Temporary wetlands of Bushmanland and Kavango, northeast Namibia

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ABSTRACT

Bushmanland and the eastern part of Kavango have extensive temporary wetlands in years of average to high rainfall. Both areas fall within the Kalahari sand sea. Most wetlands are of limited size and the period of inundation is short. But where omiramba (fossil drainage lines) and aeolian processes have cut through these sand deposits, wetland development can be extensive. All known wetland areas are reviewed as to their type, extent, utilization by both wildlife and humans, threats to the system, and management and conservation recommendations. The temporary wetlands of Bushmanland and Kavango encompass a variety of habitats and these are utilised by a wide spectrum of amphibian, reptile, bird and mammal species. The two largest temporary wetland systems in Bushmanland, the Nyae-Nyae pans and "Pannetjies veld" wetlands support large numbers of endangered species, notably wattled cranes and slaty egrets. Numbers of these species are sufficiently high to warrant the registration of these systems under the Ramsar Convention, should Namibia become a signatory. Systematic lists of amphibians, reptiles, birds and mammals found utilising the temporary wetlands of Bushmanland and eastern Kavango are given in appendices at the end of the paper.

INTRODUCTION

The hydrology, biota, functioning and value of temporary wetlands in the arid and semi-arid regions of Namibia are generally poorly known. This is primarily the result of the sporadic nature of the "wet" phase of these systems, their small size and ephemeral nature.

The importance of temporary wetlands as waterfowl/waterbird habitats in southern Africa has been known for a long time, and has received considerable attention over the years (Siegfried 1970; Skead & Dean 1977; Geldenhuys 1975 & 1976; Zaloumis & Milstein 1975). Other aspects of temporary wetland systems such as geomorphology (Lancaster 1978), vegetation (Geldenhuys 1982) and microfaunal succession (Seaman & Kok 1987) have been documented for localised areas within the subcontinent. Little work has, however, been done to 'prepare inventories of wetlands and their resources...as an aid to the formulation and implementation of national wetland policies' (Anon 1980b) on a regional basis in the arid/semi-arid parts of southern Africa.

Bushmanland and eastern Kavango both fall within the Kalahari region as described by Heine (1982). In this area the Kalahari sand deposits are of varying depth (Anon 1980a) and there is little surface run-off. Where these sand deposits are deep, temporary wetland development is usually restricted to interdune areas where drainage may be impeded by clays or calcrete formation at the base of the catena. These wetlands are localised in occurrence and are usually small (<1 ha).

There are, however, extensive wetland areas which owe their occurrence to special geomorphological features. In both Bushmanland and eastern Kavango fossil drainage lines called omiramba [omiramba = plural of omuramba] are major features of the landscape. Although surface water flow is now restricted, the direction of flow of these omiramba lies in many places across the major orientation of dune fields indicating that there was active above-ground flow of water in the past. Changes in weather patterns, tectonic events and general deposition of aeolian sands during the development of the Kalahari sand sea may have all contributed to the omiramba having limited above-ground water flow today.

The very extensive wetland systems of the eastern part of Bushmanland have developed on a broad, flat watershed situated between the Nhoma and Daneib drainage systems. The development of this broad stable watershed was as a result of the Aha Hills, in the southeast, effectively preventing or significantly reducing the westward transport of aeolian sands by easterly winds during the Late Cainozoic (i.e. during the deposition of the Kalahari sand sea) (Ward & Swart 1989). The aeolian processes active during this period resulted in a major deflation surface developing in the lee of the hills. Here surficial hardpan calcretes, granite and quartzites restrict drainage and, as there are no major drainage lines out of the area, large tracts of temporary wetlands develop. Although surface evaporation rates are high for this area these wetlands can last for up to 6 months in years of above "average" rainfall.

The climate of Bushmanland and eastern Kavango is characterised by a marked seasonality of rainfall and high summer temperatures. The area as a whole has a Koppen classification of BSh (arid steppe) (Schultze & McGee 1978). The winter "dry season" is from May to Septem-

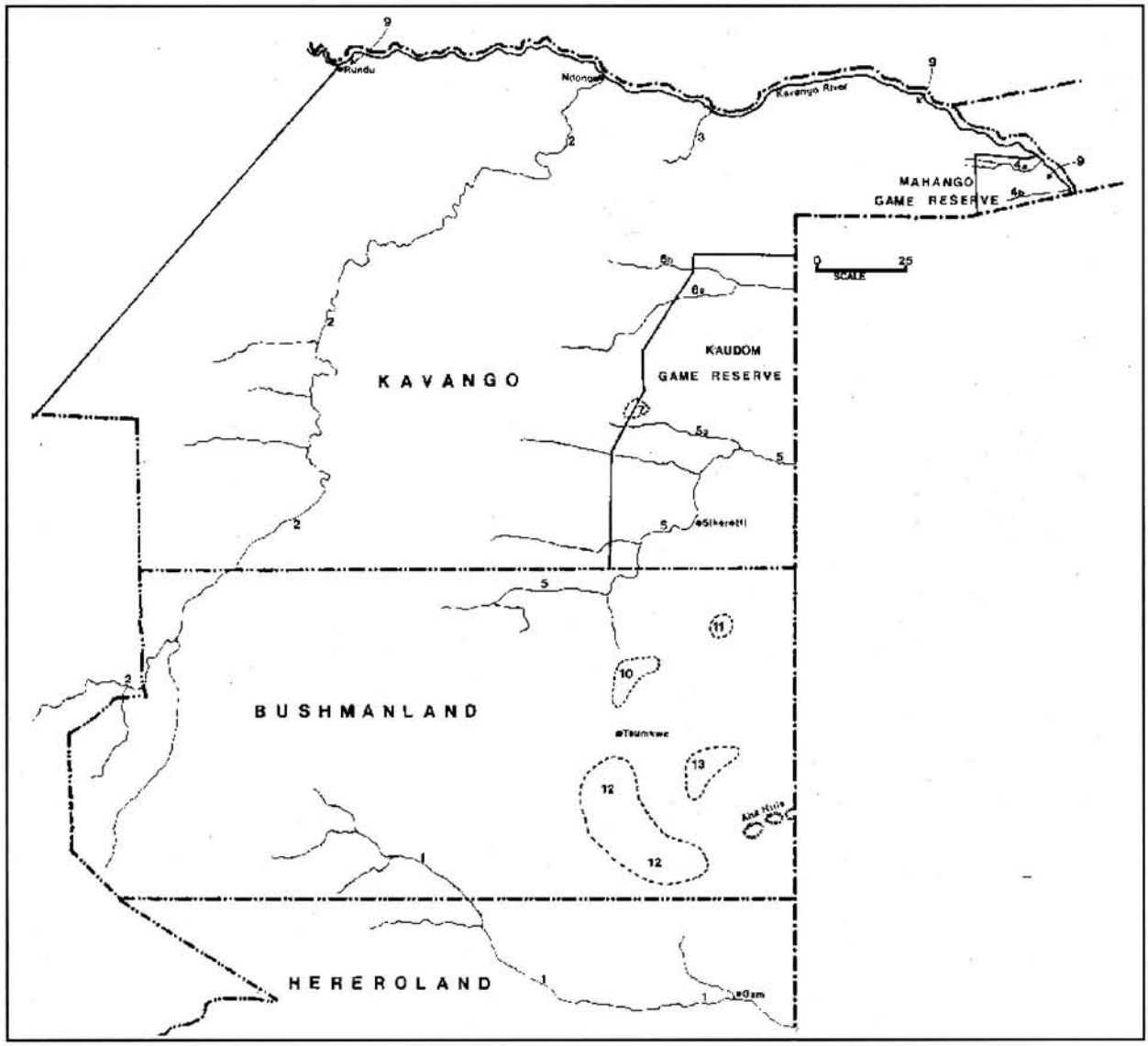

FIGURE 1: Temporary wetlands in the Bushmanland and eastern Kavango region. Numbers corespond to the numbering of wetlands in the text.

ber/October during which little rain falls. Daytime temperatures can be high (>30°C) in the latter part of the dry season and this results in high evaporation rates. The summer "wet" season is from October to April and during this period rainfall peaks in the months December to March, showing considerable spatial and temporal variability in distribution. The average rainfall for the area as a whole is *c.* 450 mm per annum (Katsiambirtis 1988), but this varies considerably from year to year. For example, rainfall data for Tsumkwe, Bushmanland, show a minimum of 110 mm and a maximum of >1200 mm in a single season over a 20 year period (unpub. data).

This paper attempts to illustrate the diversity of temporary wetland habitats, their determinants and principal biota in the northeastern Namibian territories of Bushmanland and eastern Kavango. Threats to these temporary wetlands, and management and conservation priorities are outlined.

MATERIALS AND METHODS

All the information given here is a result of personal observation during 1983—1989, unless otherwise stated. No references to the seasonal/temporary wetlands in either Bushmanland or Kavango could be found in the literature.

At present lists of Red Data species (hereafter referred to as RD species) of Namibian fauna and flora are only in the preparatory stage. Griffin (in prep.) gives information on RD species of amphibians, reptiles and mammals. Griffin (1985) is used as a reference on the distribution of amphibians, reptiles and mammals in Bushmanland and Kavango. Those bird species listed by the IUCN/ICBP as RD species (Collar & Stuart 1985) are discussed separately under each individual wetland area where they occur.

Nomenclature of plants follows Gibbs-Russell *et al.* (1985 & 1987). All fauna are referred to in the text using common names, unless no common names are available. Scientific names are listed in the relevant appendices. Nomenclature of amphibians and reptiles follows that used by Griffin (1985), birds, that used by Maclean (1984) and mammals that used by Smithers (1985).

The wetlands are classified according to the broad types

outlined by Morant (1983) where possible. Where not enough is known about a wetland area a classification has not been given. Only those wetlands that are the result of local precipitation events are covered by this paper.

The terms relating to abundance/status of habitats and species are somewhat arbitrary, due to the fact that very little quantitative data are available. The terms used (e.g. common, uncommon, *etc.)* are used entirely subjectively in an attempt to give an idea of the likelihood of seeing a given habitat/species in a particular area, and do not correspond to any numerical value.

RESULTS AND DISCUSSION

Figure 1 gives the location of the wetlands covered by this survey. The survey only covers those temporary wetlands in the Bushmanland and eastern Kavango areas. Up until recently the military situation in western Kavango precluded ground survey work and no information is available on wetland systems in this area. In the text below the following abbreviations are used under the individual wetland descriptions. **GP** - Geographical position; **WTE** - Wetland type and extent, including a broad classification; **DET** - Possible hydrological and geological determinants; **PB** - Principal biota; **THR** - Threats to the wetland system; **MCR** - Management and conservation recommendations. Where inventory is recommended in the text, this refers to inventory of all wetland resources as defined by Breen (1991) and Anon. (1980b)

WETLAND DESCRIPTIONS

1. Daneib Omuramba.

GP- The Daneib Omuramba drainage line arises in the south-central part of Bushmanland. Here it is poorly developed and is characterised by shallow drainage lines cutting through deep sands. The Daneib reaches its best expression in Hereroland, where it captures the Bierboklaagte drainage. The Daneib in turn becomes part of the Gewihabadum drainage system in Botswana. **WTE** - Poorly known. There are several small pans (<1 ha) in extent in the Bushmanland region. In Hereroland a spring/ fountain at Gam has long been known. There are several small pans in the Gam area. Classification: Palustrine systems with aquatic and emergent vegetation, with open water. Irregularly flooded, pH - circumneutral/alkaline fresh. **DET** - Unknown. Fossil drainage line, probably the result of faulting in the underlying Damara sequence rocks (Hegenberger 1983). The smaller pans are probably the result of animal wallows and deflation by wind action. Clay content of the omuramba floor is low. In several areas pedogenic calcretes may impede drainage and result in wetland formation. **PB** - Poorly known. Amphibians, reptiles and birds: no data. Mammals: north-south migrations of several large mammal species (elephant, giraffe and blue wildebeest) are known to occur between Bushmanland and Hereroland and these animals must be partially dependent on wetlands. Elephant bulls are known to use the area around Gam in the wet season. **THR** - No threats are known for the Bushmanland sector of the omuramba. In Hereroland settlement of cattle farmers in the area around Gam started in 1987. There has since been a marked degradation of grazing lands in the area and the wetlands may be equally affected. Uncontrolled hunting is also known to take place. **MCR** - Inventory and careful assessment of threats required.

2. Omuramba Omatako.

GP - The Omuramba Omatako is one of the largest inland drainage systems in Namibia. It arises in the Omatako hills south of Otjiwarongo and meanders northwards through Hereroland East, the Grootfontein district, Bushmanland and Kavango. The omuramba is fed by several small, unnamed drainage systems and is in turn captured by the Kavango River at Ndonga. The orientation of the omuramba may be the product of major fault lines along part of its length (Albat 1978). **WTE** - Poorly known. No extensive developments of wetlands are known from the Bushmanland section of the omuramba. Here there are a number of small pans (<1 ha). In the Kavango, the northern section of the omuramba is subject to seasonal floodback from the Kavango River. Further south the temporary wetlands are variable in size, but are predominantly small pans and flooded grasslands. Traditional human settlements along the omuramba developed where water is either available from a fountain or where shallow wells could be dug. Classification: Shallow palustrine systems, with aquatic and emergent vegetation, some open water. Irregularly flooded, fresh water with circumneutral to weakly alkaline pH. **DET** - Unknown. Fossil drainage line. The small pans in the omuramba are the result of animal wallows and wind action. Soils in much of the omuramba have a high clay content derived from dolerite and weathering of basal rock. Wetland formation is common where there are clay accumulations and where pedogenic calcretes and basal rocks are covered by a shallow layer of sand. **PB** - Poorly known. Amphibians, reptiles and birds: no data. Mammals: Historically the Omuramba Omatako must have been of major importance to wildlife. The explorer Andersson reports on hunting black rhino in the omuramba, and as this is a water dependent animal, temporary wetlands must have been important in its occurrence in the area. Several large game species are known to occur along the omuramba but it is uncertain whether temporary wetlands are important in their occurrence in the area. Notable species are, wild dog, leopard and elephant. Side-striped jackal should occur in the omuramba, but this has not been confirmed. **THR** - In Bushmanland settlement of people in the omuramba has been an ongoing process over a number of years. Livestock farming, cultivation and the uncontrolled use of fire in the omuramba may all pose threats to wetlands. In the Kavango the omuramba is quite densely populated (Page 1980) and here overgrazing by livestock, cultivation and clearance of vegetation may all pose some degree of threat to the temporary wetland systems. The increasing use and development of boreholes for water abstraction in both

Bushmanland and Kavango may have adverse long-term effects on the water table of the omuramba. **MCR** - Inventory and careful assessment of threats required.

3. Katere Omuramba.

GP - The Katere Omuramba is a short (*c.* 30 km), well defined omuramba running south-north into the Kavango River near Katere village. The omuramba is steep sided and narrow in its northern section giving an impression of being deeply cut into the landscape. **WTE** - Poorly known. Fossil drainage line. The northern section is subject to some flooding during high water in the Kavango River. There are some small pans (<1 ha) and flooded grassland areas further south. Classification: ?. **DET** - Unknown. The small pans may be the result of animal wallows and wind action. Clays and pedogenic calcretes may impede drainage resulting in wetland formation. **PB** - Unknown. No data for all groups. **THR** - The northern section of the omuramba near the main Rundu-Bagani road is heavily populated. Livestock farming and some cultivation takes place in the omuramba. **MCR** - Inventory and careful assessment of threats required.

4. Mahango and Thinderevu Omiramba.

GP - The Mahango Omuramba is also known as the Rukange Omuramba. Both the Mahango and the Thinderevu omiramba are short well defined drainage systems, most of which fall within the Mahango Game Reserve. The omiramba are orientated west-east and join the Kavango River floodplain within the reserve boundaries. **WTE** - The "mouths" of the omiramba are subject to seasonal flooding during high water of the Kavango River. Temporary wetland development is very limited. Several small pans occur west of the main road through the reserve. Classification: Palustrine systems, unconsolidated bottom with limited vegetation development. Irregularly flooded. **DET** - These small wetlands are probably all the result of animal wallows in the clay rich soils of the omurimba bottoms. **PB** - Poorly known. Amphibians, reptiles and birds: no data. Mammals: Primarily used as wallows by game. Other: Several species of crustaceans have been recorded in these pans, including *Triops* spp. **THR** - Threats are minimal as these systems all fall within the Mahango Game Reserve. **MCR** - An inventory of wetlands is required.

5. Nhoma Omuramba.

GP - The Nhoma Omuramba is an extensive drainage system arising in northern Bushmanland, east of the Omuramba Omatako. The principal orientation of the system at this point is west-east but soon changes to a long curve northeastwards where the drainage follows the margins of major folds and possible faults in the Nossib quartzites. The Nhoma reaches its most northern point where the Dussi Omuramba joins it, and here the orientation again changes to follow the major fault line down which the Dussi drains. Much of the Nhoma Omuramba falls within the Kaudom Game Reserve. **WTE** - There are several wetland types within the Nhoma drainage but the extent and distribution of these is poorly known, particularly in Bushmanland. Wetland types include:

(a) Open water pans - unvegetated. Usually small, shallow waterbodies, often used as wallows. This type of wetland is common along the Bushmanland sector of the omuramba.

(b) Open water pans - vegetated. These pans are usually dominated by floating macrophytes such as *Nymphaea* spp. There may be a narrow fringe of emergent macrophytes, or a surrounding ring of trees e.g. *Acacia tortilis*. These wetlands can be fairly extensive (>10 ha) and can be up to 1.5 m deep. Uncommon in the area northeast of Sikeretti.

(c) Vegetated pans. There are surprisingly no extensive developments of *Phragmites* spp. reed beds in the Nhoma. Vegetated pans are usually dominated by species of Cyperaceae. These pans can be extensive (>20 ha) and usually develop where clays impede drainage and surface water is clearly visible. There is often an underlayer of *Nymphoides indica* and *Marsilea* spp. They are uncommon in the area between Dussi and the Botswana border.

(d) Hygrophilous grasslands - *Odyssea paucinervis/ Cynodon dactylon* short grass lawns. This type tends to develop where calcareous sandy soils are subject to a short period of inundation, usually to the exclusion of other species. These grass species are probably adapted to high salt concentrations as in some areas upward percolation of salts through the soil profile has led to some salt crusting. Common between Sikeretti and Dussi.

(e) Hygrophilous grasslands - *Sporobolus coromendalianus* short grass areas. This wetland type develops where drainage is impeded by a subsurface layer of clay and upward percolation of salts causes the surface soils to be highly saline. Occur where extensive flat areas have developed in the omuramba bottom. Inundation
is of short duration. Uncommon in the Bushmanland area. Can be extensive (>20 ha).

(f) Hygrophilous grasslands - *Imperata cylindrica* tall grass areas. These wetlands occur commonly along the omuramba from Sikeretti to the Botswana border, where inundation is of short duration. Very often develop at the lowest point in extensive flat areas. *Imperata* grasslands can be extensive (>20 ha) but are usually small.

(g) Hygrophilous grasslands - *Triraphis* spp. tall grass areas. Occur where clays derived from weathered dolerite and quartzites have developed a high organic fraction possibly by internal mulching. Surface water is not a characteristic of these wetlands. *Triraphis* grasslands can be very extensive (>100 ha) and reach their best expression west of Sikeretti near the Bushmanland border. Classification: Shallow palustrine systems, with emergent/aquatic vegetation dominant, some open water wetlands with no vegetation development. Irregularly flooded, soils can be saline, with circumneutral to alkaline pH. **DET** - Unknown. Fossil drainage line. The majority of the wetlands in the omuramba are probably the result of impeded drainage because of the high clay content of the soils. Where deeper sands develop in the omuramba pedogenic calcretes may occur and also cause wetland formation. Many of the smaller pans are probably the result of animal wallows and wind action. **PB** - Poorly

known. Amphibians: 7 species confirmed occurring and a further 8 species suspected (Appendix 1). Reptiles: 3 species confirmed occurring (Appendix 2). Birds: Wetland dependent species recorded in the Nhoma Omuramba are given in Appendix 3. The total number of species recorded (66) is low, but the system as a whole has not been extensively surveyed. A number of RD species have been recorded from the Nhoma. Wattled cranes have been recorded in the omuramba east of Sikeretti, usually singly or in pairs. The habitat is not optimal and it is unlikely that high numbers will ever be recorded. Slaty egrets have been recorded in small numbers during "wet" years, on the pans east of Sikeretti. Saddlebilled storks also occur in small numbers on these pans. Mammals: Appendix 4 lists those species recorded from the Nhoma Omuramba system. Twenty-three species at least partially dependent on temporary wetlands have been recorded or are suspected to occur. Major use of wetlands is for drinking water, wallows and salt licks. The distribution of the side-striped jackal in the north-east of Namibia is closely linked to omiramba and pans. It is uncommon in the Nhoma where it is known to breed. **THR** - Unknown. In Bushmanland settlement of subsistence livestock farmers has been taking place since the early 1980's. This is centred around the army post at Nhoma. At present human densities are low, but wetlands may be threatened by overgrazing and indiscriminate use of fire. In the Kavango the omuramba lies within the Kaudom Game Reserve and threats are minimal. **MCR** - An inventory of wetlands is required. This is most urgent in the Bushmanland section of the omuramba.

6. Kaudom/Cwiba Omiramba Complex.

GP - The Kaudom and Cwiba (also known as Tclabashe) omiramba are west-east orientated drainage lines arising in Kavango. These omiramba are not long but are well defined, broad systems that cut through the deep sands and dunes in the area. Much of these omiramba falls within the Kaudom Game Reserve. **WTE** - Poorly known. Temporary wetland types include:

(a) Saline seepages and springs. These occur along both omiramba, but are commonest near the junction of the two systems. Salinities are high and largely due to sodium sulphate and sodium chloride. Usually limited in size, some of these seepages and springs have been extensively altered by animal excavation over a long period of time and are devoid of all vegetation. Generally positioned on the omuramba margins.

(b) Saline vegetated pans. This wetland type develops where seepage of saline water occurs away from the omuramba margin. Characterised by shallow, hypersaline water with sparse, stunted development of *Phragmites* spp. reeds and some salt tolerant Cyperaceae. Margins of these pans may show crystaline salt deposits and crusts. These crusts may also be found on the stems of the emergent vegetation. These wetlands are commonest near the Kaudom/Cwiba junction and may be extensive (50-100 ha) but are usually limited in size.

(c) Saline sedge wetlands. These wetlands are uncommon in the Kaudom Omuramba near the Cwiba junction. They are dominated by a species of *Juncus*, and occur in isolated patches where some saline seepage occurs. Salt deposits and crust are common features. They are usually <1 ha in extent.

(d) Open water pans - unvegetated. These wetlands are only inundated in years of high rainfall. They are usually open evaporite basins with a fringe of *Phragmites* spp. reeds. Salt crusting and crystaline deposits are common features of the pan bottom. These pans are often large (20-100 ha) and are commonest in the Kaudom Omuramba near Tamsu.

(e) Open water pans - vegetated. Uncommon in both omiramba and usually small (<1 ha). No floating aquatic macrophytes have been recorded in these pans, which are usually dominated by *Phragmites* spp. reeds and sedges. No salt crusting and deposits indicate less saline water than some of the above wetland types.

(f) Reed beds. This is the most extensive wetland type in the Kaudom/Cwiba complex. The reed beds are usually monospecific stands of *Phragmites* spp. reeds and reach their best development in the Cwiba Omuramba, and in the Kaudom east of the junction of the two drainages. These wetlands are very extensive, some sections stretching several kilometres. Deep peat accumulations indicate the ancient nature of this system.

(g) Hygrophilous grasslands - *Sporobolus coromendalianus S. spicatus* short grass areas. These wetlands are common in the Kaudom Omuramba where saline calcareous clays are subjected to short periods of inundation. Few other species of plants survive in these conditions, but there is often a surrounding fringe of *Cynodon dactylon*. These areas can be large (20-100 ha)

(h) Hygrophilous grasslands - *Cynodon dactylon* short grass lawns. This wetland type is very extensive (>1000 ha) in the Kaudom Omuramba and in parts of the upper Cwiba system. The *Cynodon* lawns tend to develop on the omuramba margins and where organic non-saline soils in the omuramba bottom are not subject to prolonged inundation. It may be argued that these lawns are not strictly "wetlands", but they have formed on hydric soils and are subject to some degree of inundation.

(i) Hygrophilous grasslands - *Imperata cylindrica* tall grass depressions. These wetlands are common in the upper sections of both omiramba. These grassy depressions can be large (>100 ha) and form where inundation is too prolonged for *Cynodon* lawns to develop. *Sesbania macowanii* is often found associated with these depressions. Classification: Shallow palustrine systems, emergent vegetation dominant when present, open water wetlands with no vegetation common. Irregularly flooded, but many wetlands result from groundwater seepage. Water slightly saline to hyper-saline. **DET** - Unknown. Fossil drainage system. Probably the most important determinant of wetland formation in these omiramba are the deep peat beds and associated reed developments which act as a sponge and impede subsurface drainage, thereby elevating the water table which result in the salt springs and seepages along the omuramba margins. The high sulphate content of the water gives an indication of organic breakdown under anaerobic conditions which occurs in peats. The hygrophilous grasslands occur where clays and highly organic soils have high water retention and hence impeded drainage. **PB** - Poorly known. Am-

phibians: 9 species confirmed, 6 species suspected. Most of these species are probably dependent on rainwater puddles and pans for breeding as the majority of wetland sites in the Kaudom and Cwiba are very saline (Appendix 1). Reptiles: Only 2 species are known to occur (Appendix 2). Birds: Appendix 3 lists those wetland/waterbirds that have been recorded in the Kaudom/ Cwiba omiramba. The low total number of birds (36) is probably due to the highly saline nature of much of the surface water making these temporary wetlands unsuitable for many species (e.g. Anatidae). Important species include black coucal and marsh owl. Mammals: Appendix 4 lists 27 species at least partially dependent on temporary wetlands, recorded in the Kaudom/Cwiba omiramba. Major use of wetlands is for drinking water, wallows and salt licks. The side-striped jackal is common along both omiramba and is known to breed in the Kaudom Omuramba. The small mammal fauna is poorly known. **THR** - The major threat to the temporary wetlands of the Kaudom/Cwiba. omiramba is the uncontrolled fires that run through the system every year. These fires have been able to get into the peat accumulations and there has been a noticeable degradation of the peats in the past five years. If, as is suspected, the peat beds are important in elevating the water table, their continued degradation will result in the drying up of the saline springs and seepages which are very important for the large game populations of the area. **MCR** - The priority management consideration for this system is to develop a programme to exclude or at least contain fires in the reed beds and peat accumulations. The fires have often been deliberately set by people settled at the police post on the Botswana border and this practice should be stopped. An inventory of the wetlands and their resources is required.

7. West Kaudom wetlands.

GP - This area of temporary wetlands is situated along the western boundary of the Kaudom Game Reserve, about 45 km north of the Bushmanland border. **WTE** - Unknown. The area was only surveyed from the air. The system comprises a number of small pans with short grass lawns between pans. The whole area is *c.* 2000 ha. **DET** - Unknown. **PB** - Unknown. **THR** - Threats to the system must be minimal as most of the area falls within the Kaudom Game Reserve. **MCR** - Inventory of the wetlands required.

8. Small interdune pans and temporary wetlands.

GP - Widely distributed in the Kalahari sand areas of the Kavango and Bushmanland. These pans and wetlands are always found in the interdune areas or localised depressions and often form as long lines of pans/wetlands. **WTE** - Poorly known. Usually small (<1 ha) individual pans or wetlands, but the interdune areas and depressions where they occur may be several kilometres long. There are several wetland types. These include:
(a) Open water pans - unvegetated. Usually small, shallow waterbodies, often used as wallows. The period of inundation is short, precluding the development of wetland vegetation. Common and widely distributed.
(b) Open water pans - vegetated. These pans are usually dominated by floating aquatic macrophytes such as *Nymphaea* spp. Very often they have a fringe of sedges and aquatic grasses such as *Echinochloa holubii*. These pans are usually small, but are common and widely distributed through the Kalahari sand area. Where these pans are large and the period of inundation prolonged, *Cynodon dactylon* lawns may develop along the upper margins of the drawdown zone.
(c) Hygrophilous grasslands - *Sporobolus coromendalianus* short grass areas. These wetlands are very common between pans and can be extensive (100-200 ha). They occur where subsurface clays Impede drainage and upward percolation of salts to the surface excludes the presence of other species. Inundation is of short duration. Classification: Shallow palustrine systems, with aquatic and emergent vegetation, some open water. Irregularly flooded, fresh to weakly saline water with circumneutral to weakly-alkaline pH. **DET** - These wetlands occur primarily as a result of drainage impeded by clays washed out of the sand deposits and dunes, to the base of the catena. The long narrow linear strings of pans and hygrophilous grasslands (e.g. near Leeupan) may represent the development of incipient drainage lines. In some areas pedogenic calcretes have formed at the base of well developed dunes (e.g. in the dune field east of Sikeretti) and this has resulted in impeded drainage and wetland development. **PB** - Poorly known. Amphibians: 5 species known to occur, a further 10 species suspected (Appendix 1). Reptiles: The terrapin *Pelomedusa subrufa* occurs commonly (Appendix 2). Birds: Appendix 3 lists those wetland/waterbirds that have been recorded utilising interdune wetland habitats. These small wetlands are relatively poorly known and this may account for the low number of species recorded (59). Slaty egrets are thought to utilise these wetlands but this has not been confirmed. Other important species are saddlebilled stork, rufousbellied heron and dwarf bittern. Mammals: Twenty-four species have been recorded (Appendix 4). Data on the small mammals of these areas is poor. Large mammals tend to utilise these wetlands as sources of drinking water, wallows and salt licks. The distribution of certain species in the Kalahari sand areas seems to be entirely restricted to these small interdune wetland areas, e.g. bat-eared foxes. This is probably due to specific substrate requirements for burrow construction rather than a direct dependence on water. **THR** - Unknown but likely to be low, due to the dispersed nature of these wetlands and the uninhabited nature of the area of their main occurrence (the deep Kalahari sands). Most of the types described are well represented within the Kaudom Game Reserve. **MCR** - Inventory of these wetlands and resources required.

9. Perched river terrace wetlands.

GP - These wetlands have a fragmented distribution along the Kavango River from Rundu to the Botswana border. They are known only from three places, the Ekongoro zoo and town sewerage treatment plant near Rundu; near Mayara about 150 km east of Rundu; and in the Mahango Game Reserve. **WTF** - Poorly known.

These wetlands are not extensive anywhere and are usually discrete entities in otherwise dryland habitat. There are several wetland types.

(a) Open water pans - vegetated. (i) At Ekongoro this type is characterised by emergent vegetation, with *Typha latifolia* and *Scirpus* spp. dominant. Floating macrophytes also occur, including *Nymphaea* spp., *Aponogeton* spp. and *Potomogeton* spp. There are several deep borrow pits at Ekongoro and these are unvegetated except on their margins. (ii) At Mayara these pans are dominated by *Nymphaea* spp. and reeds are absent. (iii) In the Mahango G.R. this wetland type is dominated by floating macrophytes such as *Nymphaea* spp. where the water is deep. Where the pans are shallower several species of *Crinum* are evident as well as dense stands of sedges. Extensive *Typha latifolia* stands are rare in the Mahango pans.

(b) Flooded grasslands - short *Cynodon dactylon* lawns. There are extensive developments of this wetland type at Ekongoro, especially in the drawdown zone bordering vegetated pans. It is not known whether this type occurs at Mayara. Absent in association with temporary wetlands in the Mahango G.R.

(c) Flooded grasslands - tall grass depressions. This wetland type is common in the Mahango G.R., where *Miscanthus lunceus*, *Panicum fluviicola*, *Echinochloa* spp. and *Cymbopogon* spp. dominate. These depressions are usually small (1-5 ha). Some aquatic macrophytes such as *Nymphaeoides indica* are associated with this wetland type. This wetland type is not known from Ekongoro or Mayara. Classification: Shallow palustrine systems, with aquatic and emergent vegetation (deep open water areas the result of human disturbance). Irregularly flooded, water fresh with circumneutral to alkaline pH. **DET** - Unknown. These wetlands may represent the relic remains of old river meanders, oxbow lakes and floodplain depressions. The clay content of the soils on the river terraces where these wetlands occur is sufficiently high to impede drainage. Certain sections of the Ekongoro wetlands may be subject to some seasonal inundation by river floodwaters. These wetlands are, however, predominantly the result of local precipitation events. **PB** - Although these wetlands have not been intensively surveyed they have by far the highest species diversity of all the wetlands described in this paper. Amphibians: 18 species have been confirmed utilising these wetland systems, a further 4 species are expected to occur (Appendix 1). Fish: At Ekongoro several species of fish have been recorded being caught by the local inhabitants. These include several species of Ciclidae and barbel *(Clarias gariepensis)*. In the Mahango G.R. the only fish noted in these wetlands were barbel (*C. gariepensis)*. Reptiles: Appendix 2 lists 8 reptile species recorded or suspected to occur in perched wetlands in the Kavango. Two species, the nile crocodile and the water leguaan, occur rarely outside the Mahango Game Reserve, and are only common within the park boundaries. Birds: Appendix 3 lists the wetland/waterbird species that have been recorded on the perched wetlands of the Kavango. The high number of species (116) is partially due to the proximity of these temporary wetlands to the permanent wetlands of the Kavango River. Slaty egrets are regularly recorded on the small pans in the Mahango Game Reserve and at Ekongoro. The occurrence of wattled cranes on these pans is only sporadic, as they tend to prefer the permanent grass swamps of the Kavango River floodplain. Wattled cranes are very rarely recorded outside the Mahango Game Reserve. Mammals: Appendix 4 lists those species utilising these wetlands (38). Several species are almost totally restricted in their distribution to these perched wetlands. The swamp musk shrew, greater cane rat, Angoni vlei rat, creek rat and water rat are all restricted to wetland habitats, including the main river floodplain. Shortridge's mouse is endemic to the region and almost only known from the perched wetlands in the Kavango. Otters have not been recorded from the temporary perched wetlands. Red lechwe and reedbuck utilise these areas during the rainy season, when the river floodwaters are not particularly high. **THR** - These wetlands have undergone considerable degradation at all three sites. The Ekongoro site has been afforded some degree of protection by being included in the zoo grounds administered by the Kavango Department of Education. At Ekongoro the use of the area for road surfacing material has stopped. Uncontrolled fishing, hunting of waterfowl and cutting of reeds all still pose some degree of threat to the wetlands at Ekongoro. The removal of cattle which used to graze in the *Typha* reed beds and on the *Cynodon* lawns has had mixed results. Although disturbance has been reduced, the cattle were important in opening the reed beds up and since their removal the *Typha* beds have become very closed leading to an overall reduction in diversity of habitats within the wetlands. The wetlands at Mayara are under some threat due to livestock grazing and human disturbance (cutting of emergent vegetation), but they are poorly known and the degree of the threat posed is unknown. In the Mahango Game Reserve several of the wetlands have been badly damaged through excavation for road surfacing material by Nature Conservation officials. It was subsequently found that the material dug out of these wetlands was unsuitable for road surfacing. The excavations and borrow pits have not been reclaimed or filled even though the spoils dumps are close at hand. **MCR** - Inventory of the wetlands and careful assessment of the threats to the Ekongoro and Mayara areas is required. Reclamation of the Mahango wetland excavations and the cessation of the use of these wetlands for road building materials is a priority.

10. Klein Dobe wetlands.

GP - The Klein Dobe pans and wetlands run on a north-south axis from about 15 km north of Tsumkwe to Klein Dobe, Bushmanland. These wetlands are localised depressions and there are no major drainage lines in the area. **WTE** - Poorly known. The wetlands are usually small (<1-10 ha) and are often just individual pans with an area of short grass between one pan and the next. *Hyphaene petersiana* palms are characteristic of the higher ground near wetlands in this area of Bushmanland. Several wetland types have been noted. These include:

(a) Open water pans - unvegetated. The large pans at Klein Dobe and Groot Dobe are the best examples of this

type. The Groot Dobe pan is seldom completely inundated and is saline with no vegetation development except on the margin where *Odyssea paucinervis* forms dense stands. Klein Dobe undergoes inundation more frequently and extensive stands of the grass *Diplachne fusca* may develop in the pan. Klein Dobe is considerably less saline than Groot Dobe. Small (<1 ha) open water pans are common in the area.

(b) Open water pans - vegetated. These pans are usually small (<1 ha) and the vegetation is dominated by floating macrophytes such as *Nymphaea* spp. with a surrounding margin of hygrophilous grasses, e.g. *Elytrophorous globularius* and *Eragrostis viscosa.*

(c) Grass pans. This wetland type is usually very limited in extent (< 0.5 ha) and is characterised by dense stands of *Echinochloa holubii* and *Echinochloa colonum.* Some grass pans are dominated by almost monospecific stands of *Diplachne fusca* but these are uncommon.

(d) Hygrophilous grasslands - *Sporobolus coromendalianus* short grass areas. This wetland type is common in the Klein Dobe area, usually forms on flat clay bottom lands and can be quite extensive (<100 ha). These grasslands are slightly different from areas described in Kavango in that they are characteristically associated with *Acacia erubescens/Terminalia prunioides* thickets, on the higher ground, with a dense underlayer of *Sansevieria pearsonii.* This wetland type very often forms between one open water pan and another. Classification: Shallow palustrine systems, with aquatic and emergent vegetation, some open water systems unvegetated. Irregularly flooded, water fresh to saline with circumneutral to alkaline pH.

DET - Poorly known. The large pans at Klein and Groot Dobe are thought to be the result of selective weathering of the underlying base-rich dolerite (Ward & Swart 1989). The smaller open water pans may be the result of wallows and wind action. The grass pans often form in the sandier parts of the area, and these pans commonly have a small rim or deposit of ferricrete. Ward & Swart (1989) suggest that this ferricrete is the result of a closed drainage system with ground water mobility and leaching of minerals, which are then reprecipitated. This suggests impeded downward drainage of water due to some underlying impervious layer. The hygrophilous grass areas with associated woody species (*Acacia erubescens*) tend to form where drainage is impeded by subsurface clays and where upward percolation of salts results in the exclusion of other hygrophilous species. **PB** - Poorly known. Amphibians: Ten species of confirmed occurrence, another 5 suspected to occur (Appendix 1). The bullfrog (*Pixicephalus adspersus*) is the commonest amphibian in the area. Reptiles: Three species have been recorded (Appendix 2). Birds: Poorly known. Appendix 3 lists the birds recorded in the Klein Dobe wetland area (78 species). Slaty egrets have been noted on several pans in the area but are uncommom. Wattled cranes have been recorded feeding and roosting in large groups (up to 19) on Klein Dobe pan. The smaller grass pans in the area also attract wattled cranes, where they have been observed feeding. Mammals: Appendix 4 lists those species utilising these wetlands. **THR** - Unknown. The Klein Dobe wetlands are thought to be unthreatened to any degree at present. Some small scale livestock farming developments are taking place nearby but these are not seen as any threat. **MCR** - Inventory of the wetlands of the area required.

11. Cin Qo wetlands.

GP - This wetland system lies about 40 km northeast of Tsumkwe, and has developed where the Kalahari beds are relatively shallow, and the underlying quartzites have impeded drainage. This wetland system may represent a northward extension of the Klein Dobe system. **WTE** - Poorly known, but the majority of wetland types in the area correspond closely to the wetlands in the Klein Dobe system, (detailed wetland descriptions given under Klein Dobe section). Wetland types include:

(a) Open water pans - unvegetated. Largely the result of animal wallowing and wind action. The large evaporite pans such as Groot Dobe are absent in this area. Common and usually small (<1 ha) but some pans quite large (>5 ha).

(b) Open water pans - vegetated. Usually dominated by *Nymphaea* spp. Small (<1 ha) and common.

(c) Grass pans. Usually dominated by *Echinochloa* spp. *Diplachne fusca* dominated pans are absent in the area. Common and usually small (<1 ha).

(d) Hygrophilous grasslands - *Sporobolus coromendalianus* short grass areas. Common and extensive (>50 ha) in the area. Classification: Shallow palustrine systems, with aquatic and emergent vegetation. Irregularly flooded, water fresh with circumneutral to alkaline pH.

DET - Unknown. Wetland formation in this area is probably largely due to the surficial Kalahari sands being shallow and the underlying Nossib quartzites impeding drainage. For individual wetland types refer to the Klein Dobe section above. **PB** - Poorly known, but species likely to be very similar to those occurring in the Klein Dobe area. Amphibians and reptiles: no data. Birds: Poorly known. Small numbers of wattled cranes have been recorded feeding and roosting on these wetlands. Slaty egrets probably occur in small numbers in wet years. Mammals: Similar to the Klein Dobe area. Elephant are known to occur in the area in the dry season in large breeding herds. **THR** - A small livestock farming operation was founded in this area in about 1987. Threats to the system as a whole are likely to be low, but there must be some degree of disturbance to both the flora and fauna of these wetlands. **MCR** - A careful inventory of the wetlands and their resources required.

12. Nyae-Nyae wetland system.

GP - The Nyae-Nyae wetland system lies in a broad arc running south-east of Tsumkwe, Bushmanland. The northern most point of the system lies just south of Tsumkwe, and the system encompasses the villages of Gautscha, Namtsoha, Nama and Karu. **WTE** - The Nyae-Nyae wetlands system is centred on the Nyae-Nyae pans, and is a large deflation basin comprising a number of dryland habitats and a variety of wetland types. The wetland system as a whole is very extensive and covers an area of

about 100, 000 ha in "wet" years. The very large pans found in the area are characterised by a calcareous base and large lunette dunes formed on the leeward side of the pan. The Nyae-Nyae wetlands system is widely interconnected and because of this many of the wetland types described here intergrade and may be difficult to separate as discrete entities. Wetland types include:

(a) Open water pans - unvegetated. These pans are generally large (>100 ha), highly alkaline evaporite basins and have no vegetation on them except perhaps on the extreme margin. The best examples of this type of pan are Nyae-Nyae pan and Gautscha pan . These pans are the last part of the wetland system to dry up and are about 1.5 m in depth when full. Inundation may last for more than six months in years of above average rainfall.

(b) Doline pans. These pans are found only on the western margin of the Nyae-Nyae system and are rare. These appear to be sinkholes (dolines) formed in areas underlain by calcrete (Ward & Swart 1989). When full these pans are >2.0 m deep, and may be unvegetated, but generally have floating mats of *Polygonum* spp. and *Panicum* spp. Examples of this pan type include Xae/sca, Te-barku and Gwaa-nwi. In the dry season water seepages occurring in the bottom of these pans are an important source of water for birds and mammals.

(c) Open water pans - vegetated Type 1. This wetland type forms where the underlying soils are not very alkaline, usually where organic muds have developed. The vegetation is dominated by floating and submerged macrophytes such as *Nymphaea* spp., *Aponogeton* spp. and members of the Characeae. Several grass species and sedges may occur in these pans but they are not the dominant vegetation. Inundation can be prolonged (>3 months) and the pans large (>20 ha). This wetland type is very common in the area between Gautscha and Nyae-Nyae pans, and in the north of the system near Tsumkwe.

(d) Open water pans - vegetated Type 2. This wetland type tends to develop where shallow calcareous sands make up the rooting material and the soils are generally alkaline. The vegetation is dominated by Cyperaceae and floating mats of *Polygonum limbatum* may form in the deeper parts of the system. This wetland type is uncommon and never extensive (<10 ha). There are several examples of this wetland type in the southem part of the system.

(e) Grass pans - *Echinochloa* dominated. These small pans (<1 ha) occur where organic clays have impeded drainage. They are dominated by *Echinochloa holubii* and *E. colonum*. They are common north of Gautscha and near Nama.

(f) Grass pans - *Diplachne* dominated. This wetland type is the commonest in the Nyae-Nyae area and covers very extensive areas (>100 ha) of the system. The grass *Diplachne fusca* dominates this wetland type and very few other species of plants grow in these pans. They tend to form on calcareous clays where the period of inundation is prolonged. Examples of this type are Nyae-Nyae south, Khabi pan, and the large unnamed pans west of Khabi.

(g) Hygrophilous grasslands - *Odyssea* short grass areas. This wetland type tends to develop on calcareous sands where the period of inundation is short. *Odyssea paucinervis* dominates this type to the exclusion of most other plant species. Prolonged inundation of *O. paucinervis* tends to kill it and these areas are subsequently dominated by *Diplachne fusca*. This wetland type is common and extensive (>100 ha) in the northern part of the system around Nyae-Nyae pan itself.

(h) Flooded woodland - Type 1. This wetland type is characterised by the presence of *Combretum imberbe* and the grass *Melinis repens*. These flooded woodlands are very common in the Nyae-Nyae area and are extensive (>200 ha). They tend to form on pedogenic calcretes where the soils are shallow(< 20 cm) and where inundation periods are prolonged. This wetland type forms an intergrading mosaic with the following wetland type. (i) Flooded woodland - Type 2. The characteristic vegetation of this wetland type is a short tree stratum dominated by *Acacia luederitzii* and *Combretum hereroensis*, and a grass layer with several species of grass including *Melinis repens, Sporobolus* spp. and *Aristida rhiniochloa*. This wetland type intergrades extensively with the *C. imberbe* flooded woodlands, but tends to occupy slightly upland areas where flooding is of short duration. *Acacia luederitzii* may be susceptible to drowning. This wetland type is common and extensive (>100 ha) in the Nyae-Nyae pan area and in the area east and south of Khabi pan.

(j) Flooded woodland - Type 3. This wetland type is common only in a narrow band running from just north of Gautscha to Nama pan. They are nowhere much larger than *c.* 10 ha, are characteristically situated on heavy black clays, where open water may or may not develop, and the vegetation is dominated by *Combretum imberbe* and *Aristida* spp. grasses (particularly *A. hordeacea, A. rhiniochloa* and *A. adscensionis).*

(k) Flooded scrub/shrub. Large areas (>50 ha) of *Grewia flava* and *Croton* spp. scrub/shrub are periodically flooded in years of very high rainfall. This may not represent a wetland type, but the opportunistic establishment of dryland species in wetland areas during drier years. Classification: Shallow to moderately deep palustrine systems, with open water and vegetated (aquatic and emergent) classes of wetlands all equally common. Water fresh to weakly saline, pH circumneutral to alkaline.

DET - The extensive wetland developments of the Nyae-Nyae area and the "Pannetjies veld" (see below) owe their existence largely to the establishment of a broad stable watershed in the mid-Tertiary (Ward & Swart 1989), which has promoted the formation of pans. The Aha hills in the south-east prevented the deposition of large aeolian sand deposits during the formation of the Kalahari sand sea, but the prevailing winds at that time effectively scoured out the Nyae-Nyae "basin"(lunette formation gives a clue to this). Most of the area is underlain by pedogenic calcretes which provide a firm base to the pans. Nama pan in the South, shows a cliffed shoreline which reflects more stable waterlevels in the recent geological past (Ward & Swart 1989). **PB** - Reasonably well known. Amphibians: All those species recorded in the Nyae-Nyae area are listed in Appendix 1. Eleven species are known to occur in the area, another 6 suspected. Reptiles: Appendix 2 lists those species recorded in the Nyae-Nyae area. Three species have been recorded. Birds: Appendix 3 lists those species recorded in the

Nyae-Nyae wetland system; 106 species have been recorded. The populations of certain species found on the Nyae-Nyae area are sufficiently large to warrant registration under the Ramsar Convention. Important species in this regard are: Wattled cranes - large numbers recorded even in relatively dry years. Usually found in small groups of 3 birds - two adults and a fully fledged juvenile. The largest number recorded in one locality was 52 birds on Nyae-Nyae pan (south). Maximum estimated population is about 150 birds. Slaty egrets are present in small numbers throughout this area. Openbilled storks have been recorded breeding in large numbers in the Khabi pan area. More than 70 nests were counted in several loosely formed colonies in March 1989. Lesser flamingos do not breed on the pans but low intensity breeding displays (marching and head-snapping) have been observed and the Nyae-Nyae area may be important for birds getting into prebreeding condition. The large colonies of blacknecked grebes and whiskered terns may be some of the largest recorded in the subcontinent (up to 180 grebe nests and more than 50 tern nests in a single colony). Mammals: Those species recorded in the Nyae-Nyae area are given in Appendix 4. No species are totally dependent on temporary wetlands. Twenty-two species have been recorded. **THR** - Overall threats to temporary wetlands in this area are low. Developments in the tourism industry and subsistence livestock farming may have negative consequences for these wetlands if not carefully controlled. Tourism is on the increase in eastern Bushmanland and the pans of the Nyae-Nyae area are heavily utilised. Threats to the system come largely from disturbance of breeding waterfowl and other birds, and 4x4 enthusiasts driving through wetland areas to "test" their vehicles. Livestock farming in the Gautscha area has already led to overgrazing of upland sites and this may change drainage patterns, groundwater percolation and vegetation development. **MCR** - Continued monitoring and inventory of these wetlands over a long period of time, encompassing both wet and dry phases could give important insights into arid zone wetland functioning and resources. Careful assessment of the threats to this system, particularly tourism, is required.

13. The "Pannetjies veld" wetlands.

GP - The "Pannetjies veld" is an area of wetlands about 25 km east of Tsumkwe. This mosaic of small pans, hygrophilous grasslands and dryland areas, overlies fragmented Fransfontein granites. The villages of Tjokwe, Gimsa and Nenihim all fall within this area. **WTE** - The wetlands in this area are all generally clay bottomed, are well vegetated and tend to form on the massive jointing intersections of the underlying granites. Several wetland types are recognisable. These are:

(a) Open water pans - unvegetated. These pans are rare and are usually small (<0.5 ha). Often heavily ulilised by large mammals as wallows.

(b) Open water pans - vegetated Type 1. This wetland type is common in the Tjokwe-Makuri area and is characterised by being shallow, inundation is for moderate periods (2-4 weeks) and the dominant vegetation is *Aponogeton desertorum, Nymphoides indica* and often a fringe of *Elytrophorus globularis*. These pans are usually small (<1 ha).

(c) Open water pans - vegetated Type 2. Most of the pans in the "Pannetjies veld" are of this type. These pans are well vegetated with *Nymphaea* spp. being characteristic of the deeper areas of the pans often associated with a floating mat of *Polygonum limbatum*. The shallower areas of the pans are dominated by a number of *Scirpus* spp. (Cyperaceae) and grasses. The proportion of sedges to grasses varies between pans. Where grasses dominate the commonest species are *Oryzidium barnardii, Echinochloa colonum* and *E. staqnina*. Certain pans are dominated by the grass *Eragrostis rotifer*, particularly where the pan margin is very shallow and inundation is not prolonged. Other plant species common on this type of pan are *Sesbania macowanii, Ottelia kunenensis, Aeschynomene indica* and the fern *Marsilea unicornis*.

(d) Grass pans. This type of pan is common in the Baraka area of the "Pannetjies veld". They are generally small (<1 ha), shallow and grasses dominate to the exclusion of other aquatic plants. The commonest species are *Echinochloa holubii, Eragrostis rotifer* and where the pan is well shaded, *Dactyloctenium giganteum*.

(e) *Acacia kirkii* tree pans. These pans characteristically occupy the lowest point on the joint junctions of the underlying granites. The most distinctive plant species is the floodplain acacia, *Acacia kirkii*. The pan may be heavily vegetated with emergent and floating macrophytes as described in (c) above. This pan type is commonest in a narrow band running between Tjokwe, Makuri and Gimsa waterholes. Certain small pans in the area seem to be suitable for colonisation by *A. kirkii*, but this species is surprisingly absent. Here the clay bottoms are deeper than other areas and it is thought the vertic (self-mulching) nature of these clays may cause root shear and hence excludes large tree species.

(f) Hygrophilous grasslands - *Sporobolus coromendalianus* short grass areas. These wetland areas are very common and extensive (>100 ha) in the Baraka and Makuri areas of the "Pannetjies veld". These grass areas occur where drainage is impeded by a subsurface layer of clay and upward percolation of salts causes the soils to be saline. In certain areas *Eriospermum bakeranum* may be a codominant. As in the Klein Dobe area the higher ground (which may be old termitaria) is occupied by dense stands of *Sansevieria pearsonii, Terminalia prunioides* and *Acacia erubescens*.

(g) Hygrophilous grasslands - *Digitaria* tall grass depressions. This wetland type occurs commonly in the dry land area between Makuri and Baraka. Here pockets of sand underlain either by impervious clays or granite become waterlogged and free water sometimes occurs on the surfacc. These depressions show thixotropic properties, where any mechanical disturbance causes the waterlogged area to turn to slush. No woody plants occur in these areas and they are generally sparsely covered by grasses, a species of *Digitaria (cf. debilis)* often dominant. They are generally small (<1 ha). Classification: Shallow palustrine systems, with aquatic and emergent vegetated classes of wetlands commonest, unvegetated open water wetlands are rare. Water fresh, pH weakly acidic to circumneutral. **DET** - This is the only area of

Bushmanland where the wetlands are not predominantly alkaline. The development of the mosaic of wetlands in the "Pannetjies veld" area is largely the result of the Aha hills obstructing the deposition of aeolian sands during the late Cainozoic (Ward & Swart 1989). The wetlands themselves tend to be small and their distribution and form are largely governed by the joint patterns in the underlying granites. The heavy clays derived from the weathering of the feldspars in the underlying granite tend to accumulate in these joints and have given rise to a number of wetland types found nowhere else in Bushmanland. **PB** - Reasonably well known. Amphibians: Nine species of confirmed occurrence, 9 species suspected (Appendix 1). Reptiles: Three species have been recorded (Appendix 2). Birds: Well known. Those species at least partially dependent on the temporary wetlands of the area are listed in Appendix 3. The mosaic of pans in the "Pannetjies veld" is one of the most important wetland areas in Bushmanland for waterfowl and wetland bird breeding. Thirty-two species of wetland birds have been recorded breeding on these wetlands. Breeding populations of dwarf bitterns, whitebacked duck, knobbilled duck, African crake, lesser moorhen, painted snipe and whiskered terns have been recorded in this area. This is the only area in Africa where slaty egrets have been recorded breeding outside a permanent wetland area. In the 1988/1989 wet season 27 nests were found on two small pans. Breeding success was very low (only 3 chicks were known to have fledged). Wattled cranes are also commonly recorded on the wetlands of the area, usually in small family groups of two adults and a fully fledged juvenile. Mammals: Twenty-two species at least partially dependent on the wetlands of the "Pannetjies veld" are given in Appendix 4. The small population of buffalo (11 known individuals) is centred in the Gimsa area. The "Pannetjies veld" supports the largest numbers of roan antelope in the Bushmanland area.. **THR** - The "Pannetjies veld" as a whole is not severely threatened. The threats to the area are similar to those posed by tourism and subsistence livestock farming in the Nyae-Nyae system. Disturbance of breeding waterbirds is likely to be the most important threat to the wetlands of the "Pannetjies veld". **MCR** - Monitoring of waterbird populations in the area, particularly slaty egrets and wattled crane, should continue. This monitoring would provide information regarding the importance of these wetlands on a regional and international basis, and could lead to the possible registration of the area under the Ramsar Convention.

CONCLUSIONS

In the past the importance of arid zone wetland system and resource values has been largely neglected, for a variety of reasons. The major problem with studying these systems is that they represent a small percentage of the total surface area of the arid zone and the "wet" phases of the systems can be widely separated in time. But the importance of these systems lies in the fact that they are not "unpredictable" to those biota utilising them. Nomadic waterfowl have obviously evolved to cope with these changeable environments in the arid zones of southern Africa, and the temporary wetlands are probably very important in overall strategies of breeding and dispersal outside of "dry period" refugia (e.g. the Okavango swamps).

In Bushmanland and eastern Kavango there are a number of temporary wetland systems, characterised by high evaporation rates and variable water quality but usually with alkaline, mineralised surface waters. These wetlands are often restricted in size and the period of inundation is highly variable. The resulting variety of wetland habitats, ranging from unvegetated open water systems to hygrophilous grasslands, supports a diverse assemblage of flora and fauna some of which are rare and/or endangered over much of their range. Internationally, the most important species utilising the wetlands of Bushmanland and Kavango are wattled cranes and slaty egrets. Although wattled cranes have not been recorded breeding on any of the temporary wetland systems described, these systems are, without doubt, of great importance as sources of food and of refuge. Wattled cranes have been recorded in "dry" years in eastern Bushmanland (Nyae-Nyae area) in quite large numbers (>10 individuals on a single pan) and the composition of the wattled crane groups (usually two adults and a fully fledged juvenile) indicate that these wetlands may be important post-breeding dispersal areas, and therefore important in overall life strategies for this species. Slaty egrets have only been recorded in the "wetter" years and breed when conditions are optimal on small wooded pans in the "Pannetjies veld" of eastern Bushmanland. The only mammal species thought to be totally dependent on temporary wetland systems is Shortridge's mouse which has been recorded from the perched wetlands in Kavango. Although this species is known to occur in Angola and Zaire, it is only well known from the Kavango River system in Namibia and northwestern Botswana where it is found on 'the fringes of wet vleis and in reed beds and swamp-grass areas' (Smithers 1983).

The long-term threats and conservation requirements to these species and the wetlands on which they are dependent, are difficult to assess. At present threats in Bushmanland are low, but could increase in the future. Unrestricted use of certain wetlands for livestock farming and the settlement of people in close proximity to important breeding areas may cause some disturbance, but overall threats from these activities are likely to be low in the long-term if the rational management plans proposed for the areas are instituted. Probably the greatest threat at present is the burgeoning tourist pressure in these areas and this can only be reduced by making people more aware of the general systems' functions and the importance of these areas for breeding waterbirds and animals. For the most part, the extremes in the wet/dry cycle of these systems are likely to deter overexploitation in that the general discomfort of waterlogged conditions, mosquitoes and reduced access, balanced by prolonged periods of drought will reduce the effectivity of any development strategies in these areas. The Kaudom/Cwiba Omiramba system is faced with a more direct threat in the continually burning peat fires, and this can only be

reduced through direct management and planning for exclusion of fires from these systems.

The most important long-term conservation action regarding wetlands as a whole in Namibia, would be for Namibia to become a signatory to the Ramsar Convention. This would lead to decision-makers becoming more aware of the importance of Namibian wetlands on both a local and a regional/international scale. Most importantly, registration of certain wetlands under the Convention will afford these areas a greater degree of protection through international pressure, and arbitrary decisions regarding exploitation would not be made lightly (e.g. the use of perched wetlands for road-surfacing material). There are a number of temporary wetland systems that would be worthy of consideration under the Convention and these are listed in Table 1. The criteria listed are those discussed by Stuart (1990) and Anon. (1990).

Table 1. Temporary wetlands of Bushmanland and eastern Kavango fulfilling registration criteria for the Ramsar Convention (Anon 1990)

SYSTEM	REGISTRATION CRITERIA
Perched wetands	i) >1 % of population of Shortridge's mouse (ii) good representative example of wetland characterstic of biogeographical region (iii) of special value for maintaining the genetic and ecological diversity of a region because of the quality and peculiarities of its fauna and flora
Nyae-Nyae pans systems	(i) >1% of population of wattled crane (ii) >1% of population of slaty egret (iii) good representative example of wetland characteristic of biogeographical region (iv) of special value for maintaining the genetic and ecological diversity of a region because of the quality and peculiarities of its fauna and flora
"Pannetjies veld" wetlands	(i) >1% of population of slaty egret, including only known breeding colony outside a permanent wetland (ii) good representative example of wetland characteristic of biogeographical region (iii) of special value for maintaining the genetic and ecological diversity of a region because of the quality and peculiarities of its fauna and flora.

Continued monitoring and research into the functioning and resources of the temporary wetlands of Bushmanland and eastern Kavango (particularly the Nyae-Nyae and "Pannetjies veld" systems) could contribute greatly to overall understanding of arid zone wetlands in Namibia and in a regional context. In addition new perspectives on the conservation and management of these systems would be gained.

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Appendix 1. List of amphibians associated with temporary wetlands in Bushmanland and Kavango.

SPECIES	WETLAND SYSTEM						
	NH	KC	ID	PW	KD	NN	PV
Xenopus muelleri				0			
Xenopus laevis					1		
Bufo garmani	0	1	0	1	1	1	0
Bufo maculatus	1	0	0	1	0	0	0
Bufo hoeschi							0
Bufo kavangensis					0		
Phrynomerus bifasciatis	1	1	1	1	1	1	1
Phrynomerus affinis	1	1	1	1	1	0	
Pyxicephalus adspersus	1	1	1	1	1	1	1
Tomopterna cryptotis	1	1	1	1	1	1	1
Tomopterna krugerensis						0	0
Tomopterna marmorata					0	0	0
Hildebrandtia ornata	0	1	0	1	1	0	1
Ptychadena mossambica					1		
Ptychadena oxyrhynchus					1		
Ptychadena taenioscelis					1		
Ptychadena mascareniensis	0	0	0	1	1	1	1
Ptychadena subpunctata	1	0	0	1	0	1	0
Phrynobatrachus natalensis	0	0	0	1	1	0	0
Phrynobatrachus mababiensis	0	0	0	1	0	1	1
Cacosternum boettgeri	0	1	0		0	1	1
Chiromantis xerampelina					1		
Leptopelis bocagei	0	1	0	0	1	0	0
Kassina senegalensis	0	1	0	1	1	1	1
Hyperolius nasutus	1	0	0	1	0	1	1
Hyperolius aposematicus					1		
CONFIRMED SPECIES	7	9	4	13	16	10	9
TOTAL SPECIES	15	15	16	14	23	17	17

Wetland codes used in Appendix 1 are as follows:
NH - Nhoma omuramba
KC - Kaudom/Cwiba omiramba complex
ID - Interdune wetlands
PW - Perched wetlands
KD - Klein Dobe and Cin Qo wetlands
NN - Nyae-Nyae wetlands
PN - Pannetjiesveld wetlands

= not recorded
0 = occurrence suspected, but not confirmed
1 = occurrence confirmed

Appendix 2. List of reptiles associated with temporary wetlands in Bushmanland and Kavango.

SPECIES	WETLAND SYSTEM						
	NH	KC	ID	PW	KD	NN	PV
Nile Crocodile *Crocodylus niloticus*	-	-	-	1	-	-	-
Helmeted Terrapin *Pelomedusa subrufa*	1	-	1	1	1	1	1
Okavango Hinged Terrapin *Pelusios bechuanicus*	-	-	-	0	-	-	-
Water Leguaan *Varanus niloticus*	-	-	-	1	-	-	-
Savanna Leguaan *Varanus exanthematicus*	1	1	1	1	1	1	1
Olive Marsh Snake *Natriciteres olivaceas*	-	-	-	1	-	-	-
Ornate Green Snake *Philothamnus ornatus*	-	-	-	0	-	-	-
African Python *Python sebae*	1	1	0	1	0	0	0
TOTAL SPECIES	3	2	3	8	3	3	3

Wetland codes used in Appendix 2 are as follows:

NH - Nhoma omuramba
KC - Kaudom/Cwiba omiramba complex
ID - Interdune wetlands
PW - Perched wetlands
KD - Klein Dobe and Cin Qo wetlands
NN - Nyae-Nyae wetlands
PV - Pannetjiesveld wetlands

\- = not recorded
0 = occurrence suspected but not confirmed
1 = occurrence confirmed

Appendix 3. List of wetland/waterbird species observed on different wetland systems in Bushmanland and eastern Kavango.

SPECIES	WETLAND SYSTEM						
	NH	KC	ID	PW	KD	NN	PV
Blacknecked Grebe *Podiceps nigricollis*	U	-	U	C	U	BrC	BrU
Dabchick *Tachybaptus ruficollis*	BrC	U	BrC	BrC	BrC	BrC	BrC
White Pelican *Pelecanus onocrotalus*	-	-	-	R	R	U	R
Pinkbacked Pelican *Pelecanus rufescens*	-	-	-	V	-	V	-
Grey Heron *Ardea cinerea*	-	-	-	U	U	C	R
Goliath Heron *Ardea goliath*	-	-	-	U	R	R	R
Purple Heron *Ardea purpurea*	R	-	-	BrU	-	-	R
Great White Egret *Egretta alba*	U	-	U	C	U	C	C
Little Egret *Egretta garzetta*	U	R	U	C	U	C	R
Yellowbilled Egret *Egretta intermedia*	-	-	-	U	-	U	U
Black Egret *Egretta ardesiaca*	?	-	R	-	R	U	U
Slaty Egret *Egretta vinaceigula*	R	-	?	U	R	R	BrU
Cattle Egret *Bubulcus ibis*	-	-	-	C	-	R	-
Squacco Heron *Ardeola ralloides*	C	-	C	C	C	C	C
Greenbacked Heron *Butorides striatus*	-	-	-	C	-	-	-
Rufousbellied Heron *Butorides rufiventris*	R	-	U	U	R	R	R
Blackcrowned Nightheron *Nycticorax nycticorax*	R	-	-	C	R	C	C
Whitebacked Nightheron *Gorsachius leuconotus*	-	-	-	R	-	-	-
Little Bittern *Ixobrychus minutus*	U	-	U	U	R	U	BrU
Dwarf Bittern *Ixobrychus sturmii*	BrC	-	BrU	BrC	BrC	BrC	BrC
Hamerkop *Scopus umbretta*	C	U	C	C	U	U	U
White Stork *Ciconia ciconia*	-	U	-	U	U	U	-
Black Stork *Ciconia nigra*	-	-	-	R	-	-	-
Abdim's Stork *Ciconia abdimii*	C	C	C	C	C	C	C

Appendix 3 continued

SPECIES	WETLAND SYSTEM						
	NH	KC	ID	PW	KD	NN	PV
Woollynecked Stork *Ciconia episcopus*	C	-	C	C	U	C	C
Openbilled Stork *Anastomus lamelligerus*	C	-	C	C	U	BrC	C
Saddlebilled Stork *Ephippiorhynchus senegalensis*	U	-	R	U	R	C	U
Marabou Stork *Leptoptilos crumeniferus*	C	U	U	U	U	C	C
Yellowbilled Stork *Mycteria ibis*	R	-	-	U	-	C	U
Sacred Ibis *Threskiornis aethiopicus*	-	-	-	U	-	R	R
Glossy Ibis *Plegadis falcinellus*	C	-	C	C	C	BrC	C
African Spoonbill *Platalea alba*	U	R	U	U	U	C	U
Greater Flamingo *Phoenicopterus ruber*	-	-	-	-	U	C	-
Lesser Flamingo *Phoenicopterus minor*	-	-	-	-	U	C	-
Whitefaced Duck *Dendrocygna viduata*	U	-	U	U	U	U	U
Fulvous Duck *Denrocygna bicolor*	U	-	U	C	U	BrC	BrC
Whitebacked Duck *Thalassornis leuconotus*	U	-	U	C	BrU	BrC	BrC
Egyptian Goose *Alopochen aegyptiacus*	-	-	R	C	R	U	-
South African Shelduck *Tadorna cana*	-	-	-	-	-	R	-
Yellowbilled Duck *Anas undulata*	-	-	V	V	-	-	V
Cape Teal *Anas capensis*	-	R	-	U	C	BrC	R
Hottentot Teal *Anas hottentota*	R	-	U	C	C	C	C
Redbilled Teal *Anas erythrorhyncha*	BrC	U	BrC	BrC	BrC	BrC	BrC
Garganey *Anas querquedula*	-	-	-	-	-	V	-
Cape Shoveller *Anas smithii*	-	R	-	U	C	BrC	U
Southern Pochard *Netta erythrophthalma*	BrC	-	U	C	BrC	BrC	BrC
Pygmy Goose *Nettapus auritus*	C	-	U	BrC	U	R	BrU
Knobbilled Duck *Sarkidiornis melanotus*	BrC	-	BrC	BrC	BrC	BrC	BrC
Spurwing Goose *Plectropterus gambensis*	C	-	U	BrC	C	BrC	BrC

Appendix 3 continued

SPECIES	WETLAND SYSTEM						
	NH	KC	ID	PW	KD	NN	PV
Maccoa Duck *Oxyura maccoa*	R	-	R	-	-	-	BrU
African Fish Eagle *Haliaeetus vocifer*	U	R	U	U	U	C	C
European Marsh Harrier *Circus aeruginosus*	-	-	-	-	-	V	-
African Marsh Harrier *Circus ranivorus*	-	-	-	R	-	-	-
Montagu's Harrier *Circus pygargus*	R	R	-	-	U	U	R
Wattled Crane *Grus carunculata*	R	-	-	R	U	C	U
Blue Crane *Anthropoides paradisea*	-	-	-	-	-	V	-
African Rail *Rallus caerulescens*	-	-	-	BrU	-	-	-
African Crake *Crex egregia*	BrU	-	U	BrU	U	BrC	BrC
Black Crake *Amaurornis flavirostris*	-	-	R	BrC	-	-	R/V
Spotted Crake *Porzana porzana*	-	-	R	-	-	C	C
Baillon's Crake *Porzana pusilla*	-	-	R	-	-	C	BrC
Striped Crake *Aenigmatolimnas marginalis*	-	-	-	-	-	-	R
Redchested Flufftail *Sarothrura rufa*	-	-	-	U	-	-	-
Purple Gallinule *Porphyrio porphyrio*	BrU	-	BrU	BrC	C	BrC	BrC
Lesser Gallinule *Porphyrula alleni*	BrU	-	BrU	BrC	C	BrC	BrC
Moorhen *Gallinula chloropus*	U	R	U	BrC	U	BrU	BrC
Lesser Moorhen *Gallinula angulata*	BrC	R	BrC	BrC	BrC	BrC	BrC
Redknobbed Coot *Fulica cristata*	U	-	-	C	R	BrC	BrC
African Jacana *Actophilornis africanus*	BrC	-	U	BrC	U	U	BrU
Painted Snipe *Rostratula benghalensis*	BrU	-	U	BrU	BrC	BrC	BrC
Ringed Plover *Charadrius hiaticula*	-	-	-	U	U	U	-
Whitefronted Plover *Charadrius marginatus*	-	-	-	C	U	U	-
Chestnutbanded Plover *Charadrius pallidus*	-	-	-	U	-	U	-
Kittliz's plover *Charadrius pecuarius*	U	-	BrU	C	C	BrC	BrU
Threebanded Plover *Charadrius tricollaris*	BrC	U	BrC	BrC	BrC	BrC	BrC

Appendix 3 continued

SPECIES	WETLAND SYSTEM						
	NH	KC	ID	PW	KD	NN	PV
Caspian Plover *Charadrius asiaticus*	U	U	-	-	U	U	-
Grey Plover *Pluvialis squatarola*	-	-	-	R	-	R	R
Blacksmith Plover *Vanellus armatus*	C	C	BrC	BrC	BrC	BrC	BrC
Wattled Plover *Vanellus senegallus*	R	-	-	BrU	-	R	R
Turnstone *Arenaria interpres*	-	-	-	R	-	R	-
Terek Sandpiper *Xenus cinereus*	-	-	-	R	-	R	-
Common Sandpiper *Tringa hypoleucos*	-	-	-	R	-	R	R
Wood Sandpiper *Tringa glareola*	C	U	C	C	C	C	C
Redshank *Tringa totanus*	-	-	-	-	-	R	-
Marsh Sandpiper *Tringa stagnatilis*	U	-	C	C	C	C	C
Greenshank *Tringa nebularia*	C	U	C	C	C	C	C
Curlew Sandpiper *Calidris ferruginea*	U	-	R	C	C	C	C
Little Stint *Calidris minuta*	U	-	R	C	C	C	U
Sanderling *Calidris alba*	-	-	-	R	-	R	-
Ruff *Philomachus pugnax*	C	-	C	C	C	C	C
Great Snipe *Gallinago media*	-	-	-	R	R	C	R
Ethiopian Snipe *Gallinago nigripennis*	BrU	R	BrU	BrC	U	BrC	BrC
Blacktailed Godwit *Limosa limosa*	-	-	-	-	R	R	R
Curlew *Numenius arquata*	-	-	-	-	R	R	-
Whimbrel *Numenius phaeopus*	-	-	-	-	R	R	-
Rednecked Phalarope *Phalaropus lobatus*	-	-	-	-	-	V	-
Avocet *Recurvirostra avosetta*	-	R	-	U	C	C	-
Blackwinged Stilt *Himantopus himantopus*	C	U	C	C	C	BrC	C
Redwinged Pratincole *Glareola pratincola*	-	R	-	C	U	U	U
Blackwinged Pratincole *Glareola nordmanni*	-	-	-	R	-	R	-

Appendix 3 continued

SPECIES	WETLAND SYSTEM						
	NH	KC	ID	PW	KD	NN	PV
Greyheaded Gull *Larus cirrocephalus*	-	-	-	C	C	C	-
Caspian Tern *Hydroprogne caspia*	-	-	-	R	-	R	-
Black Tern *Chlidonias niger*	-	-	-	-	-	R	-
Whiskered Tern *Chlidonias hybridus*	BrU	-	U	C	BrC	BrC	BrC
Whitewinged Tern *Chlidonias leucopterus*	U	-	-	C	C	C	C
Black Coucal *Centropus bengalensis*	R	U	-	R	-	-	-
Copperytailed Coucal *Centropus cupreicaudus*	-	-	-	C	-	-	-
Burchell's Coucal *Centropus superciliosus*	-	-	-	C	-	-	-
Marsh Owl *Asio capensis*		R		U	-	R	
Pied Kingfisher *Ceryle rudis*	R	-	-	C	-	-	R
Malachite Kingfisher *Alcedo cristata*	-			C			
Great Reed Warbler *Acrocephalus arundinaceus*	-	C	-	C	-	-	U
European Reed Warbler *Acrocephalus scirpaceus*				R		R	
African Marsh Warbler *Acrocephalus baeticatus*	BrC	BrC	C	BrC	C	C	C
European Sedge Warbler *Acrocephalus schoenobaenus*	C	C	C	C	C	C	C
Cape Reed Warbler *Acrocephalus gracilirostris*	-	C	C	C	-	-	-
African Pied Wagtail *Motacilla aguimp*	-	-	-	C	-	-	-
Cape Wagtail *Motacilla capensis*	-	-	-	U	-	R	R
Yellow Wagtail *Motacilla flava*	R	R	-	R	R	R	R
Richard's Pipit *Anthus novaeseelandiae*	BrC	C	-	C	BrC	BrC	U
Tropical Boubou *Laniarius aethiopicus*	-	-	-	C	-	-	-
Swamp Boubou *Laniarius bicolor*	-	-	-	C	-	-	-
Spottedbacked Weaver *Ploceus cucullatus*	BrC	BrC	BrC	BrC	BrC	BrC	BrC
Masked Weaver *Ploceus velatus*	BrC	BrC	BrC	BrC	BrC	BrC	BrC
Lesser Masked Weaver *Ploceus intermedius*	BrU	-	-	BrC	-	U	BrU
Redbilled Quelea *Quelea quelea*	BrC	BrC	C	C	C	BrC	BrC

Appendix 3 continued

SPECIES	WETLAND SYSTEM						
	NH	KC	ID	PW	KD	NN	PV
Red Bishop *Euplectes orix*	-	-	-	BrC	-	-	-
Golden Bishop *Euplectes afer*	BrC	BrU	BrU	BrC	BrC	BrC	BrC
Redshouldered Widow *Euplectes axillaris*	-	BrU	-	BrC	-	-	-
ICBP RD SPECIES	1	0	0	2	2	2	2
TOTAL SPECIES	68	36	60	110	79	106	85

Wetland codes used in Appendix 3 are as follows:
NH - Nhoma Omuramba
KC - Kaudom/Cwiba omiramba complex
ID - Interdune wetlands
PW - Perched wetlands
KD - Klein Dobe and Cin Qo wetlands
NN - Nyae-Nyae wetlands
PN - Pannetjies veld wetlands

Codes used to describe the status of birds in Appendix 3 are as follows:
Br - Indicates that the species has been recorded breeding in the given wetland area
C - Common
U - Uncommon
R - Rare
V - Vagrant
? - Unconfirmed record, occurrence suspected

Appendix 4. List of mammals associated with temporary wetlands in Bushmanland and Kavango.

SPECIES	WETLAND SYSTEM						
	NH	KC	ID	PW	KD	NN	PV
Swamp Musk Shrew *Crocidura namaquensis*	-	-	-	1	-	-	-
Tiny Musk Shrew *Crocidura bicolor*	1	1	0	1	1	1	1
Chacma Baboon *Papio ursinus*	0	1	0	1	-	1	1
Vervet Monkey *Cercopithecus pygerythrus*	1	1	1	1	-	-	-
Greater Cane Rat *Thryonomus swinderianus*	0	0	-	1	-	-	-
Angoni Vlei Rat *Otomys angoniensis*	-	-	-	1	-	-	-
Creek Rat *Pelomus fallax*	-	-	-	1	-	-	-
Water Rat *Dasymys incomtus*	-	-	-	1	-	-	-
Shortridge's Mouse *Mastomys shortridgei*	-	-	-	1	-	-	-
Brown Hyaena *Hyaena brunnea*	1	1	0	-	0	1	1
Spotted Hyaena *Crocuta crocuta*	1	1	1	1	1	1	1
Aardwolf *Proteles cristatus*	1	0	0	-	1	1	1
Cheetah *Acinonyx jubatus*	1	1	1	-	1	1	1
Leopard *Panthera pardus*	1	1	1	1	1	1	1
Lion *Panthera leo*	1	1	1	1	1	1	1
Caracal *Felis caracal*	1	1	0	0	1	1	1
African Wild Cat *Felis lybica*	1	1	1	0	1	1	1
Serval *Felis serval*	-	-	-	1	-	-	-
Bat-eared Fox *Otocyon megalotis*	1	1	1	1	1	1	1
Wild Dog *Lycaon pictus*	1	1	1	1	1	1	1
Cape Fox *Vulpes chama*	-	-	-	-	-	1	-
Side-striped Jackal *Canis adustus*	1	1	1	1	-	-	-
Black-backed Jackal *Canis mesomelas*	1	1	1	1	1	1	1
Large-spotted Genet *Genetta tigrina*	-	-	-	1	-	-	-
Large Grey Mongoose *Herpestes ichneumon*	-	1	-	1	-	-	-

Appendix 4 continued

SPECIES	WETLAND SYSTEM						
	NH	KC	ID	PW	KD	NN	PV
Whitetailed Mongoose *Ichneumia albicauda*	-	-	-	1	-	-	-
Water Mongoose *Atilax paludinosus*	-	1	-	1	-	-	-
African Elephant *Loxodonta africana*	1	1	1	1	1	1	1
White Rhinoceros *Ceratotherium simum*		EXTINCT					
Black Rhinoceros *Diceros bicornis*		EXTINCT					
Burchell's Zebra *Equus burchelli* ***	-	-	-	1	-	-	-
Warthog *Phacochoerus aethiopicus*	1	1	1	1	1	1	1
Hippopotamus *Hippopotamus amphibius*	-	-	-	1	-	-	-
Giraffe *Giraffa camelopardalis*	1	1	1	1	1	1	1
Blue Wildebeest *Connochaetes taurinus*	1	1	1	1	1	1	1
Red Hartebeest *Alcelaphus buselaphus*	-	-	1	1	1	1	1
Tsessebe *Damiliscus lunatus*	-	1	1	1	-	-	-
Oribi *Ourebia ourebi*	-	-	-	1	-	-	-
Impala *Aepyceros melampus*	-	-	-	EXTINCT			
Roan Antelope *Hippotragus equinus*	1	1	1	1	1		1
Sable Antelope *Hippotragus niger*	-	-	-	1	-	-	-
Buffalo *Syncerus caffer*	-	0	1	1	-	-	1
Greater Kudu *Tragelophus strepsiceros*	1	1	1	1	1	1	1
Bushbuck *Tragelophus scriptus*	-	-	-	1	-	-	-
Reedbuck *Redunca arundinum*	1	1	-	1	0	1	1
Red Lechwe *Kobus leche*	-	-	-	1	-	-	-
TOTAL SPECIES	23	27	24	39	20	21	22

*** Burchell's Zebra may be extinct in the Mahango Game Reserve.

Wetland and status codes used in Appendix 4 are as follows:

NH - Nhoma omuramba
KC - Kaudom/Cwiba omiramba complex
ID - Interdune wetlands
PW - Perched wetlands
KD - Klein Dobe and Cin Qo wetlands
NN - Nyae-Nyae wetlands
PV - Pannetjiesveld wetlands

\- = not recorded
0 = occurrence suspected, but not confirmed
1 = occurrence confirmed