during the time of peak Wattled Crane breeding under historic conditions yielded similar results. We observed 20 pairs and no juveniles in July 1996 and (with an expanded survey) 60 pairs and no juveniles in May 1997. Winter surveys in 1998 and 1999 revealed numerous pairs of Wattled Cranes with chicks in the southeast corner of the delta near the Cheringoma Plateau, and very few Wattled Cranes and no chicks in the core Marromeu floodplains affected by Zambezi flooding. Large non-breeding flocks were also observed in the southeastern coastal floodplains of the Marromeu Complex. Thus, although the endangered cranes are present in large, occasionally substantial numbers, repeated surveys have yielded no evidence of breeding success in the Wattled Crane population of the Zambezi River floodplains. Only where natural hydrological conditions are maintained by Cheringoma runoff are Wattled Cranes successfully breeding.

In undisturbed floodplain systems elsewhere in Africa, the breeding cycle of Wattled Cranes is intimately linked to the natural flood cycles of rivers. Wattled Crane pairs are “triggered” to nest as floodwaters begin receding after peak flooding. Nesting in deep, open water after the major flood peaks ensures that nests will be protected from predators and wildfires but will not be drowned by further rising floodwaters. As floodwaters slowly recede, Wattled Cranes raise their single chick on the pulse of exposed plant and insect life (Konrad 1981).

With the present erratic and mis-timed flooding of the lower Zambezi system, Wattled Crane pairs may not be induced to initiate nesting. Where nesting is attempted, unanticipated water level rises can drown nests and food sources. Rapid water level drawdown in the floodplains may expose nests to wildfires and predators and limit food availability. Observations from other disturbed systems support this explanation. On the Kafue Flats, Douthwaite (1974) observed that whereas 40% of Wattled Crane pairs attempt to breed in a year of normal flooding conditions, only 3% of all pairs breed in a year of negligible flooding conditions due to drought. When the hydrological regime of the Kafue Flats was altered by the Itzhi Tezhi Dam, Konrad (1981) predicted a dramatic reduction in Wattled Crane nesting sites and feeding area. Dodman (1996) observed limited breeding activity on the Kafue Flats in 1992 (a drought year) and 1993 (normal precipitation year). Based on these and other observations, and on our findings in the lower Zambezi system, we anticipate a significant decline in the ageing Wattled Crane population of the Marromeu Complex unless hydrological conditions in the lower Zambezi system are improved.

8.2 African Skimmer

The African Skimmer (*Rhynchops flavirostris*), now extinct in South Africa and restricted to a few river basins in southern Africa, occurs in small numbers in the lower Zambezi. Two small flocks totalling 10

Skimmers were observed over Marromeu during aerial surveys in 1997, but no individuals were seen during boat surveys of the lower Zambezi during 1998 and 1999. A census of the upper and middle Zambezi River yielded only 1428 birds. The global population is estimated at less than 10,000 birds (Zusi 1996).

The survival of the African Skimmer depends in large part on the rise and fall of water levels in large rivers such as the Zambezi (Coppinger *et al.* 1988). In large, unregulated rivers, water levels rise many metres during floodstage, conveying heavy loads of suspended silt from upstream. As floodwaters recede, the silt is deposited and sandbars are formed. African Skimmers nest and roost on these exposed, open sandbars. At present the sediment load of the Zambezi is trapped by Kariba and Cabora Bassa dams, and floodwaters in the delta are primarily derived from the silt-free rainfall runoff from the Cheringoma Plateau (Davies 1986). The sandbars used as nest sites for Skimmers and other species are no longer deposited downstream. Over time, older sandbars may become vegetated and abandoned by nesting waterbirds (Dennis & Tarboton 1993).

In the middle Zambezi, this loss of sandbar habitat is exacerbated by unseasonable water releases from Lake Kariba. When water is released during the dry season, a metre high wave surges downstream, sweeping away nests of any birds using the low islands (Coppinger *et al.* 1988). In the lower Zambezi, erratic water releases from Cabora Bassa are probably affecting populations in the Marromeu Complex as well. There were no observations of Skimmer nesting activity during dry season surveys. In addition, proposed dam development on the Pungwe River threatens the only other population of African Skimmers in Mozambique.

The African Skimmer, with its strong dependence on the ebb and flow of the Zambezi and its sediments, is an excellent indicator for the myriad of species that depend on the natural hydrological fluctuations of the Zambezi. The Redwinged Pratincole, with similar habitat requirements, is probably also threatened by river management.

8.3 Openbilled Stork

Openbilled Storks (*Anastomus lamelligerus*) concentrate in large numbers to feed on freshwater snails and mussels on the exposed sandbars of the lower Zambezi during the dry season (Beilfuss & Bento 1997), and feed in shallow freshwater lakes in the coastal mangrove zone during the wet season. Regulation of the river has reduced flood peaks and increased dry season flows, resulting in fewer seasonally exposed sandbars and more permanently vegetated sandbar islands. At present, Openbilled Storks appear to be thriving in the lower Zambezi system relative to other wetland areas in Africa (Dodman *et al.* 1998). However, further attempts to stabilize the Zambezi flow regime will greatly diminish the availability of sandbar habitats and threaten one of the largest populations of Openbilled Storks reported in Africa.

8.4 White and Pink-backed Pelicans

White Pelicans (*Pelecanus onocrotalus*) nest in large, conspicuous colonies in coastal mangroves and are very sensitive to disturbance (Dennis & Tarboton 1993). Floodwaters discharged from Cabora Bassa dam do not carry or deposit sufficient alluvial sediments to maintain the coastal delta in balance with the forces of coastal erosion, resulting in extensive seaward die-off of mangroves (Hughes & Hughes 1992). The shrinking density of coastal mangroves increases the susceptibility of pelicans to disturbance and will eventually force abandonment of the nesting colonies.

Dutton (pers. comm. 1999) observed large numbers of White and Pink-backed Pelicans feeding in the Zambezi Delta floodplains during the 1960s and 1970s. In recent years, pelicans have abandoned the dry floodplains of the Zambezi Delta and now feed in Lake Urema of Gorongosa National Park. They continue to roost and breed in the coastal delta, but can no longer meet their feeding requirements there.

8.5 Other Waterbird Species

The fates of other waterbird species in the Marromeu Complex are also linked to hydrological changes in the lower Zambezi. These impacts of these changes include the degradation of breeding habitats for some species and the impoverishment of feeding grounds for others. As with pelicans, Saddlebilled

Storks (*Ephippiorhynchus senegalensis*), Goliath Herons (*Ardea goliath*) and many other piscivorous waterbird species depend on concentrations of laterally migrating fish that are trapped in shallow floodplain depressions as floodwaters recede. Saddlebilled Storks nest at the end of the wet season, and fledge their chicks during the dry season when food is concentrated and easy to obtain (Hancock *et al.* 1992). Goliath Herons feed on large fish in lake edges and shallow waterbodies of the floodplain (Hancock & Kushlan 1984). Such species are now unable to utilize the vast areas of the Marrromeu Complex that no longer receive overbank flooding sufficient for fish to migrate to floodplain spawning grounds from the main channel.

9. INDIRECT IMPACTS ON WATERBIRD SPECIES

In addition to changes in the quality and quantity of waterbird habitat, hydrological changes in the Zambezi system have also contributed to the decrease in grazing and wallowing mammals, and the increase in hot dry season fires across the delta. The dramatic decrease in the previously widespread buffalo, zebra, waterbuck and other grazing species has led to greatly reduced grazing pressure on the grassy floodplains (Tinley 1969, Anderson *et al.* 1990). Many species of waterbirds feed preferentially in recently grazed floodplains, and are unable to utilize the rank grasslands of large portions of the delta that remain ungrazed during the dry season. Wattled Cranes, for example, are closely associated with areas grazed heavily by lechwe in the Kafue Flats and Bangweulu Basin in Zambia (Konrad 1981, Kamweneshe 1996). Similarly, several species of ducks feed on waste seed and rhizomes in heavily grazed areas. The near elimination of hippo from the Zambezi Delta has also resulted in a loss of open water habitat maintained by wallowing activity. In the 1960s and 1970s, hippo were vital in maintaining open water conditions in many of the small distributor channels of the delta (Tinley 1977). These channels have been subsequently choked with floating and emergent vegetation, and no longer provide open water habitat for piscivorous birds. The desiccation of the delta has also resulted in increased fire frequency during the dry season. The traditional mosaic pattern of burned dry areas and unburned wet areas has given way to extensive fires across the grasslands (Anderson *et al.* 1990) which threaten grassland birds that nest in the standing vegetation (e.g. egrets, reed cormorants). The reduction in above-ground biomass resulting from widespread fires, however, may perhaps offset some of the waterbird habitat losses caused by low grazing pressure. There is no data available to quantify the impact of these indirect effects on waterbird diversity and abundance in the Zambezi Delta.

10. THE RAMSAR CONVENTION

The Convention on Wetlands of International Importance Especially as Waterfowl Habitat, known as the Ramsar Convention, was adopted in 1971. This convention provides a framework for international cooperation in the conservation of wetlands and the communities that serve, in part, as waterbird habitat. Nations that ratify the Convention agree to designate at least one wetland for inclusion in the List of Wetlands of International Importance, to promote the wise use of all wetlands and their resources, to stem the loss of wetlands where possible, and to promote the training of personnel in wetland management. The Ramsar Convention defines the wise use of wetlands as "sustainable utilization for the benefit of mankind in a way compatible with the maintenance of the natural properties of the ecosystem" (David 1993).

Wetlands are selected as Wetlands of International Importance on the basis of sound ecological, botanical, zoological, limnological and hydrological criteria. There are currently 893 wetlands in 104 nations worldwide on the list, with a total area of over 66.8 million ha (Dwight Peck, pers. comm. 1998). In Africa, 25 nations have ratified the Convention, including Zambia, Botswana, Tanzania, Malawi and South Africa. Within the Zambezi catchment, only the Okavango Delta and the Kafue Flats are designated Wetlands of International Importance.

The Zambezi Delta easily meets the criteria as a Wetland of International Importance under the Ramsar Convention. It supports at least 17 species of global concern, including the endangered Wattled Crane, endangered African Skimmer, White Pelican, Pinkbacked Pelican, Woollynecked Stork, Openbilled Stork, Saddlebilled Stork, Yellowbellied Stork, Black Stork, Redwinged Pratincole and Caspian Tern. Eleven of the endangered species breed in the delta (Table 1). The delta also supports Globally Important breeding colonies of resident pelicans, storks, herons and egrets, and provides summer feeding grounds for palaeartic migrant shorebirds and the inter-African migrant Abdim's Stork. At least

seven palaeartic species and 28 breeding species have been recorded (Table 1), while other breeding species are still to be confirmed.

From among the many coastal wetlands of Mozambique, the Zambezi Delta is of the highest ecological value. The Inkomati, Limpopo, Sabie and Pungwe coastal floodplains are all vitally important for ducks and other waterbirds in Mozambique, but the size and diversity of the Zambezi Delta is unparalleled. It is an excellent example of the wetlands characteristic of the coastal zone of Mozambique, and it is part of a complex of high quality wetland habitats ranging from floodplain grasslands and papyrus swamps to mangrove estuaries. The Zambezi Delta has a substantial hydrological, biological and ecological role in the functioning of the Zambezi basin and coastal system, and is a wetland of great socio-economic and cultural value. It is also part of the extensive Sofala Bank system, the most important prawn fishery in Mozambique. The fisheries sector contributes significantly to Mozambique's economy, accounting for 40% of GNP and US\$55.4 million in revenue from the prawn fishery alone in 1996 (MICOA 1998).

The nomination of Marromeu as a Wetland of International Importance creates new opportunities for international awareness and ecotourism development, particularly in conjunction with ongoing efforts to link management and sustainable utilization of the Marromeu area with Gorongosa National Park to create an immense protected area system (DNFFB 1994). It creates a conservation network linking the Zambezi Delta with other major wetlands of the middle and upper Zambezi system, including the Okavango Delta and Kafue Flats and enables Mozambican resource managers to gain better access to training in wetland management and monitoring and funding for research.

11. CONCLUSIONS

The Zambezi Delta supports 73 species of waterbird, including numerous Vulnerable and Threatened species of Global Concern, large breeding colonies of several waterbird species, and numerous palaeartic and intra-African migrant species. There are 17 species that are considered Endangered in South Africa and 11 of them breed in the delta.

Total waterbird numbers in the Zambezi Delta have probably undergone a significant decrease over the past 30 years due to changes in the hydrological regime of the Zambezi River. Widespread changes in the quality and quantity of waterbird habitat have been observed. The breeding success of endangered Wattled Cranes, an indicator species for natural flooding conditions, is very low in the Zambezi Delta relative to other floodplain wetlands in Africa. Piscivorous waterbirds such as pelicans and storks occur in very low numbers in the floodplains most affected by water resources development.

The Zambezi Delta qualifies as a Wetland of International Importance under the Ramsar Convention, and is of great socio-economic and cultural value to Mozambique.

12. SURVEY CONSTRAINTS

Because of the inaccessibility of the core swamp grassland areas of the Marromeu Buffalo Reserve, ground surveys were limited to the surrounding outcrops (10, 11 and 14), the riverine corridor from Marromeu to Malingapansi, and the coastline at Chinde. We were unable to gain access on foot to shallow marsh areas in the Delta to flush and expose species such as bitterns, small herons, rails, crakes and flufftails, many of which are of critical conservation concern. However, observations in wetland pans of the miombo woodland adjacent to the Zambezi Delta revealed Africa Rail (*Rallus caerulescens*), Lesser Jacana (*Micropara capensis*) and Black Crake (*Amaurornis flavirostris*), suggesting that these species are likely to be present in the shallow depression wetlands of the delta as well.

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