

and by clumps of swamp forest along watercourses. Echinochloa pyramidalis, Oryza longistaminata and Vetiveria spp. are found on the floodplain sections. The mammalian fauna of these wetlands, including both resident species and regular visitors, comprises Atilax paludinosus, Cercopithecus ascanius, Colobus polykomos, Dasymys incomtus, Herpestes sanguineus, Hippopotamus amphibius, Kobus ellipsiprymnus, Kobus leche, Kobus vardoni, Leptailurus serval, Lutra maculicollis, Otomys angoniensis, Potamochoerus porcus, Redunca arundinum, Tragelaphus scriptus, Tragelaphus spekei and Thryonomys swinderianus. Numerous amphibians are present, together with a wide spectrum of snakes, Varanus exanthematicus and Crocodylus niloticus. There is a diverse fish fauna which includes many floodplain/swamp species such as Gymnarchus niloticus, Protopterus annectens and many clariids.

In northwestern and central Angola all rivers meander in their lowland valleys and where they cross the narrow coastal plain. All of them inundate small floodplains in these places, but the most extensive wetlands occur on the Zenza and Longa Rivers. Marshy and palm-fringed lagoons occur on the Zenza above its delta, and many reed-fringed lakes occur along the lower floodplain of the Longa.

The rivers flowing northeast to the Cuango River in the extreme north of Angola, and the valleys of the rivers flowing north in Lunda Province, are deeply entrenched, wet, and densely forested. Mean annual precipitation in this region exceeds 1700 mm, and there is much more cloud cover than in the south. The rivers have narrow valleys and are comparatively swift flowing, and where they overflow their banks it is to inundate narrow strips of woodland. The riparian forests here are characterised by the presence of several species with Guinean-Congolan affinities which extend southwards from the Zaire Basin up these deep valleys. Common trees on the valley floors are Anthocleista vogelii, Aporrhiza nitida, Carapa procera, Mitragyna ciliata, Nauclea pobeguunii, Oxystigma bucholzii, Pandanus candelabrum, Parinari congensis, Phoenix reclinata, Raphia sp., Spondianthus preusii, Symphonia globulifera, Uapaca guineensis, Ventilago Africana, Voacanga thouarsii, Wildemaniodoixa laurentii and Xylopia rubescens. The fauna also shows affinities with that of the Zaire Basin. Further details are given by Mepham & Mepham, in the IUCN Directory of African Wetlands (in prep.).

### 8.3 SEASONAL AND SEMI-PERMANENT PANS

by R.H. & J.S.MEPHAM

In South Africa water is a very limited resource, and the conservation of relatively small water bodies is of prime importance. A comprehensive survey of all water resources in South Africa is given by Noble & Hemens (1978). In this account they classify water resources into the following groups.

1. River source sponges. Water-logged and spongy areas which are the head waters of many streams and rivers. A large number of these occur high in mountain ranges such as the Natal Drakensberg and the mountains of Lesoto and Transkei, and are easily damaged by erosion and overgrazing.

2. Swamps and marshes (figure 8.6a). Throughout South Africa, even in the drier parts, there are in most river systems, flat stretches which are overgrown with reeds and other typically wetland vegetation. These areas are waterlogged for much of the year, and become inundated during the rainy seasons. Such areas are referred to locally as 'vleis', and are found both inland and on coastal plains. (See 8.11 Wetlands of the SW Cape).

3. Floodplains (figure 8.6a). A few South African rivers have regions where they periodically overflow their banks, giving rise to typical floodplain areas. The Pongolo River Floodplain (8.7) is a good example of a so-called storage floodplain in which water is retained for long periods after flooding.

4. Endorheic pans (figure 8.6b). In the drier parts of South Africa numbers of oval depressions are scattered about the countryside, which either seasonally or permanently contain water. These 'pans' are closed, having no outlet, and are thus endorheic. In the past many of them were frequented by wandering herds of antelopes and elephants seeking water and fresh pasture. Noble and Hemens have classified the pans into a number of different types.

a) Salt pans which are dry for most of the time, but may contain perennial pools filled by springs. Their soils are highly saline and devoid of any higher vegetation. The fauna includes typical temporary water forms like phyllopod crustaceans, the eggs of which need to dry out before further development can take place. Salt pans are found especially in the Karoo, Kalahari, western Orange Free State and the Transvaal.

b) Temporary pans are shallow, and dry out for long periods although they may retain a few perennial pools. Their soils are alkaline and moderately saline. Higher vegetation is restricted to a few salt-tolerant grasses and the fauna includes phyllopods. Pans of this type are found throughout the northern Cape Province, the western Orange Free State, the Transvaal and parts of SW Africa. Perhaps the most famous temporary one is Etosha Pan, which is dealt with below (8.3.b).

c) Grass pans are seasonal and dry up in the winter except for the usual perennial pools. They are covered by a thick growth of hygrophilous grasses and other low terrestrial vegetation, some of which is salt-tolerant. This vegetation is usually inundated in summer, and a diverse flora of submerged hydrophytes, and filamentous and macrophytic algae may develop. Phyllopods may also be present. The water is rich in nutrients, usually fresh in summer and slightly brackish in winter. Grass pans are found in the southern and eastern Transvaal, where the mean annual rainfall is 650-800 mm.

d) Sedge pans are also seasonal, but do not dry out in the centre sufficiently for terrestrial vegetation to become established. They have a thick growth of marsh vegetation about 1 m high around the margins, comprising mainly members of the Cyperaceae, but have no emergent vegetation in the centres. The water tends to be rich in nutrients, fresh in summer and slightly brackish in winter.

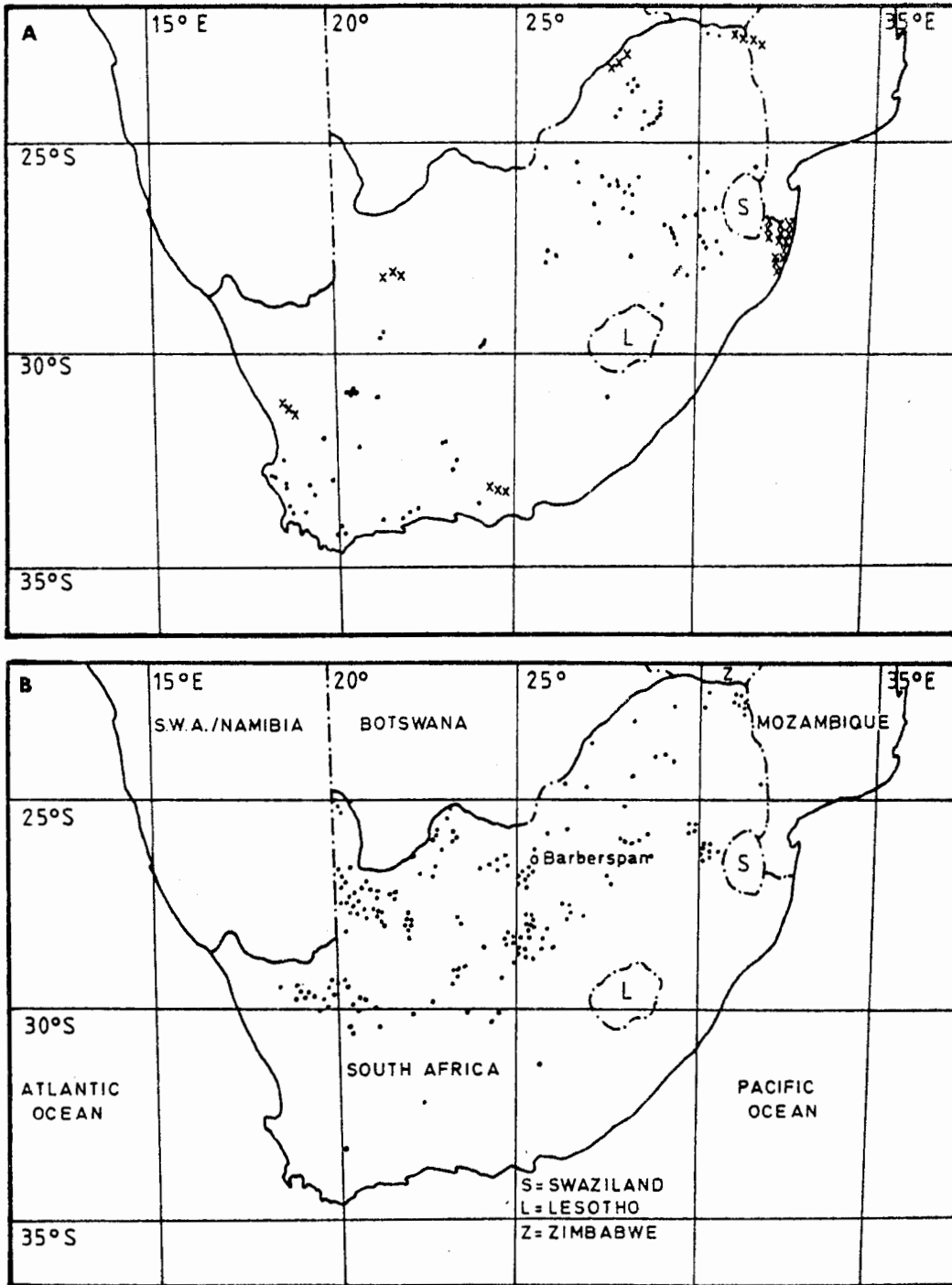


Fig. 8.6(A) Principal vleys (dots) and floodplains (crosses) in South Africa; (B) Endorheic pans and lakes in the interior of South Africa (from Noble and Hemmens, 1978).

e) Reed pans are temporary or semi-permanent pans with a dense stand of Phragmites reedswamp in the middle, and an outer narrow ring of open water. The water is clear and may be fresh to slightly brackish, and the sediments are rich in organic matter. Dense beds of algae, comprising macrophytes as well as filamentous forms, may develop in the peripheral ring of water during the summer months.

f) Semi-permanent pans and lakes are generally deeper than the other types. Some may be fresh, at times at least, but most are somewhat brackish. Some may develop fairly permanent beds of Potamogeton spp. and other aquatic flora, while others apparently do not. Most have sparse grasslands around the margins. The best known example is Barberspan (8.3.a), which is considered in some detail below.

### 8.3.a BARBERSPAN

Barberspan is a shallow alkaline lake in the western Transvaal of South Africa. Little has been published on its ecology.

#### 1. Geography

Location: 26°33'S; 25°36'E. The lake lies near the commencement of the fossil course of the Harts River, and this can be traced northward by a series of pans for a further 45 km. It has a natural outlet along this course, and flowed into the next pan, Leeupan, in 1943 and 1967. Water has been prevented from pushing past Leeupan during this century, by a slight limestone obstruction. These two pans are connected at 1347.2 m asl.

Altitude: 1348.5 m asl

Surface Area: 15.5 km<sup>2</sup>

Length: 5 km

Width: 2.5 km

Depth: The lake became completely dry in 1913, but since water from the Harts River was diverted into it in 1918 this has never recurred. In the great drought of 1933 it all but dried out leaving only 275 ha of water, mostly less than 0.5 m in depth. Between 1965 and 1970 the depth of the lake fluctuated between 3.0 and 9.5 m.

Landscapes: Barberspan lies on a great undulating plain, characterised by an absence of any marked physiographic feature.

#### 2. Geology

The greater part of the western Transvaal, in which Barberspan lies, is underlain by amygdaloidal lava of the Ventersdorp system, at least 2100 million years old. In relatively recent geological times, more than 2000 million years after the lava flow, surface limestone began to form, and this surrounds Barberspan and Leeupan almost

completely. This limestone is locally rich in amygdules, fragments of igneous rock which contains cavities partially filled with secondary minerals.

### 3. Climate

This region experiences cool dry winters from May to October, and hot wet summers from November to April.

<u>Temperature:</u>	mean maximum, June	18°C
	mean maximum, January	33°C
	absolute maximum	40°C
	mean minimum, June	0°C
	mean minimum, January	18°C
	absolute minimum	-6°C

Wind: The prevailing northerly winds have played an essential rôle in carving out Barberspan and Leeupan. Limestone dust from the pans has been blown to the south where it has formed a hill at the end of each pan. These are 24.4 m and 23.2 m high respectively. Severe dust storms sometimes occur here.

Rainfall: Continuous records are available for the period 1930-1967, which have been kept by the Visser family who live at the SW corner of Barberspan.

mean annual rainfall	557 mm
highest mean monthly rainfall	120 mm
highest maximum monthly rainfall	320 mm
wettest months	December, January
lowest mean monthly rainfall	0 mm
driest months	May to August

<u>Evaporation:</u>	
mean annual evaporation	1811.52 mm
mean monthly evaporation	80-230 mm
months of highest evaporation	November, December
months of lowest evaporation	June to August

### 4. Hydrography and hydrology

The small catchment area of only 39 km<sup>2</sup> provides little water to the pan in most years, diverted water from the Harts River being more important.

### 5. Physico-chemical characteristics of the water

<u>Temperature:</u>	mean winter	17.3°C
	absolute minimum, June	9.5°C
	mean summer	19.2°C
	absolute maximum	27.8°C

pH: mean 9.4, range 8.2-9.8

**Transparency:** The pan is reasonably clear, especially during winter. Readings taken in 1959 at one locality in the central basin were for February 39.7 cm, and for May (early winter) 1.3 m.

## 6. Vegetation

The aquatic vegetation is dominated by Potamogeton pectinatus, while small prostrate herbs occur on the exposed shore. Various members of Juncaceae (rushes) and Cyperaceae (sedges) are found on the margins of the lake. These grade into open grassland comprising Themeda triandra, Eragrostis sp., Aristida sp., Setaria sp. and other grasses typical of Mizpah soils. In shallow water areas, thick stands of the grass Panicum repens provide cover for birds during times of flood and the limestone outcrops support an abundance of Cynodon dactylon.

## 7. Invertebrates

**Zooplankton:** Greatest densities are found during November, December and March, with the lowest in August and September. Cladocerans supply the most important contribution to the total biomass, which has been estimated at  $3722.9 - 2277.5 \text{ } 10^{-6} \text{ g.l}^{-1}$ .

**Benthic Organisms** are neither abundant in species nor numbers. In a study by Roode (1967) only 4 organisms had a mean biomass for the year of more than  $10 \text{ mg.m}^3$ ; i.e. chironomid larvae, ostracods, larvae of Berosus spp. and Micronecta spp. Other organisms found included adult Berosus spp., Culicoedes sp. and members of Tubificidae.

### Other Invertebrates:

**Arthropods:** The largest arthropod found is Potamon potamon (fresh water crab) and the most numerous Hodotermes mossambicus (harvest termite). Various moths, butterflies and dragonflies have been identified.

**Molluscs:** No live molluscs were encountered by Roode (1967, in Milstein 1972), but many shells of Lymnaea sp., Bulinus tropicus, Anisus sp. and Barnupia sp. were found.

## 8. Fish

Ten species of fish occur in Barberspan, which is a popular venue for anglers. The fish are Barbus holubi (small mouth yellowfish), B. paludinosus, B. anoplus, B. trimaculatus (minnows), Labeo capensis (Orange river mudfish), L. umbratus (mud mullet) Cyprinus carpio (carp), Clarias gariepinus, Tilapia sparrmanii (vlei kurper) and Hemihaplochromis philander (dwarf kurper).

## 9. Other vertebrates

**Amphibia:** Barberspan seems less suited to amphibian life than the shallow short term pans which surround it in the rainy season,

nevertheless Bufo garmani, Bufo regularis, Cacosternum boettgeri and Pyxicephalus delandii occur there and may be relatively abundant at times.

**Reptiles:** One species of terrapin, Pelomedusa subrufa, is common in Barberspan and preys upon young waterfowl. Lizards and geckos are comparatively uncommon in the sanctuary. Those identified include Mabuza capensis (striped skink), Abelpharus wahlbergi (Wahlberg's snake-eyed skink) and Pachydactylus capensis (the Cape gecko). Snakes are fairly abundant and include Dasypeltis scabra (common egg eating snake), Crotaphopeltis hotamboeia (red lipped snake), Naja nivea (Cape cobra), Lamprophis aurora (aurora snake), Bitis arietans (puffadder) and Causus rhombeatus (night adder).

**Birds:** The bird sanctuary at the NE corner of Barberspan supports a wide range of resident and visiting birds. Birds have been ringed and recorded since 1959 and a comprehensive list of species is given in Milstein (1972).

**Mammals:** Small mammals have not been studied intensively, but rodents are known to be plentiful. Common mammals include: Rhabdomys pumilio (striped fieldmouse), Rattus rattus (black rat), Praomys natalensis (multimammate mouse), Otomys irroratus (vlei otomys), Erinaceus frontalis (African hedgehog), Rhinolophus sp., Mineopterus sp. (both bats), Lepus capensis (Cape hare), Xerus inauria (ground squirrel), Pedetes capensis (spring hare), Hystrix africaeaustralis (African porcupine), Orycteropus afer (ant bear), Cryptomys hottentotus (mole rat), Vulpes chama (silver fox), Canis mesomelas (black backed jackal), Ictonyx striatus (Cape polecat), Lutra maculicollis (spotted neck otter), Cynictis penicillata (yellow mongoose), Antidorcas marsupialis (springbok) and Raphicerus campestris (steenbok).

### 8.3.b ETOSHA PAN

Etosha Pan, together with numerous small pans, is situated in the Etosha National Park in SW Africa/Namibia. It is a flat saline depression which has not been fully flooded during the past 50 years. In most years it contains water for 4-6 months, but it is dry and salt encrusted at other times. The smaller pans contain standing water for much shorter periods. During the Pliocene the Cunene River formed a lake in the region, but subsequently abandoned its southerly course leaving Etosha Pan as a remnant of the lake. Most pans in the area provide water holes and salt licks for game, and in consequence attract large numbers of tourists. Little has been published concerning the ecology of Etosha Pan, and for some of the information presented here we are grateful to Dr H.H. Berry who has worked at the National Park since the early 1970's.

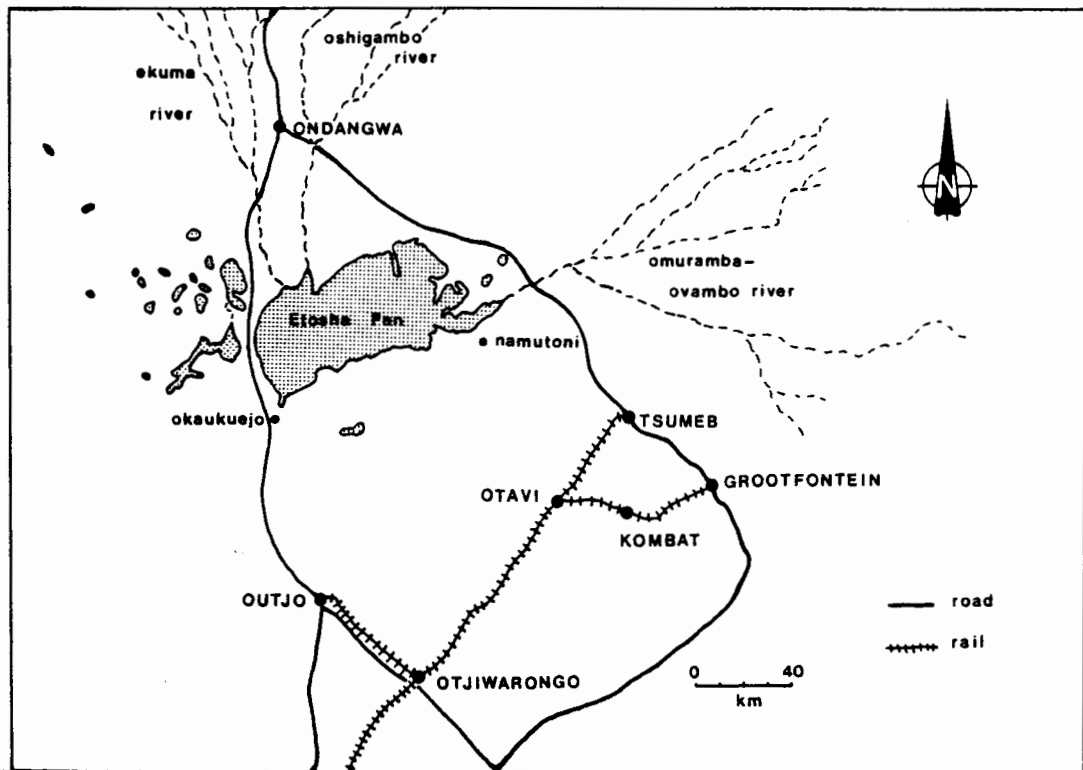


Fig. 8.7 Map of Etosha Pan and its surrounding area

### 1. Geology

The pans of Etosha lie on the Kalahari Beds, which comprise limestones, calcareous sands and gravels. The floors of the pans are made of clay, silt and fine to coarse sand. Water drains into the pans and remains there until it finally evaporates, leaving salty deposits. Where it is regularly flooded, the floor of the main pan is a hard, salt-encrusted, cracking clay, but towards the west where it is seldom flooded, it is a sandy plain. Small depressions in the pans, known locally as 'fountains', give rise to more or less permanent water holes which are heavily utilised by animals during the dry seasons.

### 2. Geography

Published estimates of the area of the main pan exceed 6000 km<sup>2</sup>, but measurements from several maps show that it is in fact about 4 080 km<sup>2</sup>, with maximum extents of 120 km from west to east and 52 km from north to south. The total area of all small pans is approximately 550 km<sup>2</sup>. The main pan lies in flat or gently undulating savanna country at an elevation very close to 1080 m asl, and is situated between longitudes 16 and 17°E at a latitude of 18°45'S.



## 3. Climate (Fig. 8.2 Ondangua)

The climate is harsh. In summer sudden thunderstorms lash the pan, to be followed by prolonged periods of intensely hot sunshine. In winter, days are warm, but nights are cold and 0°C has been recorded on occasions, and desiccating winds may gust across the pan at speeds up to 30 knots. There are usually three distinct seasons:

wet and hot;	January to April
dry and cold;	May to August
dry and hot;	September to December.

Precipitation during the wet season is unreliable and varies considerably from year to year, e.g. only 90 mm in 1946, but 975 mm in 1950. In normal years more rain falls on the eastern edge of the pan than on the western edge.

Temperature: (at Okaukuejo)

Hottest month: January:-	mean daily temperature	18.2°C
	mean monthly minimum	11.8°C
	mean monthly maximum	38.3°C
Coldest month: July:-	mean daily temperature	6.1°C
	mean monthly minimum	1.5°C
	mean monthly maximum	28.9°C

Precipitation:

(at western edge of the pan, Okaukuejo):

mean annual rainfall	418.3 mm	
wettest month - February:	mean average rainfall	107.7 mm
driest month - July:	mean average rainfall	0.0 mm

(at eastern edge of the pan, Namutoni):

mean annual rainfall	440.0 mm
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Relative Humidity: (Class A Pan): Normally evaporation exceeds precipitation by a factor greater than 6:1. During the 5 years (60 months) from 1974 to 1978 rainfall exceeded evaporation in only 2 months, February and March 1976.

Mean annual evaporation: 2662 mm.

Wind:

January-April	(hot wet season)	prevailing winds NE
May-August	(cold dry season)	prevailing winds NE
September-December	(hot dry season)	prevailing winds SW-NE

## 4. Hydrography

Direct rainfall accounts for only a small proportion of the pan's water, most being supplied by three ephemeral rivers, the Ekuma, the Oshigambo and the Omurambo-Ovambo. The first two of these drain the plains of Owambo and their mouths form deltas in the northwest of the pan. The Omurambo-Ovambo drains an area to the northeast of the pan, which it enters at its western extremity. In the wettest years the pan is partially flooded from January to April or even June, but droughts are frequent and during dry cycles (e.g. in 1980) there may be no standing water away from water holes. During these periods the

rivers do not flow at all and their courses consist of a series of pools and ponds. In 1971, a moderately wet year, some 2500 km<sup>2</sup> of the pan was flooded with water ranging in depth from 1 m at the Ekuma delta to 1 cm on the SE edge. The SW sector of the pan was not flooded at this time, and indeed it is doubtful if it has been fully flooded this century.

##### 5. Physico-chemical characteristics of the water

River water flowing into the pan early in the wet season has a pH close to 7.6, whereas pan water is more alkaline. The pH of pan water rises as the pan dries, having been measured as 9.2 in July and 9.4 in September, finally exceeding 10 before drying. Analyses of pan and river water in July and September 1971 (Berry 1972) gave the following results:

	River water (Ekuma)		Pan water	
	July	September	July	September
Conductivity (10 <sup>-6</sup> S.cm <sup>-1</sup> )	1900	45 000	26 000	67 000
TDS mg.l <sup>-1</sup>	1365	34 030	20 175	61 380
Na mg.l <sup>-1</sup>	482	12 800	7 820	22 650
K mg.l <sup>-1</sup>	10	106	111	300
SO <sub>4</sub> mg.l <sup>-1</sup>	104	2 790	890	3 700
NO <sub>3</sub> mg.l <sup>-1</sup>	7	0	0	0
NO <sub>2</sub> mg.l <sup>-1</sup>	0	0	0	0
SiO <sub>2</sub> mg.l <sup>-1</sup>	25	40	40	40
F mg.l <sup>-1</sup>	0.5	5	6	7
Cl mg.l <sup>-1</sup>	600	15 800	10 400	29 850

##### 6. Vegetation

The floors of the pans are largely unvegetated, but low islands in them, subject to inundation during floods, often support perennial grasses, reeds and sedges, and occasionally, scrubby trees. The peripheral vegetation is chiefly scrub woodland dominated by Colophospermum mopane (mopane) which is browsed by many animals. This species tends to be deciduous and is mostly bare by the end of the dry season. Other trees found on the pan margins and along associated water courses include Acacia ataxacantha, A. erioloba (camel thorn), A. erubescens (blue thorn), A. hereroensis, A. kirkii (floodplain acacia), A. leuderitzii, A. mellifera, A. nebrownii (water acacia), A.reficiens (false umbrella thorn), A. tortilis, Combretum apiculatum (rooibos), C. engleri (sand bush willow), C. hereroense (russet bush-willow), C. imberbe (leadwood), Dichrostachys cinerea (sickle bush), Elephantorrhiza suffruticosa, Erythrina decora, Olea africana (African wild olive), Sclerocarya caffra, Spirostachys africana, Terminalia brachystemma and T. prunoides.

## 7. Animals

The Etosha National Park is one of the largest and most renowned game parks in the world and the game animals which visit the pans include buffalo, eland, elephants, giraffes, hartebeest, kudu, leopards, lions, oryx, rhinoceroses, wildebeest and zebras. Among the smaller animals are found hunting dogs, foxes and jackals, wildcats, warthogs and bushpigs, baboons, scaly anteaters, hares, and numerous rodents including porcupines, ground squirrels, spring hares, gerbils, mice and dormice. A variety of snakes and other reptiles occur in and around the pans, and there is a wealth of bird life. Etosha Pan is the only known mass breeding ground of the lesser flamingo (Phoeniconaias minor) and the greater flamingo (Phoenicopterus ruber) in southern Africa, and in some years the flamingo population of the pan may exceed one million birds. Other species observed there include Aquila rapax (tawny eagle), Ardea cinerea (grey heron), Corvus alba (pied crow), Larus cirrocephalus (grey headed gull), Leptoptilus crumeniferus (marabou stork), Pelecanus onocrotalus (white pelican), Platalea alba (spoonbill), Plegadis falcinellus (glossy ibis), Struthio camelus (ostrich), Terathopius ecaudatus (bataleur eagle), Threskiornis aethiopicus (sacred ibis) and Torgos tracheliotus (lappet faced vulture).

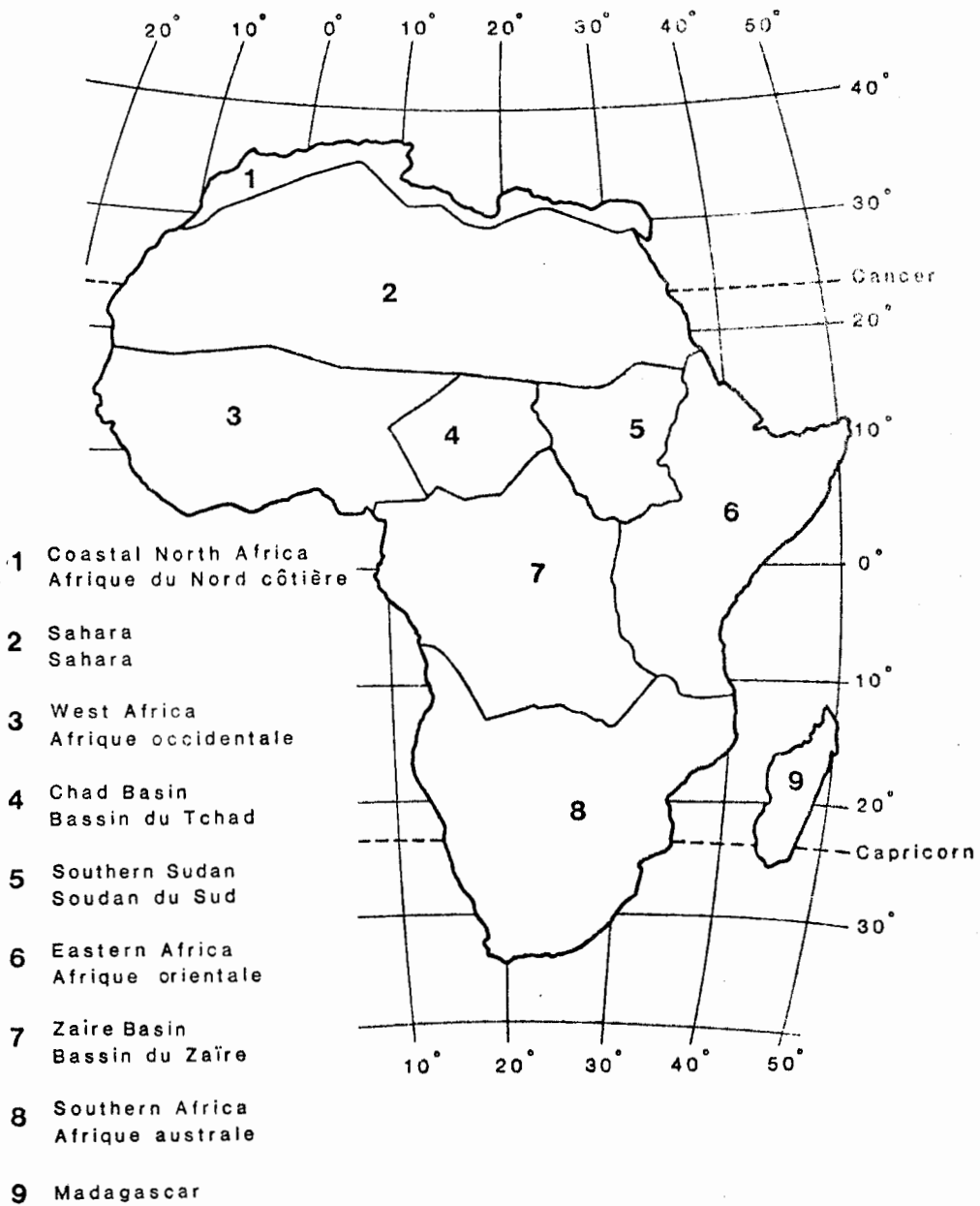
## 8. Human impact and activity

There are three camp sites in the Etosha National Park offering bungalows, cabins and tents for rental. During 1983 a total of 51 780 people visited the park; 13 959 from overseas, 18 583 from SW Africa and 19 292 from the Republic of South Africa. No other people live in the park apart from park staff, and the grazing of domestic animals is prohibited. The Etosha National Park is a protected area and is covered by a Nature Conservation Ordinance (1975). However, the use of anti-malarial agents in the catchment areas in recent years has led to the appearance of chlorinated hydrocarbons in the food chains of the pan. Most river water originates in Owambo and since 1965 indoor sprays have been applied to the roofs and upper walls of tribal huts. Today some 120 000 kg of 5% DDT solution is used annually for this purpose in the catchments, and eggs of the lesser flamingo were found to contain traces of the following compounds: DDT 0.013 ppm, TDE 0.097 ppm, DDE 0.19 ppm, dieldrin 0.03 ppm and BHC 0.03 ppm (Berry 1971).

### 8.4 THE OKAVANGO DELTA AND THE MAKGADIKGADI PANS

by J.S. MEPHAM

Readers of travellers' tales have long been enchanted by stories of a mighty river which flows into the heart of Africa and then apparently disappears. This is the Okavango River, which is no less fascinating for having been investigated to some extent in recent times. It is derived from two rivers which rise in the highlands of Angola, the Cubango and Cuito which flow in an approximately southerly direction across Angola, before uniting to form the Okavango River which enters northwestern



Regions of Africa treated in this Directory  
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**African wetlands  
and shallow water bodies**

**Zones humides  
et lacs peu profonds  
d'Afrique**

M. J. BURGIS  
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Collection **TRAVAUX et DOCUMENTS** n° 211

PARIS 1987

*This work was completed with financial assistance of :*  
Ce travail a pu être réalisé grâce au support financier de :

Council for Scientific and Industrial Research (South Africa)  
Fonds de la Recherche Fondamentale Collective (Belgique)  
Ministère de l'Environnement (France)  
Royal Society (Great Britain)  
IUCN and WWF



*Funds and facilities for the preparation of camera ready text were made available by IUCN and WWF*

L'IUCN et le WWF ont procuré les fonds et les facilités pour la préparation des manuscrits définitifs

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