



OKACOM

Fauna of the Okavango River Basin (Botswanan Sector)

Specialist Report prepared by Mark Murray for :

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1. DATA AVAILABLE

Available data on fauna of the Okavango River and Delta region in Botswana include published and unpublished reports and articles on the studies and surveys listed in Annex A: References. Of the data sources listed, 221 have been located in Gaborone, nine in Maun, and the remaining 53 are available from locations in South Africa, Namibia and Zimbabwe. Details for a large number of other known references have been requested. Amongst those are more recent studies and reports on monitoring the impacts and effectiveness of the Tsetse fly control programme (TFC Unit, Maun).

Twenty-two data sources identified in Annex A include computerised data bases, most of which are in a geographical information systems (GIS) format covering the study area. These data bases include information on large wildlife species densities and distribution (Bonifica, 1992; DWNP, 1993, 1995, 1996, 1997; ULG, 1994b, 1994c, 1994d), physical features, landforms, vegetation types, ecological zoning, land use and natural resources availability, archaeological sites and infrastructure, (Ecosurv, 1994, 1996, 1997a, 1997b; DWNP, 1996; WTC/CSIR, 1997).

2. SUMMARY DESCRIPTION OF PREVIOUS RESEARCH

Many studies on large animal populations have been undertaken by the Department of Wildlife and National Parks (DWNP) while private research (mainly as part of dissertation studies) has played a very important role, particularly in collecting information on large mammals, fish and fisheries. Both research and population censuses have tended to focus on the larger, commercially important or rare and endangered species. Few data have been collected on species of low tourism, hunting or other commercial value in the Okavango Delta region.

2.1 Mammals

Large Mammals

Wildlife Population Census

There is a fair degree of understanding of the distribution and seasonal movements of large herbivores. Aerial census data collected between 1975 and 1997 provide information on seasonal distribution and crude population estimates and trends for large wild and domestic mammal species (UNDP/FAO, 1977; KCS, 1984-85; DWNP, 1979-1997; SMEC, 1987; Bonifica, 1989-1991; ULG, 1992-1994).

The DWNP Research Unit consider data from aerial surveys conducted prior to 1989 to be either unreliable, or incompatible with recent (1989-1994) data collected in terms of the methodology employed (ULG, 1994a). However, data from some earlier surveys (e.g. UNDP/FAO 1977 and KCS, 1984-85) has been used in assessing general population trends over the past twenty years. Data from 1995 and 1996 aerial surveys are currently being re-analysed and are also considered unreliable in their current form by some DWNP Research Unit staff.

Ecological Surveys

General surveys of wildlife (mainly larger mammals) in the Okavango Delta region include Smithers' survey of mammals (1971), field surveys of the Moremi Wildlife Reserve (Tinley, 1966; Robbel and Child, 1976) and of Chief's Island (Biggs, 1979), ecological surveys carried out during the UNDP/FAO Investigation of the Okavango Delta (1977), the Southern Okavango Integrated Water Development Project (SMEC, 1986-88) and the Okavango Delta ecological zoning exercise (SMEC/KCS, 1989). A study of the ecology and functioning of perennial and seasonal floodplains at Naraga is being co-ordinated by the Okavango Research Centre in Maun.

Specific Studies

Detailed work on the ecology of individual species has been limited mainly to large mammals. Studies include those on impala (Robbel and Child, 1970), buffalo (Raseroka, 1978; Patterson, 1979), lechwe (Lent 1969; Biggs, 1979), tsessebe (Child, 1972), sitatunga (Games, 1983; Ross, 1991), wildebeest (Williamson, 1985), baboons and wild dogs (University of California, various researchers 1976-1993, and McNutt, 1993-present), zebra and wildebeest (Joos-Vanderwalle, 1993) and lions (on-going). University of Botswana students from the Departments of Biological and Environmental Science are currently conducting studies on grazing trials and behaviour of lechwe, impala and warthog as part of the floodplain ecology study co-ordinated by the Okavango Research Centre.

Elephants have received considerable attention, as their increasing numbers and expanding range in northern Botswana is perceived as a management problem and a threat to biodiversity. Elephant research has focused mainly on the interactions with vegetation in riverine habitats and over the entire range. Although most elephant research has been carried out in Chobe District, a growing number of studies have included the Okavango Delta (Moroka, 1984; Melton, 1980-1984; Work & Owen-Smith, 1986; Calef, 1985-88; Ben-Shahar, 1991 and Torr, 1996). Elephant-vegetation interactions are currently being studied at Savuti (Barnes, in progress).

Environmental Impact Assessments

Impacts on wildlife (with emphasis on larger mammals) have been assessed under the UNDP/FAO Investigation of the Okavango Delta (1977), the Southern Okavango Integrated Water Development Project (SOIWDP, SMEC, 1986-88), the SOIWDP review (IUCN, 1993), the adaptive environmental (modelling) assessment of the Okavango Delta (Wildlife Conservation International, *et. al.*) and the feasibility study on the Okavango River to Grootfontein link of the eastern national water carrier in Namibia (WTC/CSIR, 1997).

Planning Studies and Management Plans

Management and tourism development plans, including proposals for the management of wildlife resources, have been prepared for the Moremi Game Reserve by Anderson (1985), Kalahari Game Services (1991) and DWNP/PADUN (1996). The latest plan, which built upon and updated previous plans, provides for various forms of wildlife and natural resources protection and use by tourists in designated zones within the game reserve.

A study was carried out to identify potential wildlife utilisation pilot projects involving Okavango Delta communities, among others (Cumming and Taylor, 1989). A programme for the planning

of resource utilisation in the Okavango Delta region was prepared by Swedeplan (1989), and a land use plan for the Okavango and Kwando Wildlife Management Areas (WMA's) was prepared and approved by the Ngamiland District Land Use Planning Unit (1991). The land use plan resulted in zoning of Controlled Hunting Areas (CHA's) within the WMA's for various forms of wildlife-based tourism. Management and tourism development plans have subsequently been prepared for these CHA's (Ecosurv 1996, OCC, 1995 and various private sector safari operators).

Hunting licensing statistics for Ngamiland District have been collated and computerised by DWNP since 1985.

Small Mammals

Few studies on small mammals have been conducted in the study area. General taxonomy, ecology, behaviour and regional distribution data for large and small mammals of the southern African sub-region are provided by Smithers and Skinner (1990), while DeGraaf (1981) gives more detail on the rodent species. Small mammals were collected as part of a survey of impacts of Dieldrex spraying against tsetse fly by Graham (1964). Limited live trapping of small mammals (mainly rodents and shrews) was carried out as part of the field studies of SMEC (1987a) and CSIR/WTC (1997).

2.2 Fish and Fisheries

A number of surveys have been carried out on the taxonomy, distribution and abundance of fish fauna of the Okavango River and Delta region (Maar and Dibbs, 1965; Jubb and Gaigher, 1971; Bruton, 1980; Merron and Bruton, 1984, 1986c; Minshull, 1985; Skelton, 1985, 1993; Merron, 1993a, 1993b; Bills, 1996).

Studies of the fish fauna ecology and ecosystem functioning have been conducted (Fox, 1976; Merron, 1991), research has been done on fisheries productivity and development (Gilmores, 1976-79), and proposals for the management and development of fisheries resources have been made (Merron and Bruton, 1988; Merron, 1993b; SMEC, 1987a; IUCN, 1993; CSIR/WTC, 1997).

Feasibility study reports for development and expansion of commercial fisheries on the Okavango River and Delta (based mainly on technology employed in east Africa) were prepared by NORPLAN (1985) and NORFICO (1986-87). Monitoring of subsistence and commercial fishing and development efforts of the Fisheries Unit, Ministry of Agriculture were reported annually (MOA, 1987-93), and community-based fisheries and conservation programmes development has been investigated (Merron and Bruton, 1995).

Impacts on Okavango fish populations of aerial and ground spraying of various pesticides to control tsetse fly have been assessed during various studies (Graham, 1964; Russel-Smith, 1976; Gilmore, 1979; Douthwaite, 1981; Games, 1982a; Fox and Mathiessen, 1982; Merron and

Bruton, 1986; Merron, 1986-92).

2.3 Birds

Bird distribution and occurrence has been relatively well documented and specific studies and sightings are quite numerous. Borello and Borello (1997) list 387 references to works and articles on the avifauna of the Okavango Delta and River, 212 references for Lake Ngami and 127 references for the Boteti River. Penry (1994) compiled a bird atlas for Botswana, mainly from data collected by the Botswana Bird Club and affiliates, providing quarter-degree square locations for sightings of 453 species within the study area.

Fraser (1971), Herremans (1993-95) and Allen (CSIR/WTC, 1997) compiled some of the larger individual lists of birds during studies of the Okavango River and Delta, Moremi Game Reserve and Lake Ngami. These areas have been included in extensive (low intensity) surveys conducted annually for economically important, rare and endangered species as part of the African waterfowl census (International Waterfowl and Wetlands Research Bureau, 1983-95; Wetlands International, 1996). A waterbirds survey of the Okavango Delta by DWNP staff has recently begun.

Graham (1964) reported avifauna mortalities following blanket spraying of woodlands near Maun with Dieldrex. Milenski and Campbell (1976) studied bird diversity in relation to vegetation types in the Moremi Wildlife Reserve. Habitat and management requirements for locally rare or endangered bird species meriting special consideration are discussed by SMEC (1987a) and SMEC/KCS (1989).

Distribution data and population estimates for ostrich *Struthio camelus* are available from the series of aerial censuses listed in Section 2.1.

2.4 Reptiles

Apart from specific studies on the economically important Nile Crocodile, *Crocodylus niloticus* (Blomberg, 1976; Graham, 1976; Medem, 1981; Simbotwe, 1988; Simbotwe and Matlhare, 1988) little research on reptiles has been documented from the study area. Auerbach (1987) has compiled a relevant guide for Botswana, with maps showing reported distributions for reptiles species and an extensive bibliography of mainly regional publications on research. The zoogeography of herpetofauna (Simbotwe and Gillette, 1990) and general herpetology of Botswana (Simbotwe and Spawls, 1987) have been described.

Most research on reptiles in the region has been conducted by D.G. Broadley, W.R. Branch and M.P. Simbotwe, while R.D. Auerbach (1987) has conducted two surveys of the study area. Ecology, management and research recommendations for selected reptile species are discussed by SMEC (1987a) and SMEC/KCS (1989). N.G.H. Jacobsen carried out a short herpetological survey in Botswana as part of the initial environmental evaluation for the feasibility study on the

Okavango River to Grootfontein link of the Namibian Eastern National Water Carrier in December 1996 (CSIR&WTC, 1997).

2.5 Amphibians

Research on amphibians of the Okavango Delta region has apparently been limited. Auerbach (1987) provides maps showing reported distributions for amphibians in the study area and a bibliography listing (mainly regional) publications on research. Zoogeography of herpetofauna in Botswana, including amphibians, has been described (Simbotwe and Gillette, 1990). Research on amphibians in the region has been conducted by D.G. Broadley and W.R. Branch among others. Two collecting surveys were carried out by Auerbach (1987). Some amphibian species were collected and identified following aerial spraying of insecticides for tsetse fly control (Graham, 1964; Russel-Smith, 1976; Douthwaite, 1981; Games, 1982a).

Ecology, management and research recommendations for selected amphibian species are discussed by SMEC (1987a) and SMEC/KCS (1989). N.G.H. Jacobsen carried out a short herpetological survey in Botswana as part of the initial environmental evaluation for the feasibility study on the Okavango River to Grootfontein link of the Namibian Eastern National Water Carrier in December 1996 (CSIR&WTC, 1997).

2.6 Terrestrial Invertebrates

Research on terrestrial invertebrates in the Okavango Delta region has concentrated mainly on the Tsetse fly *Glossina morsitans centralis* Machado. The ecology of the tsetse fly, local history of sleeping sickness and fly control programmes and effects of control on fly population using various insecticides have been reported (Lambrecht, 1968; Davies, 1981; Davies and Bowles, 1976, 1979).

The effects of insecticides spraying on non-target arthropods (Ali (1976, 1977; Davies, 1980; Games, 1981) and some other terrestrial invertebrate orders (Douthwaite, 1981) have been documented. Other studies on arthropods include collecting surveys for butterflies and dragonflies (Pinhey, 1967-76; Silsby, 1991), monitoring of weevils (*Cyrtobagous singularis*) in the control of *Salvinia molesta* (Procter, 1983) and a survey of tick infestations on African buffalo (Carmichael, 1976). The Crop Protection Unit (MoA) have produced unpublished reports on locust outbreaks and control efforts in the region (MoA, 1978-92).

Research is currently being conducted on *Macrotermes* and *Hodotermes* spp. termite ecology, their role in nutrient cycling and ecosystem functioning in the Moremi Game Reserve (G. Schuurman, in press).

2.7 Aquatic Invertebrates

Some sampling of aquatic invertebrates was carried out under the first Okavango Hydrobiological Project (Reavell *et al.*, 1973, 1974). Limnological observations in the upper Okavango Delta at low water levels also involved sampling (Hart, 1986) and later hydrobiological research resulted in more detailed sampling of the Okavango river and upper Delta (Cronberg, 1995). IUCN (1993) carried out extensive sampling on the lower Boro, Thamalakane and Boteti Rivers, and channels and lagoons between Sepupa and Jedibe in 1992, collecting 93 aquatic invertebrate species. Freshwater snails of east Caprivi and the lower Okavango River basin in Namibia and Botswana have been described by Brown, *et al.* (1992). Research on plankton has recently been initiated as part of the floodplain ecology study coordinated by the Okavango Research Centre.

A limited number of aquatic invertebrate species were also collected in the process of sampling non-target aquatic species affected by aerial spraying of insecticides for tsetse fly control (Russell-Smith, 1976; Douthwaite, 1981).

2.8 Water-borne Disease Vectors

Considerable research into the ecology and distribution of water-borne disease vectors has been conducted in the region, but few studies have been identified for the Okavango River and Delta region in Botswana.

Carmichael (1978) collected schistosomes from wild ruminants shot by safari hunting clients during 1976-77.

Statistics on the incidence of malaria and bilharzia (schistosomiasis) have been collected by District Medical Officers at Maun and Gomare since the 1960's (IUCN, 1993).

3. OVERVIEW OF THE CURRENT SITUATION

3.1 Status of Fauna Populations

3.1.1 Mammals

Large Mammals

Thirty-three large mammal species known to occur in the Okavango Delta region are listed in Annex A, Table 1. Conservation status (IUCN) and Trade Schedules (CITES) listings have been included.

Large mammals potentially occurring in the Okavango Delta are also listed in Annex A, Table 2. Water requirements for each species and sections of the Delta from which they have been recorded are included (after CSIR and Water Transfer Consultants, 1997).

Annex A, Table 3 lists numbers of mammals counted as part of a survey conducted by DWNP over the Okavango Delta during 1992, and Table 4 provides density estimates for large mammals based on surveys conducted during 1992, 1994 and 1996 by DWNP (both after CSIR and Water Transfer Consultants, 1997).

With the notable exception of elephant, declines in populations of most large mammals have been reported during the past twenty years.

Analysis of the most recent reliable aerial census data for the Okavango Delta region (DWNP & ULG, 1989-1994) indicates the following shorter-term trends for selected large mammal populations:

*African Elephant *Loxodonta africana**

The elephant population of northern Botswana has increased significantly over the past several decades, and by nearly 10% per annum since 1989. In addition to high reproduction and low mortality, this rate of increase indicates recruitment from Caprivi and Zimbabwe, and aerial surveys in those areas support this case. The 1993 population estimate was over 79 000 with an increasing proportion occupying the Okavango Delta region. There is concern that the increase in elephants may be at the expense of other species as indicated by the changing ratio of elephant biomass to that of all other large mammals. It appears that the increasing elephant population could be having an impact on biodiversity. There is also a growing fear of epidemic disease sweeping through the elephant population at this density. There is a nominal hunting quota of 61 elephant for all the community-managed CHA's in Ngamiland during the 1997 season.

*African Buffalo *Syncerus caffer**

The buffalo population of Ngamiland comprises about 90% of the national herd. Though annual estimates have varied considerably due to the difficulty in counting the species in clumped herds, the population may have declined by almost 19% per annum between 1987

and 1994. Hunting quotas for 1997 are less than 10% of 1984 off-take levels, but reducing quotas had no impact on the rate of decline. Despite improved law enforcement efforts by DWNP and the BDF, poaching may still be a factor, as buffalo meat is highly prized. The Okavango Delta buffalo population was last estimated at between 12 000 and 15 000.

Burchell's Zebra *Equus burchelli*

Overall zebra populations are currently declining by about 4% per annum, though the Okavango sub-population appears to be recovering following large die-offs during the 1980s drought (current estimate is about 20 000). The Makgadikgadi - Nxai Pans population, which relied on the Boteti River during dry seasons, was the hardest hit by drought and still seems to be declining. Hunting quotas for 1997 are about 4% of the legal off-take in 1984.

Blue Wildebeest *Connochaetes taurinus*

The Ngamiland wildebeest population, which is concentrated in the Okavango Delta and Moremi Game Reserve, seems to have increased significantly since 1989. The total hunting quota for Okavango and Kwando CHA's during 1997 is 107 wildebeest.

The overall national wildebeest population continues to decline. Both the Makgadikgadi-Nxai Pans wildebeest, and the Kalahari wildebeest and hartebeest populations were decimated by the 1980s drought when access to surface water (including traditional sources on the Boteti River and at Lake Ngami) was restricted by veterinary cordon fences, or supplies were diverted and finally dried up. Neither wildebeest nor hartebeest appears to be recovering outside protected areas in the south-western system.

Other Ungulates

Roan and sable antelope, sitatunga and eland populations have declined significantly, while waterbuck, tsessebe and hippopotamus also appear to be declining at slower rates. This is contrasted with a marked increase in lechwe populations in the Okavango Delta (about 14% between 1987 and 1993). Other large mammal species populations appear to be stable or increasing slightly (which is also possibly an artefact of better survey methodology).

Large Predators

Aerial census data on large predators are very inaccurate. With the exception of wild dog, systematic species-specific surveys have not been conducted in the Okavango region. Reductions in many prey populations and the few age structure data available from safari hunting records suggest that lion populations (and to a lesser extent, leopard) are declining. Leopard, cheetah and brown hyaena are listed as 'vulnerable' by IUCN. The wild dog is an endangered species whose numbers have been greatly reduced through habitat displacement and livestock predation control. [McNutt's data]

Small Mammals

Ninety-eight small mammal species known to occur in the Okavango Delta region are listed in Annex A, Table 1. Conservation status (IUCN) and Trade Schedules (CITES) listings have been included. Table 2 also includes small mammals potentially occurring in

the Okavango Delta (after CSIR and Water Transfer Consultants, 1997).

The majority of small mammals is represented by the three orders Carnivora (24 spp.), Rodentia (32 spp.) and Chiroptera (28 spp.). While the general distribution of small mammals has been recorded, their status in the Okavango Delta region is not known.

3.1.2 Fish and Fisheries

Annex C, Table 1 lists fish species of the Okavango River system (after SMEC/KCS, 1989). Table 2 gives distribution of fish in the Okavango Delta, Botswana (from CSIR/WTC, 1997).

Eighty-three fish species have been identified from the Okavango River and Delta in Botswana. Five species are listed as rare (Skelton, 1987). Populations have been broadly divided into resident species, longitudinal migrants which move downstream with floods and return with receding waters, and lateral species inhabiting isolated bays and back waters on the floodplains. There are rarely more than 15-20 species common to any one community, and three or four species often comprise the largest proportion of fish biomass within a community (Skelton, *et. al.*, 1985).

Fish population ecology and reproductive biology have been fairly well studied in the Okavango Delta (Skelton, *et. al.*, 1985; Merron and Bruton, 1988; Merron, 1991, 1993b). Very few data are available on the status of fish populations and their habitat requirements in the Okavango Delta. Harvesting rates and impacts on fish populations have received little attention. During normal to high flood level regimes prevailing when much of the initial research was being conducted, over-harvesting was not perceived as a potential problem. There is now concern that Okavango Delta fish populations may be declining due to fishing pressure under current conditions. An estimated 2 000 - 4 000 residents of the Delta and neighbouring villages were fishing for home consumption and about 750 fished commercially in 1987 (Skjonsberg and Merafe). Merron (1991) estimated subsistence yields at about 1 000 tonnes, commercial fisheries yields at 1 200 tonnes and the recreational harvest at about 800 tonnes, for a total of 3 000 tonnes per annum.

Annual inundation of extensive shallow floodplains results in a nutrient pulse into the aquatic system from detritus, animal dung and vegetation, etc. This is probably the most important factor influencing fish productivity in the Okavango Delta (Merron and Bruton, 1988). Drought and low flood levels during the past decade must have adversely affected fish stock production as the extent of shallow feeding, breeding and nesting areas has been reduced for extended periods.

Use of insecticides in controlling tsetse fly has also had negative impacts on Okavango fish populations. Endosulfan and deltamethrin were found to be highly toxic to fish species at all concentration levels, and misapplications have resulted in substantial fish kills being documented (Douthwaite, 1981; Merron, 1986).

Another threat to fish populations is that posed by introduced or exotic aquatic plants. Spreading mats of *Salvinia molesta* reduce photosynthesis by algae and submerged macrophytes, lowering productivity (Merron, 1993). Few data are being collected on the impacts of these processes.

Reductions or major changes in the structure of fish populations will also have impacts on populations of fish predators. The largest and most significant of these in the Okavango Delta is the Nile Crocodile (*Crocodylus niloticus*).

3.1.3 Birds

Annex D, Table 1 includes a checklist of birds recorded from the Okavango Delta and Lake Ngami area, and a descriptive list of ornithological habitats associated with the checklist (after SMEC/KCS, 1989). Table 2 presents a list of the common and scientific names of the 280 bird species recorded during the CSIR/WTC survey of the Okavango in Namibia and Botswana (after CSIR and Water Transfer Consultants, 1997).

Penry (1994) lists 453 species recorded within the 34 quarter-degree squares including the Okavango River and Delta region, making it the richest mosaic of habitats for avifauna biodiversity in the country (496 species are verified and 59 others may occur in Botswana). Penry (SMEC, 1985) lists 45 species from the Okavango Delta region which are classified as 'threatened' or 'vulnerable' in southern Africa. About half of them are dependent on wetland or tropical habitats. The Okavango system represents a southern intrusion of wetland and tropical habitats into the Kalahari, extending the range of many species and supporting a large number of resident and migratory species.

Birds considered important in a local, regional or international context, based on their very limited distribution and breeding localities, or conservation status include the Pink-backed pelican (*Pelecanus rufescens*), Marabou stork (*Leptoptilus crumeniferus*), Yellow billed stork (*Mycteria ibis*), Open bill stork (*Anastomus lamelligerus*), Saddlebill stork (*Ephippiorhynchus senegalensis*), Rufous bellied heron (*Butorides rufiventris*), White backed night heron (*Gorsachius leuconotos*), Pygmy goose (*Nettapus auritus*), Western banded snake eagle (*Circaetus cinerascens*), Pel's fishing owl (*Scotopelia peli*), Blue quail (*Coturnix adansonii*), Wattled crane (*Grus carunculatus*), Ross's lourie (*Musophaga rossae*), Narina trogon (*Apaloderma narina*), African skimmer (*Rynchops flavirostris*) and Carmine bee-eater (*Merops nubicoides*).

The Slaty egret (*Egretta vinaceiqula*) deserves special mention as the rarest heron in the world with its range limited to the Okavango Delta, Linyanti-Chobe system and Lake Bangweulu in Zambia. It has only been recorded breeding in the Okavango Delta. Very little is known of its ecology or the details of its habitat requirements.

Among bird species which are of economic importance as potential pests of small grain crops are red-billed quelea (*Quelea quelea*), cape turtle dove (*Streptopelia capicola*) and the

spurwing goose (*Plectropterus gambensis*).

3.1.4 Reptiles

Annex E, Table 1 provides a checklist of 67 reptile species of the Okavango Delta, with comments on localities of occurrence (after SMEC/KCS, 1989). Table 2 lists a total of 64 reptiles that have been recorded or are expected to occur in the Okavango Delta region, together with their habitat requirements (from CSIR/WTC, 1997). Table 3 lists ten reptile species restricted in distribution to the Okavango River and Delta and Chobe River systems in Botswana.

Twelve reptile species, including four terrapins, the Nile monitor, python and five water snakes may be considered aquatic or near aquatic. The largest, and most important of these species in economic terms, is the Nile Crocodile (*Crocodylus niloticus*).

Commercial hunting between 1957 and 1974 decimated the crocodile population of the Okavango Delta (Blomberg, 1976). As the population recovered under protection, predation on livestock (and occasional attacks on people) increased around settlements in the Panhandle, where almost all nesting occurs. Exploitation resumed in 1983 when eggs, hatchlings, sub-adults and adults for breeding were first collected from the wild for stocking of two crocodile farms. Having captured their initial stocks, these farms were meant to breed, rear and sell their own crocodiles.

Population estimates of about 5 000 crocodiles in the Panhandle and 1 600 in the rest of the Delta in 1987 (Simbotwe, 1988b) are based on few survey data. Survival rates and sex ratios are poorly known. Aerial surveys indicated that there are about 100 nests which might be expected to yield 5 600 eggs if all nests are found on ground searches (Simbotwe, 1988a). Quotas for egg collection by farmers have been set on demand, with 3 300 eggs taken in 1995 and 4 200 collected during 1996 (CSIR/WTC, 1997). This level of off-take represents 60-75% of the estimated maximum annual reproduction, and could have significant impacts on crocodile populations if significant numbers of sub-adults are not being returned to the wild. It also indicates that crocodile farms are not sustainable, since they are still removing huge numbers of eggs from wild populations to rear and sell on as 'farmed' crocodiles 14 years after they were established. The Nile crocodile was listed as 'vulnerable' on the world level and 'rare' in Botswana (WCMC, 1991).

The Nile Monitor (*Varanus niloticus*) is also reported to be an important predator on crocodile eggs in the Panhandle (Blomberg, 1976). Monitors, tortoises, terrapins, pythons, crocodiles and their eggs are eaten by some local residents. The current status of these and other reptile species populations is unknown. There is concern that tortoises may be over-exploited, especially where they are collected for use in producing handicrafts.

Based on the very limited information available, no reptile species are yet known to be restricted only to the study area, and none is listed as endangered at present.

3.1.5 Amphibians

Annex E, Table 1 lists a total of 28 amphibians that have been recorded or are expected to occur in the Okavango Delta, with comments on localities of occurrence (after SMEC/KCS, 1989). Table 3 lists twelve amphibian species restricted in distribution to the Okavango River and Delta and Chobe River systems in Botswana (after CSIR/WTC, 1997).

Five species of frogs are known only from the Okavango River and upper Delta within Botswana, but also occur elsewhere. The yellow swamp toad (*Bufo lemairii*) has been collected at Shakawe and Xugana Lediba. These are the only records for southern Africa south of the Cunene/Zambezi catchments. Collection of the yellow-bellied grass frog (*Ptychadena guibeii*) from Gumare, Bocage's reed frog (*Hyperolius benguellensis*) from the Xo Flats, and the pygmy puddle frog (*Phrynobatrachus parvulus*) from the Khwai river are the only records for each species from Botswana. Of these *Bufo lemairii* and *Hyperolius benguellensis* are likely to be important as they represent southward extensions of predominantly tropical species (SMEC/KCS, 1989).

The bullfrogs (*Pyxicephalus adspersus* and *P. edulis*) are collected and eaten by some residents. The current status of amphibian populations is not known. As 'indicator species', amphibian populations tend to react quickly to environmental changes and water pollution. Though some specimens have been collected in a limited number of surveys (Russell-Smith, 1976; Douthwaite, 1981), very little data have been collected on the impacts of large-scale insecticide spraying programmes on amphibians.

3.1.6 Terrestrial Invertebrates

Apart from the tsetse fly (*Glossina morsitans*), the butterflies and dragonflies (Pinhey and Balinsky, 1967-76; Silsby, 1991), the introduced weevil (*Cyrtobagous singularis*) and termites, little is known of the status of most terrestrial invertebrate populations of the study area.

The tsetse fly has long affected the ecology and economy of the Okavango Delta, preventing permanent settlement and the keeping of domestic livestock throughout much of the region. Expensive long-term eradication programmes failed and the tsetse fly is currently re-invading many areas.

Other insects of economic importance as predators of cultivated crops are the red locust (*Nomadacris septemfasciata*) and African migratory locust (*Locusta migratoria migratorioides*), the American bollworm (*Heliothis armigera*), Spotted stalkborer (*Chilo partellus*), Army Worm (*Spodoptera* spp.) and Sorghum midge (*Contarinia sorghicola*).

Insects which are locally important as a human protein supplement include the mopane worm (*Imbrasia belina* larva) and termite allates (mainly *Macrotermes* and *Hodotermes* spp.).

Termites are also very important for their major role in the ecology of savanna ecosystems. Their huge populations are involved in energy and nutrient circulation, have important effects on the functioning of the Delta, and provide or modify habitats for a large number of other species. Research is currently being conducted on *Macrotermes* and *Hodotermes* spp. termite ecology in the Moremi Game Reserve (G. Schuurman []).

Dragonflies and butterflies are better known for the study area than other groups of invertebrates of similar numbers. According to Pinhey (1967-1976), 114 species of dragonflies are thought to occur in Botswana of which 84 are to be found in the Okavango Delta region. There are 29 species of damselflies (Zygoptera) from five families and 55 species of Anisoptera from four families, giving rise to the statement that the Delta is "one of the richest and most interesting Odonata ecosystems in southern Africa" (Pinhey, 1976b). Pinhey has also compiled a checklist of 123 species of butterflies (9 families) from the Okavango Delta.

Non-target arthropod specimens were collected, but not all were identified beyond sub-order, following aerial spraying of insecticides to control tsetse fly (Ali, 1976, 1977; Davies, 1980; Douthwaite, *et. al.*, 1981; Games, 1981, 1982a).

3.1.7 Aquatic Invertebrates

Annex F, Table 1 lists 93 aquatic invertebrates collected during sampling of the Lower Boro, Thamalakane and Boteti Rivers and channels and lagoons between Sepupa and Jedibe (after IUCN, 1993). Table 2 lists 25 species of freshwater molluscs collected from the Okavango River in Namibia and Okavango River and Delta in Botswana (after CSIR/WTC, 1997).

No detailed systematic surveys of the aquatic invertebrate fauna of the Okavango Delta region appear to have been undertaken. SMEC (1987a) recorded eight snails during a brief investigation of the snail hosts of schistosomes.

IUCN (1993) carried out more extensive sampling on the lower Boro, Thamalakane and Boteti Rivers, and channels and lagoons between Sepupa and Jedibe in 1992, collecting 93 aquatic invertebrate species. Freshwater snails of east Caprivi and the lower Okavango River basin in Namibia and Botswana have been described by Brown, *et. al.* (1992).

More recent surveys of the Okavango River in Namibia and Okavango River and Delta in Botswana yielded 15 snails, one limpet and seven bivalve species. Four snail species collected are of medical (bilharzia host) or veterinary (liver fluke host) importance. One bivalve (*Ceratophallus natalensis*) was collected for the first time from the Okavango River during this survey (CSIR/WTC, 1997).

A limited number of aquatic invertebrates were also collected (but not classified in detail) in the process of sampling non-target aquatic species affected by aerial spraying of insecticides for tsetse fly control (Russel-Smith, 1976; Douthwaite, 1981).

3.1.8 Water-borne Disease Vectors

Both malaria and schistosomiasis are major public health problems in the Okavango Delta region, and the incidence of both diseases can be expected to increase.

The main transmitters of malaria appear to belong to the *Anopheles gambiae* complex of mosquitoes. A fairly regular seasonal peak in the number of malaria cases in the Delta region is related to rainfall and occurs between February and April (435 confirmed cases and 3 560 'unconfirmed' cases reported in 1991 [1996 data])

From no apparent transmissions of intestinal bilharzia (schistosomiasis) in the Okavango Delta in the 1960's, infection rates of *Schistosoma mansoni* in school children around Maun were reaching levels of 80% by 1984. This is due to invasion of the intermediate host snail. Outbreaks of *Schistosoma haematobium* (urinary schistosomiasis) have been reported from communities in the panhandle, and it is possible that the intermediate host snail (*Bulinus globosus*) will find its way into the lower Okavango Delta during high flood regimes.

3.2 Habitats and Distribution

Along with generally lower flood regimes, flow changes in the Okavango Delta have resulted in drier conditions in the south-east (the Santantadibe and Gomoti River floodplains are receding), while relatively wetter conditions prevail in the northeast. Blockage of the Nqoga River (considered the most important distributary in the Okavango) is causing increased flow into the Khiandiandavu River and beyond into the Maunachira and Khwai Rivers. The Khwai River channel has higher water levels further to the east now with more sedge communities being established along the Mochaba River and generally higher wildlife densities. The Tsam Tsam molapo has also been developing as a northern arm of the perennial swamp for the past 15 years. This has resulted in the formation of a large dryland area south of the old Nqoga channel at the top of Chief's Island. These hydrological changes have influenced the dry season distribution of all water-dependent species.

3.2.1 Mammals

Large Mammals

Most large mammal species are highly mobile and therefore may occur in more than one ecological zone, often being found in a variety of habitats. All species display preferences for certain habitat types. The major habitat types in the Okavango Delta region are summarised and the different habitat types used by large mammals are indicated in Table 1 (after SMEC/KCS, 1989). Table 2 shows numbers of large herbivores per km² by habitat

and season in the southern Okavango Delta (After SMEC,1987).

Perennially Inundated Areas

1. Madiba (lakes)
2. River channels
3. Perennial swamp

Seasonally Inundated Areas

4. Seasonal long grass/sedge floodplains (wet and dry)
5. Seasonal short grass floodplains (wet and dry)

Intermittently Flooded Areas

6. Occasionally inundated grassland

Dryland Associations

7. Riverine Woodland
8. Island grassland
9. Scrub communities
10. Mixed woodland / savanna
11. Mophane woodland / savanna
12. Terminalia woodland / savanna
13. Pans (wet and dry)

Table 1: Use of different habitat types of the Okavango Delta by large mammals (after SMEC/KCS, 1989)

Species	Habitat Type												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Baboon				X	X	X	X	X	X	X	X	X	X
Brown Hyaena									X	X	X	X	X
Spotted Hyaena				X	X	X	X	X	X	X	X	X	X
Cheetah				X	X	X		X	X	X	X	X	X
Leopard				X	X	X	X	X	X	X	X	X	X
Lion				X	X	X	X	X	X	X	X	X	X
Wild Dog				X	X	X		X	X	X	X	X	X
Antbear					X	X	X	X	X	X	X	X	
Elephant		X	X	X	X	X	X	X	X	X	X	X	X
Zebra				X	X	X		X	X	X	X	X	X
Warthog				X	X	X		X	X	X	X	X	X
Hippo	X	X	X	X	X	X		X					X
Giraffe							X		X	X	X	X	X
Duiker								X	X	X	X	X	
Oribi				X	X	X							
Steenbok						X		X	X	X	X	X	
Kudu				X	X	X	X	X	X	X	X	X	X
Sitatunga		X	X			X	X						
Bushbuck						X	X	X	X				
Impala				X	X	X	X	X	X	X	X	X	X
Reedbuck				X	X	X							
Waterbuck				X	X	X	X	X					
Lechwe			X	X	X	X							X
Gemsbok									X	X		X	X
Sable					X	X		X	X	X	X	X	X
Roan					X	X	X	X	X	X	X	X	X
Eland									X	X	X	X	X
Buffalo	X	X	X	X	X	X	X	X	X	X	X	X	X
Wildebeest				X	X	X		X	X	X	X	X	X
Hartebeest										X		X	
Tsessebe				X	X	X	X	X	X	X	X	X	X

Table 2: Number of large herbivores per km² in different habitats and seasons in the southern Okavango Delta (After SMEC,1987).

Survey	Floodplain			Island		Land
	Permanent Swamp	Sedgeland	Grassland	Fringe	Wooded Grassland	Grassland
April	0.12	17.68	2.69	3.17	3.10	3.60
July	0.05	15.81	4.01	3.14	2.57	3.68
August	0.05	5.48	4.34	3.38	2.39	2.21
November	0.08	11.43	2.90	1.63	2.91	2.86
Average	0.08	12.60	3.46	2.83	2.74	2.84

Floodplains and ecotones with riparian woodland habitats on river channels support the highest large mammal biomass in the Okavango Delta. Availability of surface water and flooding of floodplains for fodder production affect the dry season distributions of most species. The availability of dry season floodplain grazing, especially in the sedge communities, is the major limiting factor to large mammal population levels in the Okavango Delta (SMEC/KCS, 1989). Floodplains are grazed during the wet season (low water period) and are normally protected from heavy grazing during the high water period (dry season). The permanently flooded perennial swamp supports very low mammal biomass.

About 50% of the distributional range of the red lechwe (*Kobus leche*) extends over the Okavango delta (Smithers and Skinner, 1990).

With a rapidly growing population of elephant in northern Botswana, there appears to be a general shift of the centre of distribution westwards into Ngamiland, with large herds concentrated in the perennial swamp ecotones in the Moremi Game Reserve and surrounding CHA's during the dry season. Resulting severe impacts on riparian woodland habitats will affect their use by a large number of other species (mainly birds, small mammals and reptiles).

The declining Buffalo population of Ngamiland, comprising about 90% of the national herd, is concentrated in the Okavango Delta and on the Kwando River during the dry season. During the 1993 dry season, about two-thirds of the Okavango population was found in the Moremi Game Reserve. Buffalo are now confined to a very restricted range. Distribution to the west, north-west and south of the Delta has been blocked by veterinary cordon fences and settlements. Elsewhere the range is restricted by availability of receding surface water supplies. There is concern that large numbers of buffalo have been fenced out of essential habitat in the process of erecting the growing network of veterinary cordon fences for disease control in cattle populations (DWNP, 1994).

The Makgadikgadi - Nxai Pans zebra population relied on the Boteti River during dry seasons, and was decimated during the 1980's drought after this water supply failed. There are indications that part of this remnant population now migrates to the Okavango Delta in the dry season.

The Kalahari wildebeest population (and to a lesser extent, hartebeest) historically relied on the Boteti River and Lake Ngami for water during drought years. Populations have suffered massive mortalities since migrations to surface water have been impeded by veterinary cordon fences during droughts since the 1960's (Child, 1972a; Williamson, 1985). Diversion of water from Lake Xau resulted in higher wildebeest mortalities during the last drought between 1981 and 1988 (Parry, 1987; Williamson and Mbanjo, 1988).

The impact of changes in the Okavango River system on Kalahari wildlife populations emphasises the importance of this system at a regional and national scale. The extent of the density distributions for Botswana buffalo, lechwe, sitatunga, tsessebe and wildebeest populations, is shown in the Density Distribution maps of these large mammals.

Within the Okavango Delta region the interrelationships between the recent declines in many large mammal species populations and increases in others (elephant, lechwe, wildebeest) are not well understood, but may relate to shifting biomass ratios. Incidence of fire, long-term desiccation in some areas and inaccessibility of traditional ranges are also likely to be factors. Reductions in the size of wildlife habitats is bound to lead to reductions in potential population levels.

Small Mammals

Floodplains and riparian woodland habitats probably also support the highest small mammal densities in the Okavango Delta. While the majority of small mammals are not dependent on surface water, the seasonal flooding of floodplains is essential for maintenance of preferred habitats for many species.

One wetland-associated rodent species, Shortridge's mouse (*Mastomys shortridgei*) occurs only in the Okavango River system in Namibia and Botswana. Brant's climbing mouse (*Dendromus mesomelas*) and the Groove-toothed mouse (*Pelomys fallax*) occur only in the Okavango River system within Botswana, but are found elsewhere in South Africa and Zimbabwe.

Four species of bats: the Midas free-tailed bat (*Tadarida midas*), the Butterfly bat (*Chalinolobis variegatus*), Ruppell's pipistrelle (*Pipistrellus ruppelli*) and Rendall's serotine bat (*Eptesicus rendalli*) are also confined to the Okavango Delta in Botswana, but also occur in Namibia, southern Angola and Zambia. Likewise the range of the white-tailed mongoose (*Ichneumia albicauda*) extends from southern Angola and Caprivi into the Delta.

The distribution of various other wetland-associated species within Botswana is confined to

the Okavango, Kwando, Linyanti and Chobe River systems.

3.2.2 Fish and Fisheries

Annex C, Table 3 lists general and breeding habitat preferences for fish species of the Okavango Delta (from CSIR/WTC, 1997).

In terms of distribution, fish populations have been broadly divided into resident species, longitudinal migrants which move downstream with floods and return with receding waters, and lateral species inhabiting isolated bays and back waters on the floodplains. Certain species are distributed throughout the Delta while others have more specialised habitat requirements. Duration and timing of floods and water levels, together with habitat preference and food supplies are the main factors affecting fish distribution.

The flood cycle also appears to have a major influence on breeding seasons for most species. Apart from directly stimulating spawning, it provides shallows for nesting sites and seasonally inundated littoral areas for nurseries. Many floodplain breeders spawn when higher temperatures are experienced (September to December). Excessively cold periods are known to cause significant fish mortalities, particularly in shallow water (Merron and Bruton, 1988).

Factors resulting in lower than expected fish productivity in the Okavango Delta include: nutrient deficiencies, habitat unpredictability, predator imbalances, delayed flood cycles in relation to the best season for fish breeding and growth, and the poor growth of algae and phytoplankton in Okavango waters. Previous dredging also reduced fish stocks creating sterile channels which most species could not use as habitats (Fox, 1976; Merron and Bruton, 1986a). More recently the widespread use of insecticides in controlling tsetse fly has also impacted on Okavango fish populations (Merron and Bruton, 1986a).

Merron and Bruton (1988) describe five major divisions of the Okavango Delta ecosystem in terms of fish fauna habitat:

- 1) Riverine Panhandle
- 2) Upper swamp
- 3) Lower swamp
- 4) Drainage rivers
- 5) Sump lakes

They estimated that the most productive perennial water areas comprised approximately 4 000 km² within the Delta in 1988.

3.2.3 Birds

Annex D, Table 1 includes a checklist of birds recorded from the Okavango Delta and Lake Ngami area, and a descriptive list of ornithological habitats associated with the checklist (after SMEC/KCS, 1989). Table 3 lists numbers of bird species and their major activities in

the various habitat types in the Okavango River and Delta systems (after Swedeplan, 1989).

Tinley (1966), Jackson (1969) and Fraser (1970, 1971b, 1971c) did some early work on bird distribution and habitat preferences at Lake Ngami (in flood), in the Moremi Wildlife Reserve and on the Khwai River. Milenski and Campbell (1976) carried out a more detailed survey in Moremi Wildlife Reserve in 1975. Numerous researchers have documented distributions for certain water bird species, especially herons and heronries, and limited information is available for raptors and game birds. Few distribution data or information on habitat preferences are available on species of the largest order, Passeriformes.

In a Botswana context, several species occur only in the Okavango Delta region, although they may be more or less widespread regionally or internationally. Some of these species are discussed under Section 3.1.3.

There is a general preference by waterbirds for seasonally inundated areas at the swamp margins. This probably relates to richer nutrient cycling and fluctuating conditions associated with seasonal wetlands. (These habitats are most likely to be adversely affected by any manipulation in water levels resulting from abstraction of water from the Okavango River). Seasonal wetlands also provide resting and feeding habitats for a large number of inter-African and palaeartic migrant species.

Highest (non-waterbird) resident species densities occur in riparian woodlands and on island fringes. The destruction of these habitats by growing numbers of elephant in the eastern Okavango Delta could displace numerous bird species. The perennial swamps support fewer species but may be used seasonally for nesting by a few species.

3.2.4 Reptiles

The few distribution data available for reptiles in the Okavango Delta region (apart from the crocodile) are provided by Auerbach (1987). Simbotwe and Guillette (1990) discuss the zoogeography of reptiles of Botswana and management implications.

The distribution of the Nile crocodile is better known than that of any other reptile species in Botswana (Blomberg, 1976; Simbotwe and Guillette, 1990). Crocodiles are distributed throughout the Okavango River and Delta in permanent swamp, rivers, madiba and seasonal swamp. However, nearly all nesting sites are found in the Panhandle above the Delta between Shakawe and Seronga (Graham and Simbotwe, 1988). Extensive movements may take place (up to 200 kms) but nearly all individuals eventually return to the Panhandle to breed. This section of the river also supports large human and livestock populations, and there are inevitable conflicts here with crocodiles taking livestock, and residents hunting or snaring crocodiles and raiding of nests (Skjonsberg and Merafe, 1987).

The Pelomedusidae (terrapins) show interesting diversity in the Okavango Delta, where four of five Botswana species are recorded. The eastern striped swamp snake (*Limnophis bicolor bangweolicus*) is an Angolan/Zambian species recorded only from Maun and Xugana lediba. The Barotse water snake (*Crotaphopeltis barotseensis*) and the western green snake (*Philothamus angolensis*) are confined in Botswana to the study area.. Four of the five Botswana records for the eastern rufous beaked snake (*Rhamphiophis oxyrhynchus rostratus*) are from the Okavango Delta (SMEC/KCS, 1989).

Twelve reptile species, including the Nile crocodile and monitor, python, five water snakes and four terrapins may be considered aquatic or near aquatic, and are restricted in their distribution to areas in/near perennial surface water. Distribution of reptiles which are not dependent on water mainly reflects their dietary preferences and the abundance of prey or plant food species. Very few data have been collected on the habitat requirements of other reptiles in the region.

3.2.5 Amphibians

The few distribution data available for amphibians in the Okavango Delta region are provided by Auerbach (1987). Simbotwe and Guillette (1990) discuss the zoogeography of amphibians of Botswana and management implications.

The inventory of amphibians and what is known of their distribution highlights the importance of the Panhandle and distributary systems towards the east and south east. The Okavango River and the Nqoga, which is the main distributary, are of major importance in influencing distribution of amphibians (SMEC/KCS, 1989). Recent hydrological changes have also limited their distribution, particularly in the south and south-east parts of the Delta.

Only two amphibian species (*Xenopus laevis* and *X. muelleri*) are fully aquatic. Most species appear to select habitats including perennial water supplies where possible, and require standing water to complete their life cycles, but they have adopted strategies of hibernation or aestivation to survive temporary and seasonal desiccation of habitats.

Findings of a recent survey in the Okavango Delta indicate a patchy distribution for many amphibian species, even on a small scale in what appear to be suitable or similar habitat types (CSIR/WTC, 1997).

Very few data have been collected on the habitat requirements of amphibians in the region.

3.2.6 Terrestrial Invertebrates

Little research has been done on the ecology and habitat requirements of terrestrial invertebrate fauna in the Okavango Delta, or elsewhere in Botswana. A few economically or ecologically important species have been studied in some detail, including the tsetse fly

(*Glossina morsitans*), the mophane worm (*Imbrasia belina* larva) the silkworm moth (*Gonometa postica*) and termites (*Macrotermes*, *Hodotermes* and other genera). Records of occurrence and limited information on distribution have been collected for species of the Orders Lepidoptera (butterflies) and Odonata (dragonflies) from the study area (Pinhey, 1967-76). A considerable body of information is available from South Africa, Namibia and Zimbabwe, particularly on species of economic importance.

Tsetse Fly

Environmentally and economically expensive control measures, including game destruction, bush clearing, tree felling and extensive ground and aerial pesticide spraying programmes conducted over the past 40 years, have failed to eradicate the tsetse fly from the Okavango Delta. Tsetse fly ranges are again reported expanding to the east and south-east from residual foci on the north-east side of Chief's Island (P. Smith, *pers. comm.*).

Butterflies

Pinhey (1967-1976) has produced a checklist of the butterflies of Botswana from which it has been possible to select several that seem to be of importance within the Okavango Delta region. *Eurema hapale* (Pieridae), which was collected at Muhembo, shows an interesting disjunct distribution with the nearest populations being found in eastern Zimbabwe and northwards into East Africa. *Acraea acerata* (Acraeidae) has only been collected at Shakawe/Muhembo south of the Zambezi / Cunene system, while *Acraea oerata* is only known from one type collected on the Okavango River. Other species limited in distribution by their associations with swamp habitats include *Sallya amulia intermedia* (Nymphalidae), *Borbo micans* (Hesperiidae) and *Mylothris bernice attenuata* (SMEC/KCS, 1989).

Dragonflies

Owing to the interest of taxonomists, this order is better known from the Okavango Delta than any other group of invertebrates of similar numbers. Pinhey listed 114 species of dragonflies expected to occur in Botswana of which 84 are found in the study area. There are 29 species of damselflies (Zygoptera) from five families and 55 species of Anisoptera from four families, giving rise to the statement that the Delta is "one of the richest and most interesting Odonata ecosystems in southern Africa" (Pinhey, 1976b).

Termites

A number of termite species occur in abundance in the Okavango Delta region. Some (especially *Macrotermes* spp. and *Hodotermes* spp.) are of great importance in nutrient and energy cycling and ecosystem functioning. Research is currently being carried out on the ecology of these Genera in the Moremi Game Reserve.

3.2.7 Aquatic Invertebrates

Very little research has done on the ecology and habitat requirements of aquatic invertebrate fauna in the Okavango Delta, or elsewhere in Botswana. General distribution information have been collected for a number of species in the study area (q.v. Annex F,

Tables 1 and 2).

Recent hydrological changes in distributary systems of the Okavango River must have also affected the distribution of aquatic invertebrates.

3.3 Environmental Water Demand

Long and short term changes in the extent, duration and timing of annual flooding and consequent changes in dependent habitats affect productivity of the Okavango Delta and the ecology and distribution of fauna. Productivity has apparently been reduced through the period of extreme low water levels experienced during the past decade and further reductions in inflow resulting from abstraction above the Delta can only exacerbate this situation.

3.3.1 Mammals

Table 3 indicates that the majority of large mammal species (particularly ungulates) of the Okavango Delta region rely on perennial surface water supplies, resulting in large concentrations of certain species at the (dynamic) river channel and perennial flood ecotones in the Delta during the dry season. Three (semi-aquatic) species remain on the ecotones throughout the year. Though species termed 'water-independent' can normally meet their water requirements through food supplies, all will drink if given the opportunity.

Large daily water and fodder demands keep the growing elephant population in or near the ecotones during the dry season. As they expand further west into the Delta, they are impacting on riparian woodlands, ecotone and island fringe vegetation communities, and altering or destroying the habitats of a number of smaller wildlife species (Ecosurv, 1996).

Table 3: Water utilisation by large mammals of the Okavango Delta (After SMEC/KCS, 1989).

Semi-aquatic	Water Dependent	Water Independent
Hippo (G)	Buffalo (G)	Antbear (I)
Lechwe (G)	Baboon (O)	Cheetah (C)
Sitatunga (G)	Bushbuck (B+G)	Duiker (B)
	Elephant (B+G)	Eland (B+G)
	Impala (B+G)	Gemsbok (G)
	Oribi (G)	Giraffe (G)
	Reedbuck (G)	Hartebeest (G)
	Roan (G)	Brown Hyaena (C)
	Sable (G)	Spotted Hyaena (C)
	Tsessebe (G)	Kudu (B)
	Warthog (G)	Leopard (C)
	Waterbuck (G)	Lion (C)
	Zebra (G)	Springbok (B+G)
	Wildebeest (G) ¹	Steenbok (B+G)
		Wild Dog (C)

NOTE: G = Grazer
B = Browser
C = Carnivore
I = Insectivore
O = Omnivore

1 = The wildebeest of the south-western (Kalahari) system require supplementary surface water only when fodder moisture levels are low during drought periods.

3.3.2 Fish and Fisheries

Impacts on fish populations and distribution in the Okavango Delta resulting from drought and natural or artificial reductions in seasonal flood levels include:

- * Reductions in areas of seasonally inundated swamps will limit available habitats and food supplies.
- * Impacts of subsistence and commercial fishing will also be increased as inaccessible habitats are reduced or eliminated.
- * Shallow floodplain pools necessary for the completion of breeding cycles of some species will be reduced in extent or eliminated over large areas.
- * Seasonal migrations and movements to deep channels may be impeded by lowered water levels.
- * Changes in species composition may occur with selective mortality in isolated pools between flood events.
- * Changes in population size and structure will affect major fish predator population dynamics (e.g.. crocodile).
- * Decreased water levels could accentuate the effects of insecticide spraying programmes aimed at controlling tsetse fly.

Most significant impacts are anticipated in the lower reaches of the seasonal swamps and in the south-eastern quarter of the Delta where the perennial swamp has receded to the upper sections of the Boro and Santantadibe River channels.

3.3.3 Birds

Low flood regimes and hydrological changes also affect the ecology, distribution, food supplies and breeding success of many waterbird species. Disturbance at heronries and other nesting sites is reported to be on the increase as growing numbers of tourists travelling in mekoros are concentrated into shrinking perennial swamp habitats and along river channels (T. Liversedge, *pers. comm.*).

Five of 26 ornithological habitats described by Plowes for the Okavango Delta in SMEC (1987c) are not associated with perennial or seasonal swamps, floodplain ecotones or riparian woodland (*C. mopane* woodland and scrub, *Terminalia* thickets and *Acacia erioloba* woodland). The latter type often borders swamp ecotones inland, and is the most heavily used 'dryland' habitat type (q.v. Annex D, Table 2).

3.3.4 Reptiles

Twelve reptile species, including the Nile crocodile and Nile monitor, python, five water snakes and four terrapins may be considered aquatic or near aquatic, and are restricted in their distribution to areas in and near perennial surface water.

Crocodile distribution, habitat preference and reproduction are closely linked to flood regimes and water levels as they affect food supplies, nest site selection and availability, cover requirements and hatchling survival rates (Graham and Simbotwe, 1988).

Retarding of flooding and causing water levels to recede further under dry season conditions, with potential changes in plant community composition, could affect habitat suitability and availability of food supplies for water-dependent species.

3.3.5 Amphibians

Water demand by most amphibian species is obviously high. Even those which do not rely on perennial water supplies, and aestivate or hibernate through dry periods, must have access to open water pools to complete their breeding cycles.

Some of the potential impacts on amphibian populations in the Okavango Delta resulting from drought and natural or artificial reductions in seasonal flood levels are similar to those listed for fishes:

- * Reductions in areas of seasonally inundated swamps will limit available habitats and food supplies.
- * Shallow floodplain pools necessary for the completion of breeding cycles will be reduced in extent or eliminated over large areas.
- * Reduction in the number and extent (of 'edge') of ephemeral pools which provide habitats for many amphibian species.
- * Changes in species composition may occur with selective mortality under drier conditions.
- * Gradual changes in the composition of plant communities may occur, with direct or indirect changes in food supplies and habitat suitability.
- * Decreased water levels could accentuate the effects of insecticide spraying programmes aimed at controlling tsetse fly.

Most significant impacts are anticipated in the lower reaches of the seasonal swamps and in the south-eastern quarter of the Delta where the perennial swamp has receded to the upper sections of the Boro and Santantadibe River channels.

3.3.6 Terrestrial Invertebrates

Long-term changes in flood level regimes could result in gradual changes in the

composition of plant communities and thus (directly or indirectly) in food supplies and habitat suitability for terrestrial invertebrates. Soil moisture levels (affected by vegetation they support) also affect habitats of ground dwelling and nesting species (most notably termites and their role in ecosystem functioning).

3.3.7 Aquatic Invertebrates

Recent hydrological changes in the distributary systems of the Okavango River have also affected the distribution of aquatic invertebrates.

Impacts on aquatic invertebrate populations and distribution in the Okavango Delta resulting from drought and natural or artificial reductions in seasonal flood levels include:

- * Reductions in areas of seasonally inundated swamps will limit available habitats and food supplies.
- * Shallow floodplain pools necessary for the completion of breeding cycles of some species will be reduced in extent or eliminated over large areas.
- * Changes in species composition may occur with selective mortality in isolated pools between flood events.
- * Changes in population size and structure may also affect predator population dynamics.
- * Gradual changes in the composition of plant communities may occur, with direct or indirect changes in food supplies and habitat suitability.
- * Decreased water levels could accentuate the effects of insecticide spraying programmes aimed at controlling tsetse fly.

Most significant impacts are anticipated in the lower reaches of the seasonal swamps and in the south-eastern quarter of the Delta where the perennial swamp has receded to the upper sections of the Boro and Santantadibe River channels.

4. GAPS IN INFORMATION

4.1 Mammals

- 1) While it appears that increasing elephant populations could be having an impact on biodiversity in the Okavango Delta region, the extent to which this is occurring is not known.
- 2) Negative impacts on wildlife (and plant communities) by growing numbers of tourists occupying reduced dry season habitats have been alleged. No supporting data are available.
- 3) While the general distribution of most predators and the smaller mammal species populations has been recorded, little is known of their status, ecology and habitat requirements in the Okavango Delta region.
- 4) Aerial census data on large predators are very inaccurate. With the exception of wild dog, systematic species-specific surveys have not been conducted in the Okavango Delta region.
- 5) The interrelationships between the recent declines in many large mammal species populations and increases in others (elephant, lechwe, wildebeest) in the Okavango Delta region are not well understood.

4.2 Fish and Fisheries

- 1) Few data are available on the current status of fish population dynamics and ecology, and their habitat requirements in the Okavango Delta.
- 2) Statistical information on fishing activities is imprecise and extremely variable. Harvesting rates and their impacts on key fish populations have received little attention.
- 3) Little is known of the limits to productivity of the waters in the Delta and the impact of floods on fish populations.
- 4) The long term effects of tsetse fly spraying on the environment, and particularly on fish populations, are not known.
- 5) There is a shortage of basic hydrobiological and limnological data for the Okavango Delta. Information on hydrobiology is the most significant gap in knowledge of the biota and processes of ecosystem functioning in this area.

4.3 Birds

- 1) There is a lack of knowledge of habitat requirements, nesting and feeding habits and sites of several bird species of special concern to conservation.

- 2) Negative impacts on vulnerable waterbird populations and nesting and roosting sites by growing numbers of tourists have been alleged. No supporting data are available.
- 3) The role of the northern wetlands in the ecology of migrant birds is poorly known.
- 3) Limited information is available for raptor species and game birds.
- 4) There is little information on habitat requirements and ecology of the species of the largest order, Passeriformes.

4.4 Reptiles

- 1) Apart from crocodiles, almost nothing is known of the status, macro distribution, ecology and habitat requirements of reptiles of the Okavango Delta region.
- 2) Very few data have been collected on the habitat requirements of reptiles in the region (other than the crocodile).
- 3) Current population estimates and dynamics information for crocodiles, including hatchling survival rates, are lacking.
- 4) Sustainable quotas for crocodile egg collection have not been determined.
- 5) The role of crocodiles in fish population ecology requires further investigation.
- 6) The current effects of human and domestic animal disturbance on crocodile nesting and reproductive success are not well known.

4.5 Amphibians

- 1) Almost nothing is known of the status, macro distribution, ecology and habitat requirements of amphibians of the Okavango Delta region.
- 2) No information is available on the microhabitat requirements of the different taxa which might explain their apparent uneven distribution (q.v. CSIR/WTC, 1997, Appendix H).
- 3) Though some specimens were collected in a limited number of surveys, very little is known of the impacts of large-scale insecticide spraying programmes on amphibians in the Okavango Delta.

4.6 Terrestrial Invertebrates

- 1) Apart from the tsetse fly, little is known of the status of terrestrial invertebrate populations of the Okavango Delta region.
- 2) Monitoring of tsetse fly control operations has been inadequate.
- 3) Little research has been conducted on the ecology and habitat requirements of terrestrial invertebrate fauna in the Okavango Delta, or elsewhere in Botswana.

4.7 Aquatic Invertebrates

- 1) No detailed systematic surveys of the aquatic invertebrate fauna of the Okavango Delta region appear to have been undertaken.
- 2) Very little research has been done on the ecology and habitat requirements of aquatic invertebrates in the Delta, or elsewhere in Botswana.

4.8 Water-borne Disease Vectors

- 1) Few data are available on the ecology and changes in distribution of the snail hosts of Schistosomes, and of trends in the incidence of schistosomiasis amongst residents of remote settlements of the study area.
- 2) Little is known of the distribution of breeding sites, and nothing is known of breeding patterns and potential resistance to insecticides of the malarial mosquitoes of the Okavango Delta region. Modern electrophoretic techniques have not been used to study this population.

5. FURTHER STUDIES REQUIRED

5.1 Mammals

- 1) Systematic aerial monitoring of large mammal distribution and population estimates should continue to be conducted annually (seasonally, if possible). Areas covered and intensity should be based on local conditions, and especially flood regimes and rainfall.
- 2) Systematic survey flights covering selected habitats (e.g. perennial and seasonal swamp floodplain ecotones) should be conducted at higher intensity during transitional phases in the annual flood regime.
- 3) Stratified random aerial census surveys of important species should be flown annually with distribution linked to habitat type occupation.
- 4) Cryptic species (mainly large predators such as lion, leopard, cheetah, wild dog, hyena, etc.) population estimates, habitat preference and ranges, breeding and behaviour information are required.
- 5) Key indicator, or vulnerable species and their habitats require monitoring. These species include the large predators, tsessebe, sitatunga, impala, giraffe, warthog, roan and sable antelope and waterbuck (ORC/UB have initiated studies on impala and warthog).
- 6) Species causing significant changes to vegetation (e.g. elephant impacts on riparian forest, hippopotamus grazing impacts and channel alteration, impala and warthog grazing impacts) should receive high research priority. Baseline data on elephant impacts should be collected immediately.
- 7) Floodplain ecotone inter-specific herbivore competition studies are required to better understand population dynamics in relation to limiting dry season floodplain (sedge community) grazing.
- 8) Limits of acceptable change (LACs) need to be determined for the habitat types affected by large herbivores, especially elephant in riparian woodlands.
- 9) Impacts on wildlife species and populations of visitor (tourist) densities and use of the Moremi Game reserve and the surrounding CHA's should be monitored as described by Ecosurv (1996).

5.2 Fish and Fisheries

- 1) Implementation of an integrated fisheries research programme and management strategy is urgently required (MoA Fisheries Unit).

- 2) A long-term monitoring programme is required to determine fish population dynamics, primary causes for changes in populations and important habitats.
- 3) A detailed survey of current traditional, commercial and recreational fishing activities is required. Harvesting rates, impacts on fish stocks, the interrelationships between different types of use, the degree of subsistence dependence and factors limiting use must be determined for management planning.
- 4) Fish farming activities should be assessed as a potential means of reducing pressure on wild fish stocks and increasing revenues and employment opportunities.
- 5) Further research on fish populations use of habitats, particularly of the Boro floodplain in relation to breeding and nursery habitats, and flow and depth requirements for sensitive species in different habitat types is required (IUCN, 1993).
- 6) Further monitoring of the effects of tsetse fly spraying activities on fish species and populations in various habitats is needed.

Hydrobiological and Limnological Studies

- 1) A complete In-stream Flow Requirement Study should be conducted for the Okavango system (CSIR/WTC, 1997).
- 2) A thorough hydrobiological and limnological investigation of the perennial swamp is needed. Attention should be focused on processes such as primary production, nitrogen fixation, decomposition and peat formation, and on the component phytoplankton, periphyton, algal and zooplankton communities, benthic fauna, bacteria and fungi, and the relationships between these. (Research on plankton has recently been initiated as part of a floodplain ecology study being co-ordinated by the Okavango Research Centre).

5.3 Birds

- 1) Population status surveys, ecological studies and monitoring of reproductive success are required for the slaty egret, pink-backed pelican, wattled crane, marabou stork, Pel's fishing owl, African skimmer and any other key species (a waterbirds survey is to be initiated under DWNP).
- 2) Monitoring the status of heronries and the potential impacts of tourist activities on occupancy and reproductive rates should be a research priority.
- 3) Management-orientated studies of the game bird species are required with a view to suggesting hunting seasons and updating quotas and bag limits consonant with species numbers and biology (SMEC/KCS, 1989).

- 4) An ecological study of the importance of Panhandle relict forests to bird populations would be of great value.

5.4 Reptiles

- 1) Macro distribution of reptile species should be assessed along fixed transects and by sampling populations using pitfall traps and drift fences (CSIR/WTC, 1997).
- 2) Monitoring at intervals using these techniques would provide indications of reptile species' status, population trends and habitat changes.
- 3) A management-orientated census survey of crocodiles and regular monitoring of active nests is required, with a view to updating quotas for egg collection consonant with population numbers and biology.
- 4) A radiotelemetric study of dispersal movements of crocodile hatchlings and juveniles, and of annual movements of females to Panhandle nesting sites should be conducted to gain information on habitat preferences and requirements.
- 5) Movements of sub-adult crocodiles released from captive populations for restocking should also be monitored.
- 6) An assessment of crocodile nesting success elsewhere in the Delta under current conditions should be carried out.
- 7) With four species of terrapin occurring in the Delta, it would be useful to know more about distribution, feeding, breeding and habitat requirements of these animals, especially in areas of sympatry (SMEC/KCS, 1989).

5.5 Amphibians

- 1) Macro distribution of amphibian species should be assessed along fixed transects and by sampling populations using pitfall traps and drift fences (CSIR/WTC, 1997).
- 2) Monitoring at intervals using these techniques would provide indications of amphibian species' status, population trends and habitat changes (particularly for sensitive frog species).
- 3) An investigation of the microhabitat requirements of the different taxa would help to explain their apparent uneven distribution within habitat types (q.v. CSIR/WTC, 1997, Appendix H).
- 4) A study of the breeding biology of frogs of the Okavango Delta should compare timing of breeding with the progress of flood regimes and with the onset of the rains.
- 5) Further monitoring of the effects of tsetse fly spraying activities on amphibian species and

populations in various habitats should be conducted.

5.6 Terrestrial Invertebrates

- 1) A general survey of the status and distribution of terrestrial invertebrate groups of the Okavango Delta region is required.
- 2) Monitoring of impacts of tsetse fly control operations and the distribution of tsetse fly using baited traps should be expanded.
- 3) Studies on the role of termites in energy cycling and ecosystem functioning should continue under the supervision of the ORC.

5.7 Aquatic Invertebrates

- 1) Better knowledge of the distributions of the major groups of aquatic invertebrates throughout the system is required. An extensive baseline survey should be followed up by regular sampling at fixed sites to monitor changes in population structure as an indicator of ecosystem functioning.
- 2) A thorough hydrobiological and limnological investigation of the perennial swamp is needed. (Plankton studies have recently been initiated as part of a floodplain ecology study being co-ordinated by the Okavango Research Centre).

5.8 Water-borne Disease Vectors

Surveys of snail populations and of breeding sites of mosquitoes around settlements and tourist camps should be conducted, and a monitoring programme established by the Ministry of Health.

The increasing incidences of chloroquine-resistant and malignant falciparum cerebral malaria provide a strong incentive to carry out these surveys and regular monitoring exercises.

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A basic management and development plan for Chobe National Park and Moremi Game Reserve which included over 100 recommendations, many of which were made in subsequent plans which have been partially implemented. Key recommendations included: revisions to the Fauna Conservation Act, increased numbers of better trained DWNP staff, land use zoning within protected areas, improved resource management planning and capacity, pilot culling of elephant populations, better control of tourism development, privatisation of tourist facilities provision, improved administration of hunting, licensing and law enforcement, among many others.

Relevant (comparison with other plans, identifying fundamental management problems existing in 1985)

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DWNP's elephant management policy in 1980 proposed reduction in elephant quotas on account of the population being over-harvested (based on age structure of the harvest at the time). [This was the only active management prior to setting limited safari hunting quotas for elephant in CMUs in 1995].

Not relevant to current situation.

Location: Department of Wildlife and National Parks, Gaborone.

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Popular article briefly discusses potential costs, benefits and some environmental impacts of the eastern national water carrier project (including the proposed Okavango-Grootfontein link).

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The paper summarises some findings of ecological studies carried out as part of the 1977 UNDP/FAO project: Investigation of the Okavango Delta as a Primary Water Resource for Botswana. (qv. UNDP, 1977: Technical Report AG:DP/BOT/71/506). Relevant to monitoring changing conditions.

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Findings of a year long study on Acacia woodland ecology and elephant - vegetation interactions in northern Botswana (mainly at Savuti in Chobe National Park, with comparative surveys in Ngamiland).

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Describes vegetation types and their annual associations in 1800 km², about 11% of the Delta area. Fairly large fluctuations occurred between peak flood and absolute dry conditions in the order of 160cm.
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Biggs, R. 1979. The ecology of Chief's Island and the adjacent flood plains of the Okavango Delta, Botswana. MSc thesis, University of Pretoria, RSA.

Historical settlement, use and manipulation of the study area are outlined. Solid and surficial geology, geomorphology, seismicity, soils, climate, vegetation types, wildlife resources, their biology, use of plant communities in relation to flood regimes, seasonal movements are all described, and seasonal population estimates provided. Initiating agents affecting the hydrology of the Delta, water flows and levels are proposed. Long-term stability of the system cannot be accurately predicted, thus major channel improvements, building and construction of internal delta dams are discarded as options since they could have major negative impacts on ecological functioning. Restoration of flow to Lake Ngami is urged. Management and land use recommendations for the entire Delta region (low-impact forms of tourism) are also included.

Relevant (ecology, history)

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Summary findings of a two year study carried out as part of the UNDP/FAO investigation of the Okavango Delta as a primary water resource for Botswana. Limited movements data was collected with census and distribution surveys, aerial and ground nesting sites surveys, location and sampling for clutch size, chronology of hatching in relation to flood water levels. Feeding habits were determined from sampling stomach contents of 204 crocodiles in seven age/size classes.

Relevant (crocodile ecology)

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The report includes regional population estimates and national distribution and density maps (based on 10x10 km grid squares), for 28 large wild animal species and five domestic livestock species enumerated during seasonal aerial census surveys conducted for the DWNP (1989-1991). Population estimates are provided for major species by (DWNP) standardised enumeration blocks, for CHAs and for protected and unprotected areas. Survey methodology and conditions are discussed and flight data are provided for each survey. GIS and ASCI computer data bases for the aerial surveys are available.

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The report describes initial measures taken for the conservation of the Kalahari ecosystem, including development of ground water supplies for wildlife in the Central Kalahari Game Reserve. Use of existing water supplies is evaluated, habitat requirements for water-dependent species and migration patterns are described, and proposals made for the provision of additional ground water supplies for wildebeest in the CKGR as a substitute for traditional water sources used during drought periods (Lake Ngami and the Boteti River).

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Symposium proceedings focused mainly on game issues surrounding photographic game-viewing tourism in northern Botswana and especially in the Okavango Delta region. Presenters also promoted safari hunting tourism in northern

Botswana and on freehold lands. The need for greater participation in the tourism industry by the private sector, and especially by Botswana entrepreneurs was a prevalent issue. Disagreement and mistrust between the principal parties (Central Government, District Councils and tour operators) was a major concern and prompted the adoption of a motion to establish a forum whereby an atmosphere of trust and co-operation could be created.
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Location: Animal Behaviour (Ethological Journal) []

Busse, C.D., 1978-79. The ecology of Chacma baboons *Papio ursinus* living in the Okavango Delta, Botswana. Quarterly Research and Progress Reports. Univ. of California, USA.
Habituation of three baboon groups totalling 204 individuals allowed detailed ethological studies, including food intake and nutrition, and its effects on group size, structure and reproductive rates. Data on predation on and by baboons were

also collected, as was information on the role of baboons in tree and fruit seeds dispersal. Detailed information is to be collected on all aspects of the ecology of Okavango Delta baboons. Records of other game animal movements on the Chief's Island floodplains was also regularly included.

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Location: Department of Wildlife and National Parks, Gaborone.

Busse, C.D., 1980. Leopard and lion predation upon Chacma baboons in the Moremi Game Reserve. Botswana Notes and Records, 12:15-21. Botswana Society, Gaborone.

Fourteen attacks on baboons, including five kills, were observed in a study area occupied by two baboon troops in Moremi Game Reserve during a 30 month period. Predation by lions and leopards was determined to be the main cause of adult mortality of baboons living in the floodplains near Chief's Island.

Location: Botswana Society, National Museum and National Archives, Gaborone.

Busse, C.D., 1981. Infanticide and parental care by male Chacma baboons, *Papio ursinus*. Ph.D. Thesis. Univ. of California, USA.

Male baboons sometimes carry their offspring and protect them during confrontations with higher ranking immigrant males which will often kill the infants, given an opportunity. Infant baboons re-introduced into groups following handling and care by humans are also killed by dominant males.

Location: University of California, Davis, California, USA []

Butynski, T. 1973. Botswana wildlife (hunting licensing and returns) statistics (1968-1973). Department of Wildlife and National Parks, Gaborone.

Provides a breakdown of returns for 1968-1973, including hunting licences sold, returns (and apparent success rates) and incomes for most CHA's, including those in the Okavango Delta region.

Relevant (Comparative / historical)

Location: Department of Wildlife and National Parks, Gaborone.

Calef, G.W. 1988. Aerial census of large mammals in northern Botswana 1988. Department of Wildlife and National Parks, Gaborone. 14 pp.

The report discusses findings of an aerial survey conducted at the end of the dry season over northern Botswana (north of 21° S. lat.). Wildlife species distribution and densities are mapped on a 100km² grid. Transects were flown north-south. Population estimates are given for major species. Computerised data base held by DWNP [?]

Relevant (wildlife population status / trends)

Location: Kalahari Conservation Society Library, Gaborone.

Calef G.W. 1987. Mapping the Movements of Botswana's Elephants. Kalahari Conservation Society Newsletter 16, 3 pp.

Movements of elephant between the Okavango, Chobe, Kwando and Linyanti river systems and wet season feeding

areas are described, based on two years of radio-collar tracking data collection (1986-87).

Relevant (comparative movements data)

Location: Kalahari Conservation Society Library, Gaborone.

Campbell, A. 1976. Traditional utilisation of the Okavango Delta. Symposium on the Okavango Delta: 163-173. Botswana Society, Gaborone.
[ECOSURV ANNOTATION]
Location: Botswana Society, National Museum and National Archives, Gaborone.

Campbell A. C. & von Richter, 1976. The Okavango Delta and tourism. In: Symposium on the Okavango Delta, pp 245-247. Botswana Society, Gaborone.

A brief discussion paper which notes that Government should not look on tourism as a revenue-earner which will show a cash profit on investment, but rather as an industry providing employment and generating other service industries.

Location: Botswana Society, National Museum and National Archives, Gaborone.

Carmichael, I.H. & E. Hobday, 1975. Blood parasites of some wild Bovidae in Botswana. Onderstepoort J. Vet. Res. 42(2):55-62.

Analyses of blood smears from 282 wild Bovidae from Ngamiland revealed anaplasma incidence in buffalo of 28,4%. Two types were found in impala. Incidence of trypanosome infections was 2,5% in buffalo and 4,3% in other species (impala, wildebeest, tsessebe, lechwe, kudu and sable antelope). Levels of blood parasites were generally lower than those for other southern and east African wild bovid populations.

Location: Onderstepoort Journal of Veterinary Research, RSA []

Carmichael, I. 1976. Ticks from the African buffalo (*Synceus caffèr*) in Ngamiland, Botswana. Onderstepoort J. Vet. Res. 43(3):27-30.

In November 1972, 93% of buffalo from three areas in Ngamiland were found to be infested with ticks (ave. number of ticks per animal was low at 8.6).

Location: Onderstepoort Journal of Veterinary Research, RSA []

Carmichael, I.H. *et al* 1978. Schistosomes from wild ruminants in Botswana. Onderstepoort J. Vet. Res. 44(2):12-22.

Schistosoma spp. were recovered from buffalo, lechwe, tsessebe, sable antelope, sitatunga, impala, kudu and reedbuck taken by safari hunters and for sampling in the Okavango Delta region during 1977-78.

Location: Onderstepoort Journal of Veterinary Research, RSA []

Chabwela, H. 1993. Southern African Wetlands Conservation Programme (draft), Vol. 2. World Conservation Union, Harare, Zimbabwe. 233 pp.

A general regional wetlands conservation programme is outlined which includes the wetlands of northern Botswana (Okavango river and delta, Chobe, Kwando and Linyanti river systems).

Relevant (regional)

Location: Department of Wildlife and National Parks, Gaborone.

Child, G. 1970. Wildlife utilisation and management in Botswana. *Biol. Cons.*, 3(1):18-22.

Measures being taken by the government in 1970 to promote the sustained use of wildlife through management, including establishment of protected areas, promoting tourist hunting and controlling subsistence and commercial hunting, are mentioned. The need for research and extension efforts to ensure long-term maintenance of wildlife resources is stressed.

Location: Biological Conservation and Department of Wildlife and National Parks, Gaborone.

Child, G. 1972a. Observations of a wildebeest die-off in Botswana. *Arnoldia* 5(13)1-3.

A survey of mass mortality of wildebeest in the vicinity of Lake Xau in Central District suggested differential mortality rates favouring survival of young breeding females that would have enhanced the population's rate of recovery once environmental conditions improved.

Location: Arnoldia, National Museums of Zimbabwe and Department of Wildlife and National Parks, Gaborone.

Child, G. 1972b. A survey of mixed heronries in the Okavango Delta, Botswana. *Ostrich*, 43:60-62.

Report of a survey of two mixed breeding colonies at Xaxanaxa and Xadikwe in the Moremi Wildlife Reserve during August 1970. Marabou and yellow-billed storks, purple and rufous-bellied herons and darters were enumerated.

Location: *Ostrich Ornithological Journal*

Child, G. 1972c. Water and its role in nature conservation and wildlife management in Botswana. *Botswana Notes and Records*, 4:253-256. Botswana Society, Gaborone.

Long and short term changes in the extent, duration and timing of annual flooding and consequent changes in dependent habitats affect productivity of the Okavango Delta. Negative impacts of flood regime manipulation on productivity are briefly discussed, and the need for international cooperation in use of water supplies and effects on wildlife conservation is stressed.

Location: Botswana Society, National Museum and National Archives, Gaborone.

Child, G. *et al* 1970. Tsetse control as a measure of large mammal population trends in the Okavango Delta, Botswana. *Mammalia*, 34: 34-75.

The use and limitations of hunting returns from tsetse-fly control hunting along the Maun Front area of the Delta over 23 years are assessed. Returns provided a sound basis for interpreting broad population trends, distribution, seasonal movements and reproductive data for several species. It was concluded that hunting programme was not achieving its objectives as several species were maintaining nearly static population levels.

Relevant (historical)

Location: *Mammalia*, *Journal of Mammalogy* []

Child, G. *Et al* 1972. Observations on the biology of the Tsessebe, *Damaliscus lunatus lunatus*, in northern Botswana. *Mammalia* 36:343-387.

Observations carried out during 1965-1970, mainly in the Okavango Delta and Chobe National Park. Tsessebe grazed almost exclusively and favoured ecotones between grasslands (or river floodplains) and woodlands. Seasonal movements were influenced mainly by availability of surface water while daily activity depended mainly on quality of grazing.

Location: *Mammalia*, *Journal of Mammalogy* []

Cholonoky B. 1966. Die diatomeen im unterlaufe des Okawango -Flusses. *Nova Hedwigia*, 21:102 pp.

Not seen.

Location: Nova Hedwigia

Claus, B. 1972. Pelicans at Lake Ngami. *Ostrich*, 43:176.

The note documents breeding of white pelicans (*Pelecanus onocrotalus*) at Lake Ngami in June 1971. Apparently there were no previous records of breeding at the lake since that made by Anderson (Notes on the Birds of Damaraland) in 1872.

Location: *Ostrich Ornithological Journal*.

Collar, N.J. & S. Stuart, 1985. Threatened birds of Africa and related islands. ICBP and IUCN, Cambridge, UK. 761 pp.

[ECOSURV ANNOTATION]

Relevant (regional / conservation)

Location: Department of Wildlife and National Parks, Gaborone.

Collins, F. and N Besansky, 1994. Vector biology and the control of malaria in Africa. *Science*, 264: 1874-1875.

Not seen.

Location: *Science* (journal)

Cronberg, G. *et al.* 1995a. Hydrobiological studies of the Okavango Delta and the Kwando/Linyanti/Chobe River, Botswana. I: Surface Water Quality Analysis. Botswana Notes and Records, Vol. 27:151-226. Botswana Society, Gaborone.

Water chemistry, bacteria assemblages and phytoplankton communities are compared for different sections of each river system (based on a limited number of samples from the Kwando/Linyanti/Chobe system). Data were considered too limited to allow an evaluation of water quality. Okavango delta waters varied considerably from those of the Kwando/Linyanti system. Both were found to be very nutrient-poor. More detailed studies are recommended based on spatial heterogeneity of these systems.

Relevant (esp. since hydrobiological data base is limited)

Location: Botswana Society, National Museum and National Archives, Gaborone.

Cumming, D. and R. Taylor, 1989. Identification of wildlife utilisation pilot projects. KCS and Department of Wildlife and National Parks, Gaborone.

Identification of wildlife utilisation pilot projects was carried out in WMAs throughout the country. Two hunting and tourism development projects were proposed for the communities of the Okavango and Kwando WMAs.

Location: KCS Library and Department of Wildlife and National Parks, Gaborone.

Cronberg, G. *Et al* 1995b. Major ion chemistry, plankton and bacterial assemblages in the Jao/Boro River, Okavango Delta, Botswana: The Swamps and Floodplains. *Arch. Hydrobiology*.

Relevant (esp. since hydrobiological data base is limited)

Location: Archives of Hydrobiology []

Davies J.E. 1980. The effects of aerial spraying with Decamethrin (NRDC 161) on non-target tree canopy and grassland Arthropods. Unpublished Report, Department of Tsetse Fly Control, Maun, Botswana.

[ECOSURV LIBRARY]

Location: Department of Tsetse Fly Control, Maun.

Davies J.E. 1981. The history of tsetse fly control in Botswana. Department of Tsetse Fly Control, Veterinary Services, Gaborone. 23 pp.

The report describes early records of tsetse fly distribution (1850-1930) the first post-rinderpest control attempts (1930s) involving ring-barking of Acacia trees, bush clearance, fencing and game destruction. Concerted control efforts stopped in 1946 and tsetse fly encroached into most former ranges. Another extensive bush clearing campaign was mounted during 1953-60, and large-scale ground spraying of pesticides using knapsack sprayers was carried out in the Okavango Delta from 1967 to 1980. Aerial spraying experiments were conducted during 1972-3 with the first systematic large-scale aerial spraying campaign launched in 1973 and continuing through 1980. Impacts on fly populations during each campaign are discussed and the few studies (to date of publication) on the effects of the various pesticides on non-target species are briefly mentioned.

Location: Kalahari Conservation Society Library, Gaborone.

Davies, J.E. & J. Bowles 1976. Ecology of the tsetse-fly in the Okavango In: Symposium on the Okavango Delta, 141-152. Botswana Society, Gaborone.

Ecology of the tsetse-fly, including the gradual expansion of the tsetse-fly range in the Delta following the rinderpest epidemic of the late 1890s is described. Habitat changes and preferences affecting ranges, periodic outbreaks and the health-related and economic impacts on human and cattle populations are discussed. The apparent impacts of recent (1976) aerial spraying with pesticides are also summarised.

Relevant (ecology)

Location: Botswana Society, National Museum and National Archives, Gaborone.

Davies, J.E. & J. Bowles 1979. Effect of large scale aerial applications of endosulfan on Tsetse fly, *Glossina morsitans centralis* Machado, in Botswana. COPR miscellaneous report no 45. Ministry of Overseas Development, London. 17 pp.
[ECOSURV]

Relevant (ecology)

Location: Kalahari Conservation Society Library, Gaborone.

Dawson, J.L. & D. Jacka, 1975. Some notes on the water birds of Lake Ngami. Department of Wildlife and National Parks, Gaborone. 19 pp. mimeo.

General discussion and notes on species made from observations between December 1970 until mid-1972 provide information on avifaunal changes accompanying the drying of the lake.

Location: Department of Wildlife and National Parks, Gaborone.

DeGraaf, G., 1981. The rodents of southern Africa. Butterworths Publishers, Pretoria, RSA. 267 pp.

Seventy-three species of rodents occurring south of the Zambezi River are described in terms of taxonomic, physiological characteristics, behaviour, feeding habits, reproduction, etc. Illustrations include colour drawings of each species and photographs of skulls and dentition. Distribution maps for each species and extensive references to regional research and collections are included.

Location: Gabane

DHV, 1980. Countrywide animal and range assessment project. Final Report of DHV Consulting Engineers to Government of Botswana. Department of Wildlife, National Parks and Tourism, Gaborone.

Reports the findings of a two-year project assessing wildlife and range resources of western Botswana at the end of a period of high rainfall and range productivity.

Location: KCS Library and Department of Wildlife and National Parks, Gaborone.

Dibbs, J.L., 1965 Report of fishery development prospects in Bechuanaland. FAO, Rome.
Not seen.
Location: FAO / UNDP Library.

Dop, H., 1985. Environmental impact study: the Thaoge River project - draft project proposal. Department of Water Affairs, MMRWA, Gaborone.
[ECOSURV ANNOTATION]
Location: Department of Water Affairs, MMRWA.

Douthwaite R.J. *et.al.*, 1981. The environmental impact of aerosols of endosulfan applied for Tsetse fly control in the Okavango Delta, Botswana. Final Report of the Endosulfan Monitoring Project. Overseas Development Administration, London. 141 pp.

Sample sites for the study were located on the Okavango River, in the Okavango Delta, on the Kwando River front and the western Linyanti swamp. Endosulfan residues of 4 ppb or less persisted for 5 to 20 days in swamp water depending on depth. Residue levels were usually below 0.2 ppm in fish predators and 0.1 ppm in insectivorous birds. No accumulation of residues in the food chain was reported (but these findings have been contradicted in more recent studies). Endosulfan was found to be highly toxic to fish species, with tissue damage to livers and brains of fish collected from all areas sprayed at all endosulfan concentration levels. Impacts on most other vertebrate species were not assessed in detail, though few impacts on piscivorous and insectivorous birds were detected.

Relevant (ecology / comparative study)

Location: Kalahari Conservation Society Library, Gaborone.

Dowsett, R., 1976 Report of the Ornithological Potential of Botswana's Major Wetlands - Technical Note No. 13, UNDP BOT/71/506. UNDP/FAO/DWA. 18 pp.

The report briefly reviews major wetlands, including the Okavango Delta, the Kwando River and Linyanti swamps, Lake Liambezi and the Chobe River. Waterfowl populations are generally described and some ringing recovery records are given.

Location: Department of Wildlife and National Parks, Gaborone.

Dowsett, R., 1981. Breeding and other observations on the slaty egret *Egretta vinaceigula*. Bulletin of British Ornithologists Club, 101: 323-327.

Not seen.

Location: British Ornithologists Club

DWNP, 1991. The Conservation and Management of Elephants in Botswana. Department of Wildlife and National Parks, Gaborone. 13 pp.

The policy document summarises one of DWNP's elephant management strategies including possible annual culling to reduce population levels or to reduce the rate of population increase.

Location: Kalahari Conservation Society Library, Gaborone.

DWNP, 1993. Aerial census of animals in northern Botswana (Dry Season). Research Division, Department of Wildlife and National Parks, Gaborone.

Population estimates, distribution and density maps (based on 10x10 km grid squares), are provided for 25 large wild animal species and four domestic livestock species from dry season aerial census surveys conducted by DWNP. (A wet

season survey was also conducted during 1993, but data from the survey were found unsatisfactory for analysis.) Population estimates are based on standardised enumeration blocks (DWNP) combining CHAs, and separately for protected areas. GIS and ASCI computer data bases for the aerial survey data are available.

Relevant (wildlife population status / trends)

Location: Department of Wildlife and National Parks, Gaborone.

DWNP, 1994. Status of selected wildlife resources in Botswana and recommendations for conservation actions. Research Division, Department of Wildlife and National Parks, Gaborone.

The report describes the current (1994) status of selected wildlife species populations of the southwestern and northern wildlife systems in Botswana and includes recommendations for conservation actions required for the maintenance of each system.

Location: Research Division, Department of Wildlife and National Parks, Gaborone.

DWNP, 1995. Aerial census of large wild and domestic animals in Botswana: wet and dry season surveys. Research Division, Department of Wildlife and National Parks, Gaborone.

Population estimates, distribution and density maps (based on 10x10 km grid squares), are provided for 28 large wild animal species and five domestic livestock species from wet and dry season aerial census surveys conducted by DWNP. Population estimates are based on standardised enumeration blocks (DWNP) combining CHA's, and separately for protected areas. GIS and ASCI computer data bases for the aerial survey data are available.

Relevant (wildlife population status / trends)

Location: Department of Wildlife and National Parks, Gaborone.

DWNP, 1996. Aerial census of large wild and domestic animals in Botswana: dry season survey. Research Division, Department of Wildlife and National Parks, Gaborone.

Population estimates, distribution and density maps (based on 10x10 km grid squares), are provided for 28 large wild animal species and five domestic livestock species from a dry season aerial census survey conducted by DWNP. Population estimates are based on standardised enumeration blocks (DWNP) combining CHA's, and separately for protected areas. GIS and ASCI computer data bases for the aerial survey data are available.

Relevant (wildlife population status / trends)

Location: Department of Wildlife and National Parks, Gaborone. Botswana Range Inventory and Monitoring Project GIS database, MOA, Gaborone.

DWNP, 1997. Aerial census of large wild and domestic animals in Ngamiland, March 1997. Research Division, Department of Wildlife and National Parks, Gaborone.

Population estimates, distribution and densities (based on 10x10 km grid squares), were recorded for 28 large wild animal species and five domestic livestock species during a survey conducted by DWNP / MOA following the CBPP control programme. The computer data base for the survey has not been set up to produce distribution maps.

Relevant (wildlife population status / trends)

Location: Department of Wildlife and National Parks and Department of Animal Health and Production (MOA), Gaborone.

Ecosurv, 1994. Natural resource utilisation: A compilation of documented natural resource use in the multiple use Controlled Hunting Areas of the Okavango and Kwando Wildlife Management Areas. for Tawana Land Board & Department of Wildlife and National Parks. 122 pp + 17 A3 maps.

The report outlines previously documented traditional use of natural resources in seven CHAs designated for multiple-

use in the Okavango and Kwando WMAs. Discussion of issues surrounding continued use of natural resources under the proposed leasehold system for these areas is also included. Location and settlement maps are provided indicating main uses and users of each area. Vegetation maps are also provided. All maps were produced using PC ArcInfo format with computer data bases held by the clients.

Relevant (natural resources, utilisation, environmental and socio-economic and impacts)

Location: Tawana Land Board, Maun and Department of Wildlife and National Parks, Gaborone.

Ecosurv, 1996. Management plans for 8 commercial photographic safari concession areas for the Tawana and Chobe District Land Boards. 148 pp + 16 x A3 maps.

The report provides the background to management plans for seven gazetted CHAs surrounding the Okavango Delta (Okavango and Kwando WMAs) and one CHA bordering the Chobe National Park in Chobe District (Nunga WMA). All eight CHAs have been zoned as commercial photographic tourism areas. The management plans, which describe land use, natural resource bases, zoning and use proposals and carrying capacities, etc., are intended to guide the development and use of the CHAs by selected operators. Maps produced for each area depict land systems (with vegetation associations), proposed management zones, and in some cases, proposed infrastructure development siting. All maps were produced using PC ArcInfo format with computer data bases held by the clients.

Relevant (natural resources, utilisation, environmental and socio-economic and impacts)

Location: Tawana Land Board, Maun, Chobe District Land Board, Kasane, Department of Lands and Department of Wildlife and National Parks.

Ecosurv, 1997a. Environmental assessment of a project for community development of Wildlife Management Areas, Botswana. Social and ecological status of controlled hunting areas for community use. Report for IFAD. 191 pp + 36 maps.

The report describes the current status of natural resources, their use and users, assesses the current socio-economic and environmental conditions and the potential for development of community-based natural resource management projects in 41 CHA's throughout Botswana that have been zoned for community use (Community Management Units, or CMUs). Seventeen of the CMUs are in Ngamiland and ten border the Okavango Delta. Base maps were produced for each CMU depicting land use and tenure, physical features, settlements, roads and tracks. All maps were produced using PC ArcInfo format with computer data bases held by the clients.

Relevant (natural resources, utilisation, environmental and socio-economic and impacts)

Location: Department of Wildlife and National Parks, Gaborone and IFAD, Rome.

Ecosurv, 1997b. Strategic Assessment of South Western Wildlife Systems. Report for IFAD.

Relevant in terms of re-establishing access to the Okavango - Boteti Rivers system for migratory Kalahari ungulate populations.

Location: Department of Wildlife and National Parks, Gaborone and IFAD, Rome.

Elder, W.H. 1970. Morphometry of elephant tusks. *Zoo. Africana*, 5(1):143-159.

Analysis of tusk shape and size proved more reliable than other methods in determining sex of elephants from the northern Botswana population. Tusk weights are usually underestimated in the field since elephants of this population have deeper rooted tusks of greater diameter than those from other populations studied.

Location: Department of Wildlife and National Parks, Gaborone.

ECILWM, 1995. Wildlife impacts in northern Botswana: Modelling vegetation and land use patterns and changes using remote sensing and collateral data. European Commission & Institute for Land and Water Management. 117 pp + 46 maps and Landsat images.

The study produced a vegetation associations map for western Chobe National Park and the Chobe Enclave using

Landsat TM images and collateral data. Zones vulnerable to vegetation deterioration were delineated and factors contributing to vegetation changes were identified (including use by elephants, human activity and climate). Fire was found to have the greatest spatial impact on vegetation and monitoring of fire impacts using NOAA/AVHRR was recommended.

Location: European Commission, Gaborone.

Falconer, J. 1971. Relationships between wild and domestic animals in the control of foot and mouth disease in Botswana. In: Botswana Notes and Records Special Edition No. 1: 153-156. Botswana Society, Gaborone.

The suspected role of buffalo in perpetuating foot and mouth disease and causing outbreaks in northern Botswana is discussed. Construction of more extensive cordon fences for disease control and use of trivalent (SAT 1, 2 and 3) vaccines are proposed.

Location: Botswana Society, National Museum and National Archives, Gaborone.

FGU-Kronberg, 1987. Review of the aerial wildlife monitoring programme of the Department of Wildlife and National Parks.

Evaluation of recent aerial surveys methodology and data, with recommendations for establishment of a permanent Aerial Surveys Unit within DWNP to provide training of personnel, consistency in data collection and improved data quality.

Location: Department of Wildlife and National Parks, Gaborone.

FGU-Kronberg, 1988. Review of wildlife utilisation in Botswana and proposals for the development of projects in this field. Report to the Department of Wildlife and National Parks, Gaborone. 187 pp + Map1.

Physical, natural, social and economic resources of Botswana are described to provide background information. Wildlife utilisation is reviewed, opportunities for its development are identified and proposals for projects and programmes in this field are formulated and presented. Main recommendations emphasise the need to stimulate private sector investment in wildlife industries and to minimise taxation and bureaucratic involvement to enhance the potential for growth. The Okavango Delta Region is earmarked for highest potential income generation through game-viewing and safari hunting tourism. A proposed wildlife utilisation land use zoning map (1:1,500,000 scale) is included.

Location: Department of Wildlife and National Parks, Gaborone.

FGU-Kronberg, 1988. Wildlife, tourism and the environment. Department of Wildlife and National Parks, Gaborone.

Wildlife-related tourism development proposals are detailed.

Location: Department of Wildlife and National Parks, Gaborone.

Fleming M. 1976. Present wildlife utilisation in the Okavango Delta. In: Symposium on the Okavango Delta, 195-222. Botswana Society, Gaborone.

The report provides a detailed breakdown of wildlife statistics and the economic return from wildlife in the Delta between 1967 and 1975.

Location: Botswana Society, National Museum and National Archives, Gaborone.

Forchhammer, P. 1986. Annotated list of Cerambycidae, subfamily Lamiinae collected in Tanzania, Zambia and Botswana 1969-80 with description of 86 new taxa. - *Natura Jutlandica* 22(1):1-72.

Not seen.
Location: Botswana National Archives, Gaborone.
Fothergill, A. 1983. A study of the mixed 'heronries' found at Cakanaca, Gcodikwe and Gcobega lagoons. Babbler 5: 8-14.

Article describes species composition and inter-specific competition for nesting sites, food resources and reproductive success.

Location: Botswana Bird Club, Gaborone.

Fox, P.J. 1976. Preliminary observations of fish communities of the Okavango Delta. In: Symposium on the Okavango Delta, 125-130. Botswana Society, Gaborone.

The article describes Okavango fish communities as a whole and discusses mechanisms important to determining fish stocks. Reasons for lower than expected fish productivity in the Okavango Delta are discussed, including nutrient deficient water inflows, habitat unpredictability, predator-prey imbalances, and delayed flood cycles in which the flood is largely withheld until winter, after the optimum season for fish growth.

Location: Botswana Society, National Museum and National Archives, Gaborone.

Fox, P.J. and P. Mathiessen, 1982. Acute toxicity to fish of low dose aerosol applications of endosulphan to control tsetse fly in the Okavango delta. Environ. Pollut. 27(2):129-142.

Not seen.

Location: Environmental Pollution

Fraser, W. 1970. Lake Ngami Avian Surveys. First and second reports. Department of Wildlife and National Parks, Botswana.

Two reports describe avian surveys of Lake Ngami during 1969 when water levels in the lake were exceptionally high. Species collected and identified are listed and nesting colony populations of waterfowl were estimated.

Location: Department of Wildlife and National Parks, Gaborone.

Fraser, W. 1971a. Breeding herons and storks in Botswana. Ostrich, 42:123-127.

Observations are recorded from heronries near Xaxanaxa camp on the Khwae river in 1971. Colonies of nesting purple heron (*Ardea purpurea*), wood stork (*Ibis ibis*) and marabou stork (*Leptoptilos crumeniferus*) were located. Data on breeding, nesting and feeding behaviour, predation and vegetation types were collected.

Location: Ostrich Ornithological Journal.

Fraser, W. 1971b. Birds at Lake Ngami, Botswana. Ostrich, 42:128-130.

The article describes findings of five trips to Lake Ngami during 1969 when water levels were exceptionally high, with extensive areas of bush above the lake bed being flooded. Twenty three species are described in detail, including some common palaeartic migrants.

Location: Ostrich Ornithological Journal.

Fraser, W. 1971c. Birds recorded in the Moremi Wildlife Reserve, Botswana. South African Avifauna Series, 75: 1-43.

Location: South African Avifauna Series.

Freeman, J., 1993. Trends in large mammal populations in northern Botswana for the period 1989-1992 using aerial surveys. Department of Wildlife and National Parks, Botswana.

The report documents declines in populations of all large wild animal species in northern Botswana, with the notable exception of elephant, based on aerial survey result from 1989-92.

Location: Department of Wildlife and National Parks, Gaborone.

Games, I. 1980. Aspects of the biology of Sitatunga (*Tragelaphus spekei selousi*) in the Okavango Delta, Botswana. Progress reports to the Department of Wildlife and National Parks.

Observations on group structure, activity patterns and feeding records are presented. Abiotic environment, vegetation and habitat surveys, seasonal movements, habitat use and distribution, interspecies relationships and mortality rates are described.

Location: Department of Wildlife and National Parks, Gaborone.

Games, I. 1981. Report on the effects of a Deltamethrin and Endosulphan mixture on non-target arthropods during the 1981 tsetse spraying programme. Tsetse Fly Control Division, DAHP. [ECOSURV]

Location: Tsetse Fly Control Division, DAHP.

Games, I. 1982a. Report on some effects on non target organisms during the spraying for tsetse fly in the Okavango Delta, 1982. Tsetse Fly Control Division, DAHP. [ECOSURV LIBRARY]

Location: Tsetse Fly Control Division, DAHP.

Games, I. 1982b. Guidelines for management of Sitatunga (*Tragelaphus spekei selousi*) in the Okavango Delta. Report to the Department of Wildlife and National Parks. 4 pp. + Map at 1:250 000 scale.

Suggests no increase in hunting quotas, extension of Moremi Game Reserve and further research. Map enclosed shows proposed Moremi Game Reserve boundary extensions.

Location: Department of Wildlife and National Parks, Gaborone [WP/RES 2/18 (10)].

Games, I. 1983a. Observations on the Sitatunga (*Tragelaphus spekei selousi*) in the Okavango Delta of Botswana. Biol. Cons., 27:157-170.

Preliminary findings of the study described below (q.v. Games, 1983b; 1984).

Location: Biological Conservation.

Games, I., 1983b. The Okavango Sitatunga. African Wildlife, 37 (3):96-101.

Ecology of the Okavango sitatunga (*Tragelaphus spekei selousi*) is generally discussed. Reductions in historic ranges during the past 150 years with reductions in the extent of perennial swamp are described. Behaviour was found to be dictated mainly by flood regimes, with seasonal movements limited and influenced mainly by water levels. Sitatunga were recorded grazing and browsing on at least 34 plant species. During period of low water levels (August-February) *Cyperus papyrus* accounts for more than 80% of the diet.

Location: African Wildlife

Games, I. 1984. Feeding and movement patterns of the Okavango Sitatunga. Botswana Notes and Records, 16: 131-137. Botswana Society, Gaborone.

Feeding and movement patterns of the Okavango sitatunga (*Tragelaphus spekei selousi*) are described. The range of sitatunga has shrunk considerably in the region during the past 150 years as the extent of perennial swamp has been reduced. Behaviour is dictated mainly by flood regimes. Seasonal movements are limited and influenced mainly by water levels. Sitatunga are non-selective feeders grazing and browsing on at least 34 plant species. During the period of lowest water levels (August-February) more than 80% of the diet may consist of *Cyperus papyrus*.

Location: Botswana Society, National Museum and National Archives, Gaborone.

Gillies, M. And M. Coetzee, 1987. A supplement to the Anophelinae of Africa south of the Sahara. South African Institute of Medical Research Report No. 55. 143 pp.

Location: South African Institute of Medical Research, Pretoria, RSA.

Gilmore, C. 1979a. Food preferences and trophic relationships of fish from two unenriched Okavango Delta madiba. Botswana Notes and Records, 11:103-106. Botswana Society, Gaborone.

Two unenriched *madiba* at Maphaneng and Mankunyane in the Okavango Delta were sampled to determine feeding habits and trophic levels of 22 fish species. Few species appeared to have fixed diets on a daily or seasonal basis. Non-specialisation exhibited by most Okavango Delta fish species allows for adaptation to often rapidly changing environmental conditions.

Location: Botswana Society, National Museum and National Archives, Gaborone.

Gilmore, C. 1979b. The effects of ULV aerial applications of endosulfan on the feeding habits of *Schilbe mytus* and *Mormyrus lacerda* in the Okavango Delta, 1977. Botswana Notes and Records, 11:107-114. Botswana Society, Gaborone.

Following aerial applications of endosulfan at levels of 50g/Ha, significant changes in feeding habits of *Schilbe mytus* were noted as this mixed-feeder became wholly piscivorous, feeding on smaller fish apparently disabled or killed by endosulfan. A 70% drop in abundance of one insect group (Chironomids) in the diet of *Mormyrus lacerda* had no significant impact on total food consumption. No live fish were recovered from *madiba* sampled following applications of endosulfan at levels of 120g/Ha.

Location: Botswana Society, National Museum and National Archives, Gaborone.

Gilmore, K. 1976. Development potential and constraints of a fishing industry in the Okavango Delta. In: Symposium on the Okavango Delta (pp 175-178). Botswana Society, Gaborone.

Proposals for development of a commercial fishing industry included formulation of a national policy on fisheries development, resource investigations to enable management planning for the resource and training in use of equipment and effective harvesting methods. Marketing constraints were not discussed.

Location: Botswana Society, National Museum and National Archives, Gaborone.

Government of Botswana, 1976. Fish Protection Act (38:05) Government Printer, Gaborone.

This Act provides for the protection of specific fish, particular areas important to fish, and touches on prohibited methods of fishing (e.g. use of poisons and explosives). Amendments to the Act have been made redefining legal fishing methods, type of gear to be used etc. Game fishing size and bag limits were established and closed seasons for certain areas defined.

Location: Government Gazette, Government Printer / National Archives, Gaborone.

Government of Botswana, 1979. Unified hunting regulations. Statutory Instrument No.19. Government Printer, Gaborone.

An attempt to simplify the hunting licensing system and to make it more equitable resulted in the promulgation of the Unified Hunting Regulations (UHR), giving all citizens theoretically equal access to wildlife resources on hunting quotas throughout the country. In effect, affluent residents of urban areas gained priority access to wildlife resources under the UHR (in terms of relative affordability). Many poorer residents of rural villages who were dependent on hunting for part of their subsistence suffered reduced access to wildlife resources. This inequity has been addressed informally in a few cases, but not legally, as the UHR are still in force. Remote area dweller (RAD) subsistence hunters were first licensed to hunt under the UHR, but were restricted to use of traditional weapons and were not allowed to trade freely in wildlife products, as was originally proposed.

Location: Government Gazette, Government Printer / National Archives, Gaborone.

Government of Botswana, 1982. Fauna Conservation (Amendment) Act. (Cap 38:01 – unrepealed amendments and schedules). Government Printer, Gaborone.

The Fauna Conservation Act (FCA)(Cap 38:01) of 1976 superseded the Fauna Conservation Proclamation of 1961 as the main set of laws governing the use and conservation of wildlife resources. The FCA have been amended seven times, most extensively in 1982, and most recently through related amendments to the National Parks Act (1976) Amendment of 1992.

Location: Government Gazette, Government Printer / National Archives, Gaborone.

Government of Botswana, 1986. Wildlife Conservation Policy. Government Paper No. 1 of 1986. Government Printer, Gaborone.

The Wildlife Conservation Policy stated Botswana Government's policy of promoting the economic utilisation of wildlife resources on a sustainable basis to the benefit of all Batswana. Although the policy described various means of use and types of benefits expected from the resource, mechanisms and legislation enabling most of those were not in place. Amendments to both the Fauna Conservation and National Parks Acts have since allowed certain land and resource uses described in the policy document, but amendments to realize many policy goals are still required.

Location: Government Printer / National Archives, Gaborone.

Government of Botswana, 1990. National tourism policy (Govt. Paper No. 2 of 1990). Government Printer, Gaborone.

[ECOSURV]

Location: Government Printer / National Archives, Gaborone.

Government of Botswana, 1990. Botswana National Conservation Strategy: National Policy on Natural Resources Conservation and Development.

The policy document outlines Government's national strategy (formulated according to IUCN guidelines) for the conservation of natural resources in Botswana.

Location: Government Printer / National Archives, Gaborone.

Government of Botswana, 1992. Wildlife Conservation and National Parks Act, No. 21 of 1992. Government Printer, Gaborone.

The Act includes amendments and updated legislation further to the Fauna Conservation (Amendment) Act (FCA) (Cap

38:01) of 1982, including more detailed legislation regarding land use in Wildlife Management Areas and Controlled Hunting Areas (including gazetted boundary descriptions for the Kwando and Okavango WMAs and 22 CHAs comprising these WMAs in Ngamiland), National Parks and Game Reserves. Convention on International Trade in Endangered Species (CITES) Appendices are also included.

Location: Government Gazette, Government Printer / National Archives, Gaborone.

Graham, A.D. 1976. A management plan for the Okavango crocodile. In: Proceedings of the Symposium on the Okavango Delta. Botswana Society, Gaborone.

A management plan for the Okavango crocodile population, based on modelling population structures and experimental cropping to obtain biological data in the process of exploiting the resource is proposed. Research and monitoring programmes to obtain additional information for management are discussed.

Location: Botswana Society, National Museum and National Archives, Gaborone.

Graham, A.D. & Simbotwe, P. 1988. Monitoring an exploited crocodile population on the Okavango River, Botswana. DWNP, Gaborone. (typescript)

Location: Department of Wildlife and National Parks, Gaborone.

Graham, P., 1964. Destruction of birds and other wildlife by Dieldrex spraying against tsetse-fly in Bechuanaland. *Arnoldia*, 1(10):1-4.

Dead birds and other fauna were collected on the first, third and tenth day following spraying of an *Acacia* spp. woodland with Dieldrex to eliminate tsetse-fly in 1963. Blanket spraying of the isolated pocket of woodland was considered necessary for health reasons, as it was located immediately across the Thamalakane river from Maun.

Location: Arnoldia, National Museums of Zimbabwe.

Graham, P., 1967. An analysis of the numbers of game and other large mammals killed in tsetse-fly control operations in northern Bechuanaland, 1942-1963. *Mammalia*, 31:186-204.

Numbers of large mammals killed in control areas around Maun remained almost constant over the twenty year period, probably due to recruitment from the Delta. Recommendations are made for cropping schemes to provide sustained yields as were inadvertently provided by this operation.

Location: *Mammalia*, Journal of Mammalogy.[]

Griffin, M. and A. Channing, 1991. Wetland associated reptiles and amphibians a national review. *Madoqua* 17(2):221-225.

Location: *Madoqua Journal* (Namibia)

Guillet, A. and T. Crowe, 1986. A preliminary investigation of patterns of distribution and species richness of southern African waterbirds. - *South African Journal of Wildlife Research* 16(3):66-81.

Location: *South African Journal of Wildlife Research*

Hamilton, W.J. & C. Busse, 1982. Social dominance and predatory behaviour of Chacma baboons. *J. Human Evolution*, 11:567-573.

Dominance and rank are examined as determinants to predatory behaviour amongst Chacma baboons living the

Okavango Delta. As with most large carnivores, when kills are made a dominance order in feeding on the carcass is observed.

Location: Journal of Human Evolution

Hamilton, W.J. *et al.* 1978-87. The ecology and behaviour of Chacma baboons (*Papio ursinus*) living the Okavango Delta, Botswana. Publication of research findings. University of California, USA.

Series of studies on Chacma baboons living the Okavango Delta, including primate carnivory, omnivory and use of food resources, predation, environmental determinants of object manipulation, paternalism, paternity of infants, dominance rank acquisition, inter-troop interactions, inbreeding avoidance, male inter-troop transfer, sex ratio manipulation and competition for resources.

Location: Kalahari Conservation Society Library, Gaborone.

Hart, R., 1986. Some limnological observations in the upper Okavango Delta at low water level. In: J.L.B. Smith Institute of Ichthyology Investigational Report No 18, Grahamstown, RSA.

Location: Kalahari Conservation Society Library, Gaborone.

Hedger, R.S. 1972. Foot and mouth disease and the African buffalo (*Syncerus caffer*). J. Comp. Path., 82:19-28.

The article discusses the history and findings of the disease in sub-populations of the African buffalo (*Syncerus caffer*) in southern Africa, including those of northern Botswana.

Location: Journal of Comparative Pathology

Heiden, L. van der, 1991. Okavango Delta - the current state of planning and conservation. [ECOSURV]

Location: Kalahari Conservation Society Library, Gaborone.

Herremans, M. 1994. Conservation status and assessment of current wildlife conservation and management efforts for birds in Botswana. Research Division, Department of Wildlife and National Parks, Gaborone.

Location: Department of Wildlife and National Parks, Gaborone.

Hill, A. 1988. Wildlife parks and reserves in northern Botswana: a survey of visitor patterns and densities from 1984-1988. Grad. School of Business Studies, Univ. of Cape Town.

Location: Kalahari Conservation Society Library, Gaborone.

Int'l Crane Foundation, 1993. Proceedings, 1993 African Crane and Wetlands Training Workshop. ICF, Wisconsin, USA. 662 pp.

The proceedings include a survey of wattled crane populations in Botswana, their status and conservation needs (Mpiga J.J. Mangubili), and a Botswana Crane and Wetland Action Plan, describing conservation measures required by area, including the Okavango Delta, Kwando-Linyanti and Chobe river systems. (M. Herremans, J. Mangubili, and S. Motaloate - pp. 591-5).

Location: Department of Wildlife and National Parks, Gaborone.

IUCN, 1993. The IUCN review of the Southern Okavango Integrated Water Development Project. Final

Report to Government of Botswana by Int'l. Union for the Conservation of Nature and Natural Resources (World Conservation Union), Gland, Switzerland. 543 pp.

The Southern Okavango Integrated Water Development Project was reviewed in detail by a thirteen person team during 1991-92. The proposed IUCN alternatives to the SOIWDWP include: further groundwater development for Maun and Orapa; conjunctive use of surface water from the Thamalakane River to supply Maun seasonal needs; agriculture, fisheries and tourism development to increase production, incomes and improve living standards amongst rural residents; improved water and other natural resources management and monitoring through on-going research programmes and surveys.

Annex D: Environmental Aspects, includes:

List of 80 fish species found in the Okavango River and Delta, upper Zambezi, Selinda Spillway and Kwando River.

List of 93 invertebrates found when sampling the lower Boro, Thamalakane and Boteti Rivers, and channels and lagoons between Sepupa and Jedibe.

Location: IUCN, Gaborone; Kalahari Conservation Society Library, Gaborone.

IWWRB, 1992. African Waterfowl Censuses. International Waterfowl & Wetlands Research Bureau. 87 pp.

Includes a very general waterfowl census of northern Botswana for economically important, rare and endangered species (in the Okavango, Chobe, Linyanti and Kwando river systems).

Location: Department of Wildlife and National Parks, Gaborone.

IWWRB, 1994 African Waterfowl Censuses. International Waterfowl & Wetlands Research Bureau. 134 pp.

Includes a very general waterfowl census of northern Botswana for economically important, rare and endangered species (in the Okavango, Chobe, Linyanti and Kwando river systems).

Location: Department of Wildlife and National Parks, Gaborone.

IWWRB, 1995. African Waterfowl Censuses. International Waterfowl & Wetlands Research Bureau. 192 pp.

Includes a very general waterfowl census of northern Botswana for economically important, rare and endangered species (in the Okavango, Chobe, Linyanti and Kwando river systems).

Location: Department of Wildlife and National Parks, Gaborone.

Jacka, D., 1972. Breeding white pelicans at Lake Ngami. Botswana Notes and Records, 4:281-282. Botswana Society, Gaborone.

During the period May-July 1971, a breeding population of white pelicans at Lake Ngami estimated at about 5,000 adult birds fledged only 595 chicks. Disturbance of nesting birds by tourists, photographers, residents of neighbouring cattleposts and their livestock caused heavy mortality as nests, eggs and chicks were destroyed or abandoned. Predation by marabou storks was heavy where pelicans were forced to leave nests.

Location: Botswana Society, National Museum and National Archives, Gaborone.

Jackson, H. 1969. Notes on a collection of birds from the Khwae River in Botswana. *Arnoldia*, 4(24):1-9.

The article describes an expedition of the National Museum of Rhodesia to collect birds from the Khwae river area (and also from Maun and Toteng) in Ngamiland during December, 1968. All data and specimens collected are lodged with the National Museum at Bulawayo.

Location: *Arnoldia*, National Museums of Zimbabwe.

Joos-Vanderwalle, M. E., 1993. Movements and distributions of migratory zebra and wildebeest in northern Botswana. Department of Wildlife and National Parks Research Division,

Gaborone.

Location: Department of Wildlife and National Parks Research Division,
Gaborone.

Joubert, E. 1972. A note on the challenge rituals of territorial lechwe. *Madoqua Ser.* 1(5):63-68.

Various antagonistic displays and displacement activities of territorial male lechwe in the Moremi Game Reserve are described. based on observations made during October 1971.

Location: Madoqua Series.

Jubb, R.A. & I.G. Gaigher 1971. Check list of the fishes of Botswana. *Arnoldia* 5(7):1-22.

The history of fish collection from Botswana and identification of specimens is briefly described. A checklist of 81 species is given, based on collections made up to April 1969, and zoogeographical affinities of the major species are discussed.

Location: Arnoldia, National Museums of Zimbabwe.

Kalahari Cons. Society, 1983. Which Way Botswana's Wildlife? Proceedings of a Symposium of the Kalahari Conservation Society, Botswana.

Proceedings of the 1983 symposium emphasised the need for a national policy on wildlife utilisation (to appear in a very general form in 1986) at a time when the use of wildlife resources was being hampered by lack of appropriate enabling legislation and by inaction on the part of DWNP. Wildlife resources were still considered abundant and of great potential value, although most populations were in decline and certain species were suffering mass mortalities at the time of the conference.

Location: Kalahari Conservation Society Library, Gaborone.

Kalahari Cons. Society, 1984. Aerial monitoring of major wildlife species in northern Botswana. Survey 1 (April/May 1984). 26 pp. (incl 19 maps).

The report discusses methodology and findings of an initial aerial survey conducted at the end of the wet season over northern Botswana (north of 21° S. lat.). Wildlife species distribution and densities are mapped on a 100km² grid along east-west transects. Population estimates are given for major species.

Location: Kalahari Conservation Society Library, Gaborone.

Kalahari Cons. Society, 1985a. Aerial monitoring of major wildlife species in northern Botswana. Survey 2 (Oct/Nov 1984). 30 pp. (incl. 21 maps).

The report discusses findings of a second aerial survey conducted at the end of the dry season over northern Botswana (north of 21° S. lat.). Wildlife species distribution and densities are mapped on a 100km² grid. Transects were flown east-west. Population estimates are given for major species.

Location: Kalahari Conservation Society Library, Gaborone.

Kalahari Cons. Society, 1985b. Aerial monitoring of major wildlife species in northern Botswana. Survey 3 (March 1985). 31 pp. (incl. 20 maps).

Methodology and findings of a second wet season aerial survey over northern Botswana (north of 21° S. lat.) are described. Wildlife species distribution was mapped (along east-west transects), but wildlife populations and densities could not be estimated since observational strip widths were not established and survey height varied.

Location: Kalahari Conservation Society Library, Gaborone.

Kalahari Cons. Society, 1990. The Future of Botswana's Elephants. Proceedings of a workshop. KCS and Department of Wildlife and National Parks.

The proceedings of this one-day workshop/symposium focused on the conflicting views and debate surrounding the management of Botswana's burgeoning elephant population. Government's draft elephant management plan proposed annual culling to maintain population levels at approximately 60,000. Revenues generated would pay for large-scale culling and other wildlife management and development programmes (prior to the total ban on trade in elephant products). Opponents of the plan claimed it could not be implemented on an effective scale, and that the Government would face stiff international opposition to large-scale culling. The increase in elephant populations and the debate continue.

Location: Kalahari Conservation Society Library, Gaborone.

Kalahari Cons. Society, 1985. The present status of wildlife and its future in Botswana. Proceedings of a symposium. KCS and Chobe Wildlife Trust.

This two-day symposium had several ambitious aims, viz. to initiate discussion on the current levels of wildlife populations, their management and predicted future (assuming the mainstream view was still of abundant wildlife resources); to raise awareness amongst "user groups" (who were not in attendance) as to the fragility of the resource base; to predict future conflict areas and to propose resolutions; to set a direction for management plans and options for the future of wildlife; and to attempt to produce implementable management objectives and plans. Again, there were calls for a comprehensive national wildlife management strategy to be implemented by a more effective, well-trained and better-staffed Department of Wildlife and National Parks (qv. DWNP, 1995).

Location: Kalahari Conservation Society Library, Gaborone.

Kalahari Game Services/KCS, 1991. Moremi Game Reserve Management Plan, Vols. I & II. Report for the Botswana Department of Wildlife and National Parks.

This second and more detailed management plan prepared for the Moremi Game Reserve has been updated and modified considerably under the DWNP/EC Project carried out during 1992-95 by the Protected Areas Development Unit, North (PADUN) in Maun.

[ECOSURV]

Location: Kalahari Conservation Society Library, Gaborone.

Lambrecht, F. 1968. Notes on the history of sleeping sickness. Botswana Notes and Records, Vol. 1:41-49. Botswana Society, Gaborone.

Historical distribution of Tsetse fly, sleeping sickness and nagana in Africa and specifically in northern Botswana are discussed. Limited distribution following the rinderpest epidemic, medical surveys and efforts to limit the spread of Tsetse fly, including establishment of the TFC Units is outlined.

Location: Botswana Society, National Museum and National Archives, Gaborone.

Lent, P.C. 1969. A preliminary study of the Okavango lechwe (*Kobus leche leche* Gray). E. Afr. Wildl, J., 7:147-157.

The general ecology, habitat preferences, feeding and breeding behaviour and daily activity cycles of lechwe observed on Okavango floodplains are described.

Location: East African Wildlife Journal

Liversedge T. 1980. A study of Pel's fishing owl (*Scotopelia peli* Bonaparte) in the Panhandle region of the Okavango Delta, Botswana. Proceedings, 4th Pan African Ornithological Congress: 291-299.
Location: Proceedings, 4th Pan African Ornithological Congress

Maar, A. 1965. Report on a fisheries survey in Bechuanaland BP in the years 1963/64. Report to Oxfam. 38pp.

The survey assessed fisheries resources in the Okavango and Kwando-Linyanti-Liambezi-Chobe systems. Based on estimated resource potential, a commercial fisheries development plan was proposed following more detailed research.
Location: MOA Fisheries Section.

Masundire, H. *et. al.* 1995. Proceedings of the Conference on Wetlands Management in Botswana. Wetlands Coordinating Committee. 160 pp.

Includes papers on the ecology, management and conservation of wetlands in Botswana, utilisation of economic resources, and community-based fisheries and wildlife resource management.
Location: Department of Wildlife and National Parks, Gaborone.

Matiza, T. & H. Chabwela, 1991. Wetlands Conservation Conference for Southern Africa - Proceedings of the SADCC Wetlands Conference. IUCN Wetlands Programme. 224 pp.

The proceedings includes research and planning presentations for the Okavango Delta and Chobe-Linyanti river systems in Botswana.
Location: Department of Wildlife and National Parks, Gaborone.

Medem, F. 1981. Assistance to crocodile management in rural areas of Botswana. UNDP / FAO Consultancy Report. 29 pp.

The report discusses past use and present (estimated) status of Nile crocodile populations in Botswana and proposes a management programme including setting of egg collection and live capture quotas based on aerial and riverine surveys, and small scale, community-based crocodile rearing and processing units.
Location: Department of Wildlife and National Parks, Gaborone.

Melton, D.A. 1980. Report on the condition and growth of baboons (*Papio ursinus*) captured in the Okavango swamp, Botswana. Department of Wildlife and National Parks, Gaborone.

Twenty-nine female and 26 male baboons were immobilised. Results of blood assays, morphometries, growth and physical condition assessment are provided.
Location: Department of Wildlife and National Parks, Gaborone.

Melton, D.A. 1981. Report on an aerial survey of the Gumare CFDA, 17 November 1981. Department of Wildlife and National Parks, Gaborone.
[SEE WP RES 2/19 I(56)]
Location: Department of Wildlife and National Parks, Gaborone.

Melton, D.A. 1985. The status of elephants in northern Botswana. Biol. Cons. 31:317-333.

Data on elephant populations distribution and abundance in northern Botswana (north of 21° S. lat.) are provided. Conservation and management problems resulting from apparently rapid population increases are discussed and the urgent need for an assessment of management options and action are emphasised.
Location: Department of Wildlife and National Parks, Gaborone.

Melton, D.A. & C. Melton, 1981. Immobilisation and blood analyses of baboons (*Papio ursinus*) in the Okavango swamp, Botswana. Botswana Notes and Records, 13:119-122. Botswana Society.

Sixty-three Chacma baboons (*Papio ursinus*) from Chief's island in the Okavango Delta were immobilised using a blow dart system and blood analyses were carried out. Blood urea nitrogen (BUN) and cholesterol levels were found to be lower than those of captive baboons on simulated 'natural' diets, but similar to those for wild baboons in east and southern Africa. Blood parasites had no apparent effect on condition and dominance ranking or stress levels in individuals were not detectable from 14 common blood parameters measured.
Location: Botswana Society, National Museum and National Archives, Gaborone.

Melton, D.A. & C. Melton, 1982. Blood parameters of wild Chacma baboons (*Papio ursinus*). S. Afr. J. Zool., 17:85-90.

Blood parameters were examined in 63 immobilised Chacma baboons from Chief's island in the Okavango Delta, Botswana. Most values were similar to those found previously in captive baboons, though some differences were noted. Blood urea nitrogen (BUN) and cholesterol levels were found to be lower than those of captive baboons on simulated 'natural' diets, but similar to those for wild baboons in east and southern Africa. Blood parasites had no apparent effect on condition and dominance ranking or stress levels in individuals were not detectable from 14 common blood parameters measured.
Location: South African Journal of Zoology []

Merron, G. 1986. A report on fish mortality after aerial spraying with endosulfan cocktail in the Okavango Delta, Botswana. Investigational Report No. 20. J.L.B. Smith Institute of Ichthyology, Grahamstown, RSA.

Results of an investigation by the Tsetse-fly Control Unit and J.L.B. Smith Institute of Ichthyology to quantitatively assess the impact of a recent application of 6g/Ha of endosulfan and 0.1g/Ha of deltamethrin on the fish populations in the spray block area are presented. Apparent reasons for high fish mortalities are discussed, and recommendations for continued research made to monitor effects of the spraying programme on the entire aquatic ecosystem.
Location: Kalahari Conservation Society Library, Gaborone.

Merron, G. 1991. The ecology of the fishes of the Okavango Delta, Botswana. J.L.B. Smith Institute of Ichthyology, Grahamstown, RSA.
[ECOSURV]
Location: Kalahari Conservation Society Library, Gaborone.

Merron, G. 1992. Tsetse fly control and the environmental implications for fish in the Okavango Delta. Botswana Notes and Records, 24:49-56. Botswana Society, Gaborone.

The paper warns against further detrimental effects anticipated with continued aerial application of endosulfan (which has been widely banned) in controlling Tsetse fly in the Okavango Delta, and implications for fish populations. Better-controlled, more accurate aerial application and ground spraying using a low volume deltamethrin formulation, and trapping are proposed as environmentally acceptable alternatives.
Location: Botswana Society, National Museum and National Archives, Gaborone.

Merron, G. 1993a. A synopsis of presentations and discussions on the fish and fishery in the Okavango Delta, Botswana. Botswana Notes and Records, 25:133-140. Botswana Society, Gaborone.

The paper provides a summary of presentations and discussions on the fish, research and development of fisheries in the Okavango Delta. Fish contribute to the diets and incomes of many residents of the Delta region, though commercial yields are considerably lower than in most other African wetland ecosystems due to low nutrient availability. Recreational fishery is also gaining importance, with an estimated 2000 fisherman visiting the Okavango annually (1992). There is concern that Okavango fish populations are declining due to fishing pressure, drought, reduced flood levels and use of insecticides. Very few data have been, or are being collected on the impacts of these processes. An integrated fisheries research programme and management strategy is urgently required. The potential for development of fish farming should also be assessed as a means of reducing pressure on wild fish stocks and increasing revenues and employment opportunities.

Location: Botswana Society, National Museum and National Archives, Gaborone.

Merron, G. 1993b. The diversity, distribution and abundance of the fishes in the Moremi Wildlife Reserve, Okavango Delta, Botswana. S. Afr. J. Wildl. Res. 23(4):115-122.
Location: South African Journal of Wildlife Research

Merron, G. 1993c. Okavango water - to use or not to use. African Wildlife, 47(5) 222-224.
Location: African Wildlife (periodical)

Merron, G. 1995. Fish and water plants of the Okavango. Marung (Botswana), 11(79): 16-17.
Location: Marung (Botswana), (Periodical of Air Botswana)

Merron, G. S. & M. Bruton, 1984. Report on the 1984 expedition to the Okavango Delta, Botswana. J.L.B. Smith Institute of Ichthyology, Grahamstown, RSA.
[ECOSURV LIBRARY]

Merron, G. and M. Bruton, 1985. Progress report for the Okavango fisheries research programme for 1985. J.L.B. Smith Institute of Ichthyology, Grahamstown, RSA.
Location: J.L.B. Smith Institute of Ichthyology, Grahamstown, RSA.

Merron, G. S. & M. Bruton, 1986a. The physiological and toxicological effects of aerial spraying with insecticides on the fish stocks of northern Botswana. J.L.B. Smith Institute of Ichthyology, Grahamstown, RSA.

A large-scale fish kill occurred in the lower swamp area of the Okavango Delta during August 1986. The extent and magnitude of the fish kill was monitored by the author and by officers of the Tsetse-fly Control Unit, Maun. Results of this monitoring effort were reported by Merron (1986). Based on the results of this survey, and considering the long time period since any detailed monitoring has been conducted it is recommended that an intensive three-year research programme be initiated to focus on the potential impact of the insecticide cocktail on Delta fish communities.

Location: Kalahari Conservation Society Library, Gaborone.

Merron, G. and M. Bruton, 1986b. Where are all the Okavango fishes? Kalahari Conservation Society

Newsletter, 13: 4-5.

Location: Kalahari Conservation Society Library, Gaborone.

Merron, G. and M. Bruton, 1986c. Results of two expeditions to the Okavango Delta, October, 1985 and February, 1986. Unpublished report. J.L.B. Smith Institute of Ichthyology, Grahamstown, RSA.

Location: J.L.B. Smith Institute of Ichthyology, Grahamstown, RSA.

Merron, G. S. & M. Bruton, 1988. The ecology and management of the fishes of the Okavango Delta, Botswana, with special reference to the role of the seasonal floods. Ministry of Agriculture, Fisheries Division and J.L.B. Smith Institute of Ichthyology, Grahamstown, RSA.

The report provides the most complete information to date on the ecology and management of the fishes and fisheries of the Okavango Delta. The role of the seasonal flood in enriching the ecosystem through flooding vegetated dry land areas, enhancing production potential and providing shallow water nesting sites and protected areas for important fish species is described in detail.

Location: Kalahari Conservation Society Library, Gaborone.

Merron, G. and M. Bruton, 1995. Community ecology and conservation of fishes in the Okavango Delta, Botswana. *Environmental Biology of Fishes*, 43(2): 109-119.

Location: *Environmental Biology of Fishes* (Journal)

Milenski, A.V. & B. Campbell, 1976. Bird diversity in relation to vegetation types in the Moremi Wildlife Reserve. - *Trans. Orn. Soc. S. Afr.* 42:174-184.

Location: *Transactions of the Ornithological Society*

Minshull, J. 1985. A collection of fish from the lower Okavango swamp, Botswana, with comments on aspects of their ecology. *Arnoldia Zimbabwe*, 9(20): 277-290.

Location: *Arnoldia Zimbabwe* (journal)

MOA, 1987-93. Annual Reports, Ministry of Agriculture Fisheries Section.

Fisheries development plans, progress with implementation and activities of the section during the year, including training, distribution of equipment against grants, etc.

Location: Ministry of Agriculture (Fisheries Section).

MOA, 1987-88. Foot and Mouth Vaccination Returns, September 1987 - August 1988. Ministry of Agriculture, Veterinary Department, Maun.

As per title.

Location: Department of Animal Health and Production, Gaborone.

Moroka, D.N., 1984. Elephant-Habitat relationships in northern Botswana. Dept. of Wildlife and National Parks, Gaborone. 49 pp.

The impact of elephants on woodland was investigated at Savuti, on the Chobe River front and at Nantanga. *Acacia* and *Mopane* woodlands were most severely affected by elephants feeding and in the case of *Acacia* woodlands the damage was permanent and high tree mortality was recorded. Further evidence of dramatic habitat changes by large numbers of elephants was documented.

Location: Kalahari Conservation Society Library, Gaborone.

Nadeau, W.J. 1997. The current effects of the northern Buffalo Fence on local wildlife species. Unpublished report. CSA Botswana and Conservation International, Maun.

Reports results of a three day transect survey of 11 km of the northern Buffalo Fence in CHA NG22. Wildlife contacts with the fence were counted based on spoor, dung, damage to the fence and animal sightings. An average of 19.5 contacts per km of fence were recorded with frequency of buffalo contacts four times higher than other species (impala, sable, zebra, giraffe). Predators and small mammals passed through or under the fence.

Location: Conservation International, Maun.

Ngamiland DLUPU, 1991. Kwando & Okavango Wildlife Management Areas Land Use Plans. Ngamiland District Land Use Planning Unit, Maun. [] pp.

[ECOSURV ANNOTATION]

Location: Ngamiland District Land Use Planning Unit, Maun & Department of Wildlife and National Parks, Gaborone.

NORFICO, 1986. Fishing gear technology. Ministry of Agriculture, Fisheries Section. 21 pp.

Proposals for adoption of appropriate technology from Kenya and Malawi to enhance development and off-takes from the local fishing industry in the Okavango and Kwando-Linyanti-Liambezi-Chobe systems (discounting known factors already limiting harvests in these areas).

Location: Ministry of Agriculture, Fisheries Section.

NORFICO, 1987. Fish processing and marketing. Ministry of Agriculture, Fisheries Unit. 29 pp.

Historic review of fish processing and marketing with recommendations for improvements (pending the recovery of some fish populations), including trial regional frozen fish marketing, improved marketing of dried fish and continued use of dried fish as drought relief rations.

Location: Ministry of Agriculture, Fisheries Section.

NORPLAN, 1985. Botswana Fisheries, status and strategies. Ministry of Agriculture, Fisheries Unit. 88 pp.

A synopsis of commercial fishing activities and proposals for further development of the industry at the village level.

Location: Ministry of Agriculture Library, Gaborone.

Okavango Community Consultants, 1996. Community-based management plans for multiple-use Controlled Hunting Areas. Tawana Land Board / DWNP, Maun. []pp.

Basic management plans are included for eight multiple-use controlled hunting areas (CHAs) surrounding the Okavango Delta.

[ECOSURV ANNOTATION]

Relevant (Land Use Planning).

Location: Tawana Land Board, Maun & Department of Wildlife and National Parks, Gaborone.

PADUN, 1996. Management and tourism development plans for Moremi Game Reserve. Protected Areas Development Unit (North), Department of Wildlife and National Parks, Maun.
[ECOSURV ANNOTATION]
Location: Department of Wildlife and National Parks, Maun and Gaborone.

Parry. D.C. 1987. Wildebeest (*Connochaetes taurinus*) mortalities at Lake Xau, Central District, Botswana. Botswana Notes and Records, 19:95-101. Botswana Society, Gaborone.

The article supports documentation of mass mortality of kalahari wildebeest around Lake Xau in Central District (Williamson, 1985), identifying the cause of mortality as starvation resulting from: depletion of animal condition due to a series of drought years; absence of forage in the Lake Xau area due to overgrazing by cattle under drought conditions; inability of wildebeest to shift from grazing to browsing; high energy losses due to distance between food and water supplies.

Location: Botswana Society, National Museum and National Archives, Gaborone.

Parry. D.C. 1989. The wildlife management areas of Botswana. Msc thesis, University of Zimbabwe. 160 pp.

The study examined attitudes towards wildlife and Wildlife Management Areas (WMAs) in Botswana in 1988-89. Findings showed that administrators and biologists were well-informed regarding WMAs, related policy and land use issues, and considered the economic viability of WMAs more important than social or conservation-related issues. Rural communities had negative attitudes towards wildlife generally, and particularly towards the administrators (DWNP), were distrustful of government motives and had a poor understanding of the WMA concept. Results indicated however that attitudes and understanding could be improved, and a framework for this process was provided.

Location: Ecosurv Consultants

Patterson, L. 1976. An introduction to the ecology and zoogeography of the Okavango Delta. In: Symposium on the Okavango Delta, 55-60. Botswana Society, Gaborone.

Low nutrient inputs into the system from the Okavango River are discussed as the main factor limiting most fauna population levels over much of the delta. Extensive permanent flood habitats also limit niches for many species (small mammals, birds and reptiles). Though wildlife densities are relatively low, they are viable for purposes of tourism and few areas with such a high degree of natural beauty remain in Africa. Increased demands on resources from the Delta make active management necessary to keep development and conservation options open in the future.

Location: Botswana Society, National Museum and National Archives, Gaborone.

Patterson, L. 1978. Elephant Distribution Census. Dept. of Wildlife, National Parks and Tourism, Maun. 4 pp (typescript).

The area covered by the census was the proposed North Okavango WMA (including Khwai, Savuti and Kwando CHAs). Coverage of 8,000km² at 20% yielded a population estimate of 8,800 elephants.

Relevant (Elephant population trends)

Location: Department of Wildlife and National Parks, Gaborone.

Patterson, L. n.d. Buffalo: Population biology and management in the Okavango Delta. Technical Note No. 11. UNDP/FAO Project DP:BOT/71/506.

A report of findings of a study in progress on the buffalo population biology and management in the Okavango Delta. The Okavango buffalo population appeared to be stable despite reported heavy utilisation at the time of the study.

Location: UNDP Library, Gaborone.

Patterson, L. 1979. Studies on the Population Biology of the African Buffalo (*Syncerus caffer*) in Botswana. Department of Wildlife and National Parks, Gaborone. 110 pp.

A report of findings of a two year study on the population Biology of the African Buffalo (*Syncerus caffer*) in Botswana. At the time of the study buffalo ranges elsewhere in the country and region were shrinking, but Okavango herds appeared to be stable despite reported heavy utilisation (mainly poaching).

Location: Kalahari Conservation Society Library, Gaborone.

Patterson, L. 1979. Wildlife surveys of north Okavango Wildlife Management Area (May 1978-June 1979). for Department of Wildlife and National Parks, Gaborone.

Elephant and buffalo distribution are plotted from aerial surveys data collected between May 1978 and June, 1979.

Location: Kalahari Conservation Society Library, Gaborone.

Patterson, L. 1980. Assessment of wildlife populations and management potential in northern Botswana. Interim report for Department of Wildlife and National Parks, Gaborone.

Reports on aerial survey findings for Ngamiland and Chobe Districts from May 1978. Major species population estimates and apparent trends are given.

Location: Department of Wildlife and National Parks, Gaborone.

Penry, H. 1994. Bird Atlas of Botswana. University of Natal Press, Pietermaritzburg. 319 pp.

Distribution maps based on frequency of reliable sightings (mainly from data collected by the Botswana Bird Club and affiliates) are provided for 496 bird species verified as occurring in Botswana. 453 species have been recorded within the 34 quarter-degree squares including the Okavango River and Delta, Lake Ngami and the Boteti River, making it the richest habitat for avifauna biodiversity in the country. Brief status and habitat descriptions are provided for each species. General vegetation and habitat types are mapped and discussed. Extensive references and a gazetteer of sighting locations are also included.

Location: University of Natal Press, Pietermaritzburg and Department of Wildlife and National Parks, Gaborone.

Pinhey, E. 1967. Odonata of Ngamiland (1967). *Arnoldia*, 3(15):1-17.

Sixty three species of Odonata were collected from sites in the Okavango Delta and along the Okavango and Boteti rivers in February 1967. A number of unexpected species favouring palustrine and lacustrine conditions were recorded due to the unusually wet conditions prevailing at the time of the survey.

Location: Arnoldia, National Museums of Zimbabwe.

Pinhey, E. 1968. Check List of the Butterflies (Lepidoptera Rhopalocera) of Botswana: Part 1 (with illustrations). *Botswana Notes and Records*, Vol. 1:85-92. Botswana Society, Gaborone.

Forty one species of butterflies of the families Papilionidae and Pieridae are briefly described (28 of these species were collected in the Okavango Delta region).

Location: Botswana Society, National Museum and National Archives, Gaborone.

Pinhey, E. 1971. Check List of the Butterflies (Lepidoptera Rhopalocera) of Botswana: Part 2. *Botswana Notes and Records*, 3:148-152. Botswana Society, Gaborone.

Thirty two butterfly species of the families Pieridae, Danaidae, Acraeidae and Satyridae are listed and briefly described (18 of these species were collected on the Okavango River or in the Okavango Delta).

Location: Botswana Society, National Museum and National Archives, Gaborone.

Pinhey, E. 1974. Check List of the Butterflies (Lepidoptera Rhopalocera) of Botswana: Part 3 (with illustrations). Botswana Notes and Records, 6:197-214. Botswana Society, Gaborone.

Thirty additional species of butterfly belonging to the family Nymphalidae are listed and briefly described (16 of these species were collected on the Okavango River or in the Okavango Delta).

Location: Botswana Society, National Museum and National Archives, Gaborone.

Pinhey, E. 1976a. Check List of the Butterflies (Lepidoptera Rhopalocera). Botswana Notes and Records, 8:269-288. Botswana Society, Gaborone.

The final section of the butterfly check list deals with the Lycaenidae (Blues and Coppers) and the Hasperiidae (Skippers). Of ninety-six species collected and briefly described, more than 60 were found on the Okavango River or in the Okavango Delta region.

Location: Botswana Society, National Museum and National Archives, Gaborone.

Pinhey, E. 1976b. Dragonflies (Odonata) of Botswana, with ecological notes. Occasional Papers of the National Museums of Rhodesia. B5(10):524-601.

Sixty three species of Odonata were collected by the author from sites in the Okavango Delta and along the Okavango and Boteti rivers in February 1967. A number of unexpected species favouring palustrine and lacustrine conditions were recorded due to the unusually wet conditions prevailing at the time of this survey. A follow-up survey in 1974 produced fewer, but two new species. These are described and notes on habitat, reproduction and ecology of Odonata are included.

Location: National Museum of Zimbabwe, Bulawayo (including material collections)

Pooley, A.C. 1981. The Status of African Crocodiles in 1980. In: R. J. Bryant (ed) Crocodiles. IUCN publication, New Series. Gland, Switzerland. pp 174-228.

Distribution and status of Botswana's Nile crocodile populations are described, based mainly on research carried out by Blomberg (1976) and Graham (1976, 1978). Kwando-Linyanti-Chobe populations are included in estimates, though limited research was carried out in the system.

Location: Department of Wildlife and National Parks, Gaborone.

Procter, D. 1983. Biological Control of the Aquatic Weed *Salvinia molesta*, D.S. Mitchell in Botswana Using the Weevils *Cyrtobagous singularis* and *Cyrtobagous* sp. nov. Botswana Notes and Records, Vol. 15:99-101. Botswana Society, Gaborone.

Factors inhibiting efficacy of weevils *Cyrtobagous* spp. in controlling *Salvinia molesta* invasion are discussed. Trial use of other biological control measures are proposed as is regular monitoring of *Salvinia* invasion and on-going control measures.

Location: Botswana Society, National Museum and National Archives, Gaborone.

Randall, R. 1988. The Ardeidae at the Xaxaba reed-bed. Babbler, 15:31-32.

A description of heron and egret roosts at the Xaxaba reed-bed, feeding, competition and inter-specific behaviour.

Location: Botswana Bird Club, Gaborone.

Randall, R. 1990. Herons and egrets roosting at the Xaxaba reed-bed. Babbler, 19:14-15.

A description of heron and egret roosts at the Xaxaba reed-bed, feeding, competition and inter-specific behaviour.

Location: Botswana Bird Club, Gaborone.

Randall, R. and M. Herremans, 1994. Breeding of the slaty egret *Egretta vinaceigula* along the Boro River in the central Okavango Delta (Botswana). *Ostrich*, 65:39-43.

The article is one of few observations of breeding of the slaty egret in the central Okavango Delta. No breeding records have been verified elsewhere

Location: *Ostrich* (ornithological journal)

Raseroka, B. 1975. Past and Present Distribution of Buffalo in Botswana. *Botswana Notes and Records*, Vol. 7:131-140. Botswana Society, Gaborone.

Buffalo distribution in Botswana since 1800 is discussed and estimated distribution prior to 1840 is mapped for eastern and southern Botswana. Restricted ranges of 1975 (also mapped) were assumed the result of drying up of surface water supplies, displacement by livestock, disease (and control) as well as hunting pressure.

Location: Botswana Society, National Museum and National Archives, Gaborone.

Raseroka, B. 1978. A study of some aspects of the behaviour of African buffalo (*Syncerus caffer* Sparrman). Unpublished Ph.D. Thesis, University of Sussex. UK. 213 pp.

Present and historic ranges of African buffalo in Botswana are described and reasons for changes proposed. Data on ageing of buffalo using horn rings and body weight in relation to heart girth are compared. Seasonal movement patterns, based on climatic conditions, and according to herd types and composition are also described and core seasonal habitat areas defined.

Location: Department of Wildlife and National Parks, Gaborone.

Reavell, P. 1977. A discussion of factors limiting plankton growth in the water of the Okavango Delta. *Botswana Notes and Records*, 9:129-137. Botswana Society, Gaborone.

Linear regressions were used to analyze the relation between chlorophyll a in the system and potential factors limiting its production and the growth of phytoplankton in Okavango Delta waters. Availability of phosphorus, followed by nitrogen appear to be the key limiting elements. Loading of both or either of these elements through extensive use of fertilizers in farming (including fish farming) could have significant impacts on phytoplankton and other plant growth. Cultural eutrophication would lead to channel blockages affecting drainage patterns. Increases in oxygen demand, and deoxygenation during low flood regimes could result in numerous plants and animals being eliminated from the system while sedimentation would favour water hyacinth or *Salvinia molesta*.

Location: Botswana Society, National Museum and National Archives, Gaborone.

Reavell, P. 1981. A study of the relationship between phytoplankton growth and nutrient concentrations in the waters of the seasonally inundated Okavango Delta, Botswana. MSc thesis, University of the Witwatersrand, RSA.
[ECOSURV]

Reavell, P. 1984. Further deterioration of the swamp ecosystem in the Boro - Thamalakane region, Okavango Delta, Botswana. *Botswana Notes and Records*, 15:105-106. Botswana Society, Gaborone.

Deterioration of the swamp ecosystem in the Boro - Thamalakane region is attributed first to building and dredging of channels to provide a more reliable water supply to the diamond mine at Orapa, and secondly to overgrazing, soil erosion and vegetation changes resulting from heavy use of the area by domestic livestock. Declaring the region a wildlife conservation area is proposed to restore the system.

Location: Botswana Society, National Museum and National Archives, Gaborone.

Reavell P. E. *et al*, 1973. Okavango Hydrobiological Project. First Yearly Report, 1972-73. Department of Botany, University of the Witwatersrand, RSA.
[ECOSURV ANNOTATION]

Robbel H. and G. Child, 1970. Notes on the 1969 impala rut in the Moremi Wildlife Reserve. Botswana Notes and Records 2:95-97. Botswana Society, Gaborone.

Observations were made between March 18 and June 14 with the peak of the rut in Moremi occurring between May 12-16 in 1969. Rutting and mating behaviour, particularly of male impala, are described in detail.

Location: Botswana Society, National Museum and National Archives, Gaborone.

Robbel H. and G. Child, 1975. Notes on territorial behaviour of lechwe. Mammalia, 39:707-709.

Short note based on observations made along the Khwae River in Moremi Game Reserve during 1974.

Location: Mammalia, Journal of Mammalogy.

Robbel H. and G. Child, 1976. Notes on the ecology of the Moremi Wildlife Reserve. DWNP&T. Government Printer, Gaborone.

Notes on the ecology and large wildlife species of the Moremi Wildlife Reserve are presented, based on a study conducted during 1965-1970.

Location: Department of Wildlife and National Parks, Gaborone.

Rodgers, W. 1991. Land resource assessment for land use planning, Botswana - and evaluation for wildlife utilisation. UNDP/FAO and Government of Botswana.

The report includes an overview of land and wildlife resources, wildlife utilisation and related planning initiatives in the region, and an evaluation of the potential for future development of wildlife-based economic activities. Game viewing and safari hunting tourism in the Okavango Delta region feature high on the list of income-generating activities.

Location: Kalahari Conservation Society Library, Gaborone.

Ross, K., 1987. Okavango - jewel of the Kalahari. Southern Book Publishers, Johannesburg, RSA.

A popular illustrated publication describing the natural resources, ecology, landscape, land use, history and tourism, etc. in the Okavango Delta.

Location: Kalahari Conservation Society Library, Gaborone.

Ross, K., 1991. A survey of the status and distribution of the Sitatunga (*Tragelaphus spekei*) in the Okavango Delta. Department of Wildlife and National Parks, Botswana.

[ECOSURV LIBRARY]

Location: Department of Wildlife and National Parks, Gaborone.

Russel-Smith, A. 1976. Preliminary observations on the effects of insecticide application on the aquatic fauna of the Okavango Delta. In: Symposium on the Okavango Delta, 153-160. Botswana Society, Gaborone.

The author first warns that data presented from the first four months of aerial insecticide applications are too incomplete to draw conclusions from. Then he proceeds to speculate from these data that it is unlikely that spraying will have significant impacts on fish or aquatic invertebrate populations, and reports that plans call for increased application rates during the next seasons trials prior to research establishing sub-lethal doses to important non-target species.

Location: Botswana Society, National Museum and National Archives, Gaborone.

SADCC, 1988. Record of the 13th SADCC Technical Consultation Meeting on Fisheries and Wildlife, Gaborone, Botswana (16-18 March 1988). SADCC / IUCN. 58 pp.
Location: Department of Wildlife and National Parks, Gaborone.

Sherburne, J. *et. al.*, 1974. A report on wildlife utilisation in Botswana. African Wildlife Leadership Foundation for the Botswana Department of Wildlife and National Parks.

This report was an initial investigation into wildlife utilisation planning in Botswana. Land use zoning proposals were made, including changes to some protected areas boundaries, eg. the expansion of Moremi Game Reserve boundaries and a link with Chobe National Park. The establishment of Wildlife Management Areas (WMA's) was proposed on most unsettled land to act as buffer zones, wildlife utilisation areas and migration routes between protected areas.

Location: Department of Wildlife and National Parks, Gaborone.

Silsby, J., 1991. Some observations on the dragonflies of the Okavango Delta. *Kimminsia*, 2:8.
Location: *Kimminsia* (journal)

Simbotwe, M. 1988a. Crocodile Research and Management. *Kalahari Conservation Society Newsletter* No 21:8-9.

The article describes the author's research into Nile crocodile population structure, dynamics and reproduction in northern Botswana and summarises a proposed management plan involving restocking from captive (commercial) breeding stock.

Location: Kalahari Conservation Society Library, Gaborone.

Simbotwe, M. 1988b. Crocodile Management and Conservation: Country Report for Botswana. Paper presented to the 9th meeting of the Crocodile Specialist Group, IUCN / SSC. Lae, Papua New Guinea. 35 pp.

The article summarises previous research and describes the authors research into Nile crocodile population structure, dynamics and reproduction in Botswana. Management and conservation proposals, including restocking from captive breeding stocks and establishing small-scale village crocodile farming are discussed.

Location: Kalahari Conservation Society Library, Gaborone.

Simbotwe, M. & J. J. Matlhare 1988. Crocodile management in Botswana. Department of Wildlife and National Parks, Departmental Paper No. 1, September 1988. 34 pp.

As above with more detailed discussion of current status and distribution.

Location: Department of Wildlife and National Parks, Gaborone.

Simbotwe, M.P. & S. Spawls, 1987. Herpetology in Botswana. *British Herpetological Society Bulletin*, 21:23-25.

A brief summary of the state of knowledge of the resources and research in herpetology in Botswana.
Location: [DWNP?]

Simbotwe M. and L. Gillette, 1990. Zoogeography of the herpetofauna of Botswana and its management implications. *African Journal of Ecology*, 28: 103-110.
As per title.
Location: African Journal of Ecology

Skelton, P., 1987. South African Red Data Book - Fishes. South African National Scientific Programmes Report No. 137. 199 pp.
Location: South African National Scientific Programme

Skelton, P. 1993. Complete Guide to the Freshwater Fishes of Southern Africa. Southern Book Publishers. 388pp.

The guide includes descriptions of most fish species common to the Okavango river and delta and the Chobe, Linyanti and Kwando river systems. Habitat, breeding and feeding requirements are described.
Location: Department of Wildlife and National Parks, Gaborone.

Skelton P.H. *et al.*, 1985. The Fishes of the Okavango drainage system in Angola, South West Africa and Botswana: taxonomy and distribution. *Bull. J.L.B. Smith Institute of Ichthyology*, No. 50, Grahamstown, RSA.

As per the title, the work describes the taxonomic characteristics and distribution of the fishes of the Okavango drainage system from the Angolan highland through the Caprivi Strip in Namibia and into the Okavango Delta, Lake Ngami and the Boteti River.
Location: J.L.B. Smith Institute of Ichthyology.

Skjonsberg, E. & Y. Merafe. 1987. The Okavango Fisheries Socio-Economic Study. Ministry of Agriculture, Gaborone.

The report emphasises the importance of artisanal subsistence and small-scale commercial fishing to residents of the Okavango Delta and neighbouring villages. The authors estimate the between 2,000 and 4,000 villagers fished for home consumption in 1987.
Location: Ministry of Agriculture library, Gaborone.

SMEC, 1986. Southern Okavango Integrated Water Development Project (SOIWDP) Phase I: Environmental Impact Study Inception and Progress Reports.
[ECOSURV ANNOTATION]
Location: Kalahari Conservation Society Library, Gaborone.

SMEC, 1987a. Southern Okavango Integrated Water Development Project (SOIWDP) Phase I, Vols. I & II: Final Report, Environmental Impact Study, Project Impact Assessment, Annexes A-F.
[ECOSURV ANNOTATION]
[ECOSURV LIBRARY - modified and moved from original list]
Location: Kalahari Conservation Society Library, Gaborone.

- SMEC, 1987b. SOIWDP Phase I: Summary Final Report.
[ECOSURV ANNOTATION]
Location: Kalahari Conservation Society Library, Gaborone.
- SMEC, 1987c. SOIWDP Phase I, Vol. II: Project Impact Assessment, Annexes C - F.
[ECOSURV ANNOTATION]
Location: Kalahari Conservation Society Library, Gaborone.
- SMEC, 1987d. SOIWDP Phase I: Draft Study Extension, Western Fringe Okavango Delta, Vol. I - Main Report.
[ECOSURV ANNOTATION]
Location: Kalahari Conservation Society Library, Gaborone.
- SMEC, 1987e. SOIWDP Phase I: Draft Study Extension, Western Fringe Okavango Delta, Vol. II - Appendices.
[ECOSURV ANNOTATION]
Location: Kalahari Conservation Society Library, Gaborone.
- SMEC, 1988a. SOIWDP Phase I, Vol. III: Sukwane Reservoir Impact Assessment.
[ECOSURV ANNOTATION]
Location: Kalahari Conservation Society Library, Gaborone.
- SMEC, 1988b. SOIWDP Phase I: Environmental Impact Study: Draft Report on Impacts on Bird Populations.
[ECOSURV ANNOTATION]
Location: Kalahari Conservation Society Library, Gaborone.
- SMEC, 1991a. SOIWDP Phase I: Revised Summary Report.
Location: Kalahari Conservation Society Library, Gaborone.
[ECOSURV ANNOTATION]
[ECOSURV LIBRARY]
- SMEC, 1991b. SOIWDP Phase I: Environmental Impact Study -Sukwane Reservoir and Pipeline to Mopipi.
[ECOSURV ANNOTATION]
Location: Kalahari Conservation Society Library, Gaborone.
- SMEC/KCS, 1989. Ecological Zoning Okavango Delta Final Report, Vol. I: Main Report; Vol. II: Appendices.
[ECOSURV ANNOTATION]
Location: Kalahari Conservation Society Library, Gaborone.
- Smithers R., and J. Skinner 1990. The mammals of the southern African sub-region. Univ. of Pretoria, Pretoria, RSA.
763 pp.

The work provides taxonomic descriptions, summarised life histories and habits, and general range distribution maps for all mammals of the southern African region, including the Okavango Delta drainage system from the Caprivi Strip in

Namibia southwards.
Location: Department of Wildlife and National Parks, Gaborone.

Spinage, C. 1989. Annotated bibliography of wildlife research and related topics in Botswana, 1959-1988.
Department of Wildlife and National Parks, Gaborone.

Contains 89 entries on wildlife research projects and related reports from the Okavango Delta region.
Location: Department of Wildlife and National Parks, Gaborone.

Spinage, C. 1990. Botswana's problem elephants. *Pachyderm*, 13:14-19.

The rapidly increasing elephant population is described, and management options discussed, based on various land uses and competition and limits of acceptable change to the environment.
Location: Department of Wildlife and National Parks, Gaborone.

Spinage, C. 1994. First Discoveries of New Antelopes in Botswana. *Botswana Notes and Records*, Vol. 26:109-113. Botswana Society, Gaborone.

Four new antelope species were discovered in northern Botswana in the 19th century (Sitatunga, Chobe Bushbuck, Puku and Red Lechwe). All four species occur in the Kwando-Linyanti-Chobe rivers system. Circumstances of their discoveries and identification are provided.
Location: Botswana Society, National Museum and National Archives, Gaborone.

Spinage, C. and J. Matlhare, 1991. Is the Kalahari cornucopia fact or fiction. *Journal of Applied Ecology*, 28:113-122.

The article describes the historical situation with cyclical increases in Kalahari ungulate populations following extended periods of above average rainfall and mass out-migrations and mortality of wildebeest and hartebeest documented during extended droughts.
Location: *Journal of Applied Ecology*.

Stigand, A. 1923. Ngamiland. *Geographical Journal*, 62(6): 401-419.
[ECOSURV ANNOTATION]
Location: Botswana National Archives, National Museum Library, Gaborone.

Swedeplan, 1989. Programme for the Planning of Resource Utilisation in the Okavango Delta Region, Vol. I: Natural Resource and Utilisation Inventory; Vol. II: Planning Programme; Vol. III: Executive Summary and Recommendations.

Inventory of natural resources and land use zoning and planning study for the Okavango Delta Region, including the Kwando-Linyanti-Chobe River systems.
Location: Swedeplan, Gaborone.

Tinley K. L. 1966. An ecological reconnaissance of the Moremi Wildlife Reserve, northern Okavango swamps, Botswana. Okavango Wildlife Society, RSA. 146 pp, incl. 42 photo-plates.

Report on a survey of Moremi Wildlife Reserve conducted in July 1964 and funded by the Okavango Wildlife Society of South Africa. The physical environment is described, soils and plant communities were sampled and classified. Large wildlife species, habitat requirements and movements are generally described. Lists of plants, mammals and birds

sighted during the survey are included. Recommendations are made for nature conservation measures, land use and management of tourism and more detailed ecological studies in the reserve, the Okavango delta and other important wildlife areas in the country.

Location: Okavango Wildlife Society, National Museum Library, National Archives, Gaborone.

Tlou, T. 1972. The taming of the Okavango swamps - the utilisation of a riverine environment, 1750-1800. Botswana Notes and Records 4:147-160. Botswana Society, Gaborone.

Prior to the immigration of the baYei and haMbukushu (ahead of the expanding Lozi empire) into the Okavango Delta region during the mid-18th century, the area had been occupied by the baNoka (river bushmen) for centuries. The baNoka relied primarily on hunting antelope and small game species and on gathering prior to the arrival of the other groups. They were also fishermen though lack of canoes (mekoro) limited their use of the Delta's waterways. New technologies introduced by the baYei and haMbukushu included iron working, mekoro, fish traps, harpoons for hippopotamus hunting, and floodplain and molapo cultivation, among others.

Location: Botswana Society, National Museum and National Archives, Gaborone.

Tree, A. J. 1972. Pectoral sandpiper *Calidris melanotos* in Botswana. Ostrich, 43:184.

The article describes a record sighting of the Pectoral sandpiper *Calidris melanotos* on the Boteti River in April 1971.

Location: Ostrich Ornithological Journal.

Turner, G. 1987. Hunters and herders of the Okavango Delta, northern Botswana. Botswana Notes and Records 19:25-40, Botswana Society, Gaborone.

Faunal remains from the sites at Matlhapaneng, Lotshitshi and Qugana on the southeastern edge of the Okavango Delta, dating from the 17th century BC to the 19th century AD, indicate mixed economies of wild hunted, snared, fished and gathered resources. The Qugana inhabitants depended entirely on wild resources while those from Matlhapaneng and Lotshitshi also kept cattle and/or goats. The presence of cattle at or before the fourth century AD contributes to the growing body of evidence suggesting that foragers acquired domestic stock at an early date, though it had not yet become an important part of the economy.

Location: Botswana Society, National Museum and National Archives, Gaborone.

ULG, 1994a. Status and trends of selected wildlife species in Botswana. Research Division, Department of Wildlife and National Parks, Gaborone. 85 pp.

Status and population trends for nineteen large wildlife species populations are discussed based on findings of country-wide aerial census surveys conducted between 1989 and 1993. Data from infrequent aerial surveys over various parts of the country dating back to 1978 (DHV, 1980) are mentioned, but were not used in the reported analyses. Changes in population estimates for the survey period are listed by District or region with population trends displayed graphically. Distribution maps delineate sub-populations through Botswana. Large declines in the populations of buffalo, eland, wildebeest, hartebeest and zebra (except in the Okavango Delta) are documented. Less significant declines in populations of other species by area are indicated. Kudu, reedbuck and waterbuck populations are apparently increasing throughout their ranges (possibly partly an artefact of better surveys). Springbok and tsessebe populations show slow increases during the survey period. Lechwe numbers appear to be stable in Okavango Delta and crashing in Linyanti. The elephant population continued to increase between 1987 and 1993 at a phenomenal 10% per annum (obviously including immigration from other countries).

Location: Department of Wildlife and National Parks, Gaborone.

ULG, 1994b. Aerial census of animals in Botswana - wet season, 1994. Technical Assistance to the Department of Wildlife and National Parks, Gaborone.

The report includes national distribution and density maps (based on 10x10 km grid squares) for 28 large wild animal species and five domestic livestock species enumerated during wet season aerial census surveys conducted for the DWNP in 1994. Population estimates are provided for major species by enumeration blocks and for protected and unprotected (tribal and freehold land) areas. Survey methodology and conditions are briefly discussed and flight data are provided for each survey. Computer data base includes transect counts, population estimates, density and distribution maps.

Location: Department of Wildlife and National Parks, Gaborone. Botswana Range Inventory and Monitoring Project GIS database (PC ArcInfo format), MOA, Gaborone.

ULG, 1994c. Aerial census of animals in Botswana - dry season, 1994. Technical Assistance to the Department of Wildlife and National Parks, Gaborone.

The report includes national distribution and density maps (based on 10x10 km grid squares) for 28 large wild animal species and five domestic livestock species enumerated during dry season aerial census surveys conducted for the DWNP in 1994. Population estimates are provided for major species by enumeration blocks and for protected and unprotected (tribal and freehold land) areas. Survey methodology and conditions are briefly discussed and flight data are provided for each survey. Computer data base includes transect counts, population estimates, density and distribution maps.

Location: Department of Wildlife and National Parks, Gaborone. Botswana Range Inventory and Monitoring Project GIS database (PC ArcInfo format), MOA, Gaborone.

ULG, 1994d. Aerial census of animals in northern Botswana - September 1993 (dry season). Technical Assistance to the Department of Wildlife and National Parks, Gaborone.

The report includes distribution and density maps based on 10x10 km grid squares, for 28 large wild animal species and five domestic livestock species enumerated during an aerial census survey of northern Botswana (north of 21° S. lat.) conducted for the DWNP in September 1993. Population estimates are provided for major species by CHA and for the Okavango Delta, Moremi Game Reserve, Chobe National Park, all protected areas (also including the Makgadikgadi-Nxai Pan National Park) and for unprotected areas. Survey methodology is discussed and flight / transect data are provided. Twenty-two large wild animal species and five domestic livestock species were enumerated in the Kwando-Linyanti-Chobe river drainages. Computer data base includes transect counts, population estimates, density and distribution maps.

Location: Department of Wildlife and National Parks, Gaborone.

UNDP/FAO, 1977. Investigation of the Okavango Delta as a primary water resource for Botswana, Vols. I & II. Technical Report AG:DP/BOT/71/506.

The reports were prepared as part of the first detailed study of the Okavango Delta as a primary water resource for potential agricultural, mining and industrial development (though several related studies and proposals preceded it). Physical characteristics of the region are described. Detailed information on assessments of resources, including water, fisheries, wildlife, livestock and human resources are provided. Mathematical modelling of water and other resources was introduced, as was the use of remote sensing and aerial surveys technology for the first time in the region. The influence of measures for artificial manipulation of flow during this period of general high flood levels was shown to be small in relation to natural variations. The study concluded (as it was meant to do) that such manipulations of flow constituted no serious risk to established ecological conditions on which wildlife resources depend.

Location: UNDP, Kalahari Conservation Society Library, Gaborone. Botswana National Archives.

UNDP/FAO, 1977. Investigation of the Okavango Delta as a primary water resource for Botswana - Okavango Bibliography. Technical Report AG: DP/BOT /71/506.
[ECOSURV ANNOTATION]

Location: UNDP, Kalahari Conservation Society Library, Gaborone [?], Botswana National Archives.

Van Rensburg H 1971. The ecology of the Okavango swamps. FAO/UNDP Tech. Note No. 19.

A summary report on the the ecology of the Okavango swamps based on preliminar data collection in preparation for the FAO/UNDP investigation of the Okavango Delta as a primary water resource for Botswana (1977).
[ECOSURV LIBRARY]

Verlinden,A. 1994. An action plan for the management of wildebeest populations in the Kalahari. Department of Wildlife and National Parks Research Division, Gaborone. 28 pp.

The report summarises Kalahari wildebeest habitat requirements and migration patterns and makes proposals for the provision of ground water supplies for wildebeest in the CKGR as a substitute for traditional water sources used during drought periods (Lake Ngami and the Boteti River).

Location: Department of Wildlife and National Parks Research Division, Gaborone.

von Richter,W 1973. Recent publications in the field of wildlife and related topics in Botswana. Botswana Notes and Records, Vol. 5:220-224. Botswana Society, Gaborone.

Fifty-two publications are listed and very briefly described, including 30 on studies concerning or conducted in the Okavango Delta region.

Location: Botswana Society, National Museum and National Archives, Gaborone.

von Richter,W 1976. Wildlife utilisation and integrated land use planning in Botswana. Field Doc.4, BOT/7/020. FAO, Rome.

The report presents finding on a wildlife utilisation survey of Botswana conducted during 1972-74 and follows closely on zoning and land use planning recommendations proposed by Sherburne, *et. al.*, 1974.

Location: Department of Wildlife and National Parks, Gaborone.

von Richter, W. & T. Butynski, 1973. Hunting in Botswana. Botswana Notes and Records 5:191-208. Botswana Society, Gaborone.

The article briefly describes the history of licensed hunting in Botswana, its legal framework and administration under the Fauna Conservation Proclamation (No. 22 of 1961) and its various amendments up to 1973. The need to recognise the traditional rights of various user groups through further amendment to the legislation is discussed.

Location: Botswana Society, National Museum and National Archives, Gaborone.

Water Transfer Consultants & CSIR, 1997a. Feasibility study on the Okavango River to Grootfontein link of the eastern national water carrier. Vol. 4, Part 3: Appendices. Downstream environmental impacts: Specialist Report, Appendix F: Freshwater molluscs and water-borne diseases in the Okavango River and Okavango Delta.

Downstream environmental impacts on freshwater molluscs and the incidence and distribution of water-borne diseases resulting from abstraction from the Okavango River and Delta are discussed. It was determined that proposed water off-take rates are unlikely to have impacts on downstream invertebrate fauna or the spread of water-borne diseases as water levels would not be significantly altered, with changes far less extreme than existing natural fluctuations within the system.

Surveys of the Okavango River in Namibia and Okavango River and Delta in Botswana yielded 15 snails, one limpet

and seven bivalve species. Four snail species collected are of medical (bilharzia host) or veterinary (liver fluke host) importance. One bivalve (*Ceratophallus natalensis*) was collected for the first time from the Okavango River during this survey.

Table 3b: Density of snails in Okavango Panhandle and Delta, Botswana, December 1996.

Annexure 1B: Details of collecting sites in the Okavango River and Delta in Botswana, December 1996.

Location: Water Transfer Consultants and CSIR, Pretoria, RSA.

Water Transfer Consultants & CSIR, 1997b. Feasibility study on the Okavango River to Grootfontein link of the eastern national water carrier. Vol. 4, Part 3: Appendices. Downstream environmental impacts: Specialist Report, Appendix G: Fish populations of the Okavango River system in Namibia and the Okavango Delta in Botswana.

Distribution of fish populations in the Okavango River and Okavango Delta is described and species listed (Annexure Tables 3 and 5); the status of fish communities was investigated; fish habitat preferences are described (Annexure Tables 4 and 6); importance of fish populations to ecosystem functioning was assessed; existing and potential future threats to fish populations were categorised.

Potential downstream environmental impacts on fish populations resulting from water abstraction from the Okavango River and Delta in Botswana were determined. The main impacts identified are:

Reductions in areas of seasonally inundated swamps will reduce available habitats and food supplies.

Shallow floodplain pools necessary to completion of breeding cycles in some species will be reduced in extent.

Seasonal migrations and movements to deep channels may be impeded by lowered water levels while water is already reaching record low levels.

Changes in species composition may occur with selective mortality in isolated pools between flood events.

Decreased water levels could accentuate the effects of insecticide spraying programmes aimed at controlling tsetse fly.

Most significant impacts are anticipated in the Okavango river between Rundu and the Cuito River confluence, and in the lower reaches of the seasonal swamps.

Location: Water Transfer Consultants and CSIR, Pretoria, RSA.

Water Transfer Consultants & CSIR, 1997c. Feasibility study on the Okavango River to Grootfontein link of the eastern national water carrier. Vol. 4, Part 3: Appendices. Downstream environmental impacts: Specialist Report, Appendix H: Reptiles and amphibians of the Okavango River system in Namibia and the Okavango Delta in Botswana.

A total of 64 reptiles and 28 amphibians have been recorded or are expected to occur in the Okavango Delta region. The largest and most important of these in economic terms is the Nile Crocodile (*Crocodylus niloticus*). Few species were recorded during field investigations, possibly due to the extremely dry conditions prevailing. Downstream environmental impacts on reptiles and amphibians of the Okavango River system in Namibia and the Okavango Delta in Botswana resulting from water abstraction for the eastern national water carrier in Namibia are discussed. The main impacts identified were:

Possible retarding of flooding and causing water levels to recede further under dry season conditions; reduction in the number and extent (of 'edge') of ephemeral pools which provide habitats for many Amphibian species;

gradual changes in the composition of plant communities and thus (directly or indirectly) in food

Supplies and habitat suitability.

These impacts are likely to be fairly localised at the distal end of the seasonal swamps in the Okavango Delta.

Annexure Table 1: List of reptiles and amphibians already recorded, or which are expected to occur, along the Okavango River and its environs in northern Namibia (N) and in the Okavango Panhandle and Okavango Delta in north-western Botswana (B), together with their habitat requirements (data after Griffin, 1985; Auerbach, 1987; Channing and Griffin, 1993).

Annexure Table 3: Reptiles and amphibians of Botswana restricted to the Okavango River, Delta and Chobe River System.

Location: Water Transfer Consultants and CSIR, Pretoria, RSA.

Water Transfer Consultants & CSIR, 1997d. Feasibility study on the Okavango River to Grootfontein link of the eastern national water carrier. Vol. 4, Part 3: Appendices. Downstream environmental impacts: Specialist Report, Appendix I: Mammals of the Okavango River system in Namibia and the Okavango Delta in Botswana.

Downstream environmental impacts on mammals of the Okavango River system in Namibia and the Okavango Delta in Botswana resulting from water abstraction for the eastern national water carrier in Namibia are discussed. The main impacts identified are:

Namibia: Increased habitat destruction due to demographic changes along lower reaches of the Okavango River.

Indirect impacts due to changes in timing, volume, duration and frequency of flooding of floodplains.

Botswana: Minimal reduction in mammal species diversity and abundance at the distal end of the seasonal swamps due to possible extension of dry periods.

Minimal reduction in mammal species diversity and abundance over the entire Delta as flooding regimes are slightly altered.

Annexure Tables 1-11. Mammal species lists, occurrence, water requirements, field survey findings (1996) and DWNP aerial census survey data (1992, 1994, 1996).

Location: Water Transfer Consultants and CSIR, Pretoria, RSA.

Water Transfer Consultants & CSIR, 1997e. Feasibility study on the Okavango River to Grootfontein link of the eastern national water carrier. Vol. 4, Part 3: Appendices. Downstream environmental impacts: Specialist Report, Appendix J: The avifauna of the Okavango River system in Namibia and the Okavango Delta in Botswana.

Field data collection involved compiling 44 bird checklists for quarter-degree squares visited in Namibia and Botswana during November and December 1996 (q.v. Annexures 1-13). Thirty-three checklists focused on waterbirds. Twenty-three Red Data List (IUCN) species were identified amongst a total of 280 species enumerated. Impressions from the field work indicated a preference by waterbirds for seasonally inundated areas at the swamp margins, rather than for permanently flooded areas. This probably relates to richer nutrient cycling and fluctuating conditions associated with seasonal wetlands. (These habitats are most likely to be adversely affected by any manipulation in water levels resulting from abstraction of water from the Okavango River). No specific impacts of water abstraction are discussed by the author.

Annexure 1: The common and scientific names of the 280 bird species recorded during this survey in Namibia and Botswana.

Annexures 2-13: Details of Namibia and Botswana bird counts.

Location: Water Transfer Consultants and CSIR, Pretoria, RSA.

Water Transfer Consultants, 1997a. Feasibility study on the Okavango River to Grootfontein link of the eastern national water carrier. Vol. 4, Part 2: Appendices. Pipeline initial environmental evaluation: Specialist Report, Appendix E: Amphibians and Reptiles.

Impacts on amphibians and reptiles resulting from the construction and use of the pipeline linking the Okavango River to the eastern national water carrier in Namibia are discussed. The main impacts identified are: disturbance and reductions in bio-diversity due to vegetation clearing, construction impacts, settlement, increased livestock numbers and agricultural developments, possible genetic isolation due to construction of barriers to movement and translocation of species to new ranges via the pipeline (including diseases that may affect species in other areas).

Table 1: List of 80 reptiles and 26 amphibians recorded, or that may occur along the Okavango River and environs and the proposed Rundu - Grootfontein pipeline, northern Namibia (after Griffin and Channing, 1991).

Location: Water Transfer Consultants.

Water Transfer Consultants, 1997b. Feasibility study on the Okavango River to Grootfontein link of the eastern national water carrier. Vol. 4, Part 2: Appendices. Pipeline initial environmental evaluation: Specialist Report, Appendix F: Birds.

A list of avian species recorded from the study area is not provided. At least eight arid woodland species listed on the Bird Red Data List (IUCN) occur in the study area.

Impacts on birds resulting from the construction and use of the pipeline linking the Okavango River to the eastern national water carrier in Namibia are discussed. The main impacts identified are: possible disturbance and displacement from the vicinity of the pipeline following settlement and resulting changes in land use, including increased livestock densities, tree felling, vegetation clearing and hunting.

Location: Water Transfer Consultants.

Water Transfer Consultants, 1997c. Feasibility study on the Okavango River to Grootfontein link of the eastern national water carrier. Vol. 4, Part 2: Appendices. Pipeline initial environmental evaluation: Specialist Report, Appendix G: Mammals.

Impacts on mammals resulting from the construction and use of the pipeline linking the Okavango River to the eastern national water carrier in Namibia are discussed. The main impacts identified are: potential loss of wildlife habitat and movement corridors if land along the pipeline's northern sections is converted to agricultural use; possible beneficial effects on water-dependent species if waterpoints along the pipeline are accessible.

Of 88 species of mammals potentially occurring in the area between Rundu and Grootfontein, only one, the wild dog (*Lycan pictus*) is endangered. Six other species that may occur here are considered vulnerable, and two (rodents) are considered rare.

Table 1: List of 88 Mammalian species potentially occurring in the pipeline area between Rundu and Grootfontein, including conservation status, water requirements and references.

Location: Water Transfer Consultants.

Water Transfer Consultants, 1997d. Feasibility study on the Okavango River to Grootfontein link of the eastern national water carrier. Vol. 4, Part 2: Appendices. Pipeline initial environmental evaluation: Specialist Report, Appendix H: Water-borne diseases.

Impacts on the incidence and distribution of water-borne diseases resulting from the construction and use of the pipeline linking the Okavango River to the eastern national water carrier in Namibia are discussed. Impacts identified are: the possible spread of malaria and (unlikely) bilharzia where standing water pools are allowed to develop at offtake points along the pipeline; possible, but unlikely, transport of viable trematode cercariae to the Grootfontein canal where they may be consumed by water users.

Location: Water Transfer Consultants.

WCI *et.al.*, 1992. Adaptive environmental assessment in the Okavango Delta, Botswana. Wildlife Conservation International, Conservation International and Univ. of Florida, USA.

A proposal for an adaptive environmental assessment the Okavango Delta, based primarily on systems modelling.

Location: Department of Wildlife and National Parks, Gaborone.

WCMC, 1991. Biodiversity guide to Botswana. Natural habitats, wild species and conservation areas. EEC, World Conservation Monitoring Centre, Cambridge, UK.

The report summarises the state of species biodiversity and conservation in Botswana in 1991. Threats to biodiversity and important areas without official protection status (including much of the Okavango Delta region) are identified.

Location: Department of Wildlife and National Parks, Gaborone, World Conservation Monitoring Centre, Cambridge,

UK.

Weaver, C. 1997. Background and potential impacts resulting from construction of a game and livestock proof fence by the government of Botswana, south of the West Caprivi Game Reserve. LIFE Project, Windhoek, Namibia.

The report reviews potential negative impacts of erecting a veterinary cordon fence on the Botswana-Namibia border where considerable cross-border movement has occurred.

Location: LIFE Project, Windhoek, Namibia.

Wetlands Int'l., 1996. African waterfowl census. Wetlands International, Washington, D.C. 206 pp.

This collection covering most African wetlands includes a very general waterfowl census of northern Botswana for economically important, rare and endangered species (in the Okavango, Chobe, Linyanti and Kwando river systems).

Location: Department of Wildlife and National Parks, Gaborone.

Williamson and Williamson, 1985. Kalahari Ungulate Movement Study. Final Report. Frankfurt Zoological Society, WWF, IUCN, Gland, Suisse. 128 pp.

The report summarises the findings of a four year study of ungulate movements, habitat use and preferences, and ecology in the northern Central Kalahari Game Reserve (CKGR), Botswana. Migration of wildebeest and hartebeest from western Kgalagadi and Ghanzi Districts through the CKGR in search of better grazing conditions and water supplies during drought was documented. Movements of other (water-independent) ungulate species were limited to response to local rainfall events or food supplies within the reserve

Location: Department of Wildlife and National Parks, Gaborone.

Williamson, D. and B. Mbano, 1988. Wildebeest mortality during 1983 at Lake Xau, Botswana. African Journal of Ecology, 26:341-344.

The article describes a sample survey of wildebeest carcasses conducted at Lake Xau during October 1983. It was estimated that more than 50,000 wildebeest which had migrated to the area from southwestern Botswana may have died due to lack of grazing within access of water supplies during a severe drought.

Location: Department of Wildlife and National Parks, Gaborone.

Work, D.R. & Owen-Smith, 1986. Preliminary management recommendations for Elephant in Northern Botswana. 14 pp. (typescript).

Based on research conducted since 1983, the report recommended that management plans must consider the regional, rather than national elephant population, that Chobe and Linyanti populations should be managed separately and that specific habitats under threat should receive protection. However, large-scale culling was not recommended.

Location: Department of Wildlife and National Parks, Gaborone.

Table 1: List of mammals of the Okavango Delta region, including conservation status (IUCN) and trade schedules (CITES) listings.

Thirty-three large mammal species and ninety-eight small mammal species have been recorded from the Okavango Delta region. The Black Rhinoceros (*Diceros bicornis*) and White Rhinoceros (*Ceratotherium simum*) almost certainly no longer occur in the region.

The Class Mammalia is represented by six Orders, viz:

1. Primates (one family)
2. Carnivora (three families)
3. Tubulidentata (one family)
4. Proboscidea (one family)
5. Perissodactyla (one family?)
6. Artiodactyla (four families)

Conservation Status:

P	=	Protected (Wildlife Conservation and National Parks Act, 1992)
PP	=	Partially Protected (Wildlife Conservation and National Parks Act, 1992)
E	=	Endangered (International Union for Conservation of Nature and Natural Resources)
V	=	Vulnerable (IUCN)
R	=	Rare (IUCN)
I	=	Appendix I, Convention on International Trade in Endangered Species, CITES)
II	=	Appendix II, CITES)
III	=	Appendix III, CITES)

LARGE MAMMALS

Primata:

Cercopithecidae	<i>Papio ursinus</i>	Chacma Baboon
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Carnivora:

Hyaenidae	<i>Hyaena brunnea</i>	Brown Hyaena (P,I)
	<i>Crocuta crocuta</i>	Spotted Hyaena

Felidae	<i>Acinonyx jubatus</i>	Cheetah (P,I)
	<i>Panthera pardus</i>	Leopard (PP,R,I)
	<i>Panthera leo</i>	Lion (PP)

Canidae	<i>Lycaon pictus</i>	Wild Dog (P,E)
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Tubulidentata:

Orycteropodidae	<i>Orycteropus afer</i>	Antbear (P,II)
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Proboscidea:

Elephantidae	<i>Loxodonta africana</i>	African Elephant (PP)
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Perissodactyla

Equidae	<i>Equus burchelli</i>	Burchell's Zebra
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Artiodactyla:

Suidae	<i>Phacochoerus aethiopicus</i> <i>Potamochoerus porcus</i>	Warthog Bush Pig (R)
Hippopotamidae	<i>Hippopotamus amphibius</i>	Hippopotamus (P,V)
Giraffidae	<i>Giraffa camelopardis</i>	Giraffe (P,V)
Bovidae	<i>Sylvicapra grimmia</i> <i>Ourebia ourebi</i> <i>Raphicerus campestris</i> <i>Tragelaphus strepsiceros</i> <i>Tragelaphus spekei</i> <i>Tragelaphus scriptus</i> <i>Aepyceros melampus</i> <i>Redunca arundinum</i> <i>Kobus ellipsiprymnus</i> <i>Kobus leche</i> <i>Oryx gazella</i> <i>Antidorcus marsupialis</i> <i>Hippotragus niger</i> <i>Hippotragus equinus</i> <i>Taurotragus oryx</i> <i>Syncerus caffer</i> <i>Connochaetes taurinus</i> <i>Alcephalus busephalus</i> <i>Damaliscus lunatus</i>	Duiker Oribi (P) Steenbok Kudu Sitatunga (V,III) Bushbuck (PP,V) Impala Reedbuck Waterbuck (P,R) Lechwe (V,II) Gemsbok Springbok Sable Antelope (PP,V) Roan Antelope (P,R,II) Eland (PP) African Buffalo Blue Wildebeest Red Hartebeest Tsessebe (V)

SMALL MAMMALS

Carnivora:

Canidae

<i>Canis mesomelas</i>	Black-backed jackal
<i>Canis adustus</i>	Side-striped jackal
<i>Otocyon megalotis</i>	Bat-eared fox (V)
<i>Vulpes chama</i>	Cape fox

Protelidae

<i>Proteles cristatus</i>	Aardwolf (P,R,III)
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Felidae

<i>Felis caracal</i>	Caracal (II)
<i>Felis lybica</i>	African wildcat (V,II)
<i>Felis serval</i>	Serval (P,II)
<i>Felis nigripes</i>	Black-footed cat (P,I)

Mustelidae

<i>Aonyx capensis</i>	Cape clawless otter (P,R,II)
<i>Lutra maculicollis</i>	Spotted-necked otter (P,R,II)
<i>Ictonyx striatus</i>	Striped polecat
<i>Mellivora capensis</i>	Honey badger (P,V,III)

Viverridae

<i>Genetta genetta</i>	Small-spotted genet
<i>Genetta tigrina</i>	Large-spotted genet
<i>Civettictis civetta</i>	African civet (P,R,III)
<i>Paracynictis selousii</i>	Selous' mongoose (R)
<i>Herpestes ichneumon</i>	Large grey mongoose
<i>Atilax paludinosus</i>	Water mongoose
<i>Cynictis penicillata</i>	Yellow mongoose
<i>Herpestes sanguineus</i>	Slender mongoose
<i>Ichneumia albicauda</i>	White-tailed mongoose
<i>Mungos mungo</i>	Banded mongoose
<i>Helogale parvula</i>	Dwarf mongoose

Rodentia:

Hystriidae

<i>Hystrix africaeaustralis</i>	Crested porcupine (III)
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Pedetidae

<i>Pedetes capensis</i>	Springhare
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Scuiridae

<i>Paraxerus cepapi</i>	Tree squirrel
<i>Xerus inauris</i>	Ground squirrel

Gliridae

<i>Graphiurus murinus</i>	Woodland dormouse
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Muscardinidae

<i>Graphiurus murinus</i>	Dormouse
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Thryomyidae

<i>Thryonomys swinderianus</i>	Greater cane rat
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Cricetidae / Muridae

<i>Pelomys fallax</i>	Groove-toothed mouse
<i>Acomys spinosissimus</i>	Spiny mouse
<i>Lemniscomys rosalia</i>	Single-striped mouse
<i>Rhabdomys pumilio</i>	Striped mouse
<i>Zelotomys woosnami</i>	Woosnam's desert rat (R)
<i>Dasymys incomtus</i>	Water rat
<i>Mastomys natalensis</i>	Multimammate mouse
<i>Praomys shortridgei</i>	Shortridge's mouse (R)
<i>Thallomys paedulus</i>	Tree mouse
<i>Aethomys namaquensis</i>	Namaqua rock mouse
<i>Aethomys chrysophilus</i>	Red veld rat
<i>Otomys angoniensis</i>	Angoni vlei rat
<i>Saccostomus campestris</i>	Pouched mouse

<i>Leggada minutoides</i>	Pygmy mouse
<i>Dendromus melanotis</i>	Grey climbing mouse
<i>Dendromus mesomelas</i>	Chestnut climbing mouse
<i>Dendromus mysticalis</i>	Lesser climbing mouse
<i>Steatomys pratensis</i>	Fat mouse
<i>Steatomys minutus</i>	Tiny fat mouse
<i>Steatomys krebsii</i>	Peter's fat mouse

<i>Desmodillus auricularis</i>	Short-tailed gerbil
<i>Gerbillurus pæba</i>	Hairy-footed gerbil
<i>Tatera leucogaster</i>	Bushveld gerbil
<i>Tatera brantsii</i>	Highveld gerbil

Bathyergidae

<i>Cryptomys damarensis</i>	Damara molerat
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Insectivora:

Maroscelididae

<i>Elephantulus brachyrhynchus</i>	Short-snouted elephant shrew
<i>Elephantulus intufi</i>	Bushveld elephant shrew

Soricidae

<i>Suncus lixus</i>	Greater dwarf shrew
<i>Crocidura occidentalis</i>	Giant musk shrew
<i>Crocidura mariquensis</i>	Swamp musk shrew
<i>Crocidura bicolor</i>	Tiny musk shrew
<i>Crocidura cyanea</i>	Reddish-grey musk shrew
<i>Crocidura hirta</i>	Lesser red musk shrew

Erinaceidae

<i>Atelerix frontalis</i>	African Hedgehog (R)
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Chiroptera:

Pteropodidae

<i>Epomophorus crypturus</i>	Epauletted fruit bat
<i>Eidolon helvum</i>	Staw-coloured fruit bat

Emballonuridae

<i>Taphozous mauritanus</i>	Tomb bat
<i>Taphozous perforatus</i>	Egyptian tomb bat

Molossidae

<i>Tadarida aegyptiaca</i>	Egyptian free-tailed bat
<i>Tadarida midas</i>	Midas free-tailed bat
<i>Tadarida condylura</i>	Angola free-tailed bat
<i>Tadarida nigeriae</i>	Spillmann's free-tailed bat
<i>Tadarida pumila</i>	Little free-tailed bat

Vespertilionidae

<i>Miniopterus schreibersii</i>	Schreibers long-fingered bat
<i>Pipistrellus ruppelli</i>	Ruppell's pipistrelle
<i>Pipistrellus rusticus</i>	Rusty pipistrelle
<i>Pipistrellus nanus</i>	Banana bat
<i>Eptesicus capensis</i>	Cape serotine bat
<i>Eptesicus rendalli</i>	Rendall's serotine bat
<i>Eptesicus zuluensis</i>	Aloe bat
<i>Scotophilus dinganii</i>	Yellow house bat
<i>Scotophilus leucogaster</i>	Lesser yellow house bat
<i>Chalinolobis variegatus</i>	Butterfly bat
<i>Nycticeius schlieffenii</i>	Schlieffen's bat
<i>Kerivoula harrisoni</i>	Harrison's wooly bat
<i>Laephotis wintoni</i>	Winton's long-eared bat

Nycteridae

<i>Nycteris thebaica</i>	Common slit-faced bat
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Rhinolophidae

<i>Rhinolophus clivosus</i>	Geoffroy's horseshoe bat
<i>Rhinolophus denti</i>	Dent's horseshoe bat
<i>Rhinolophus darlingi</i>	Darling's horseshoe bat

Hipposideridae

<i>Hipposideros commersoni</i>	Commerson's leaf-nosed bat
<i>Hipposideros caffer</i>	Sundevall's leaf-nosed bat

Primata:

Lorisidae

<i>Galago moholi</i>	Lesser night ape (P,II)
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Cercopithecidae

<i>Cercopithecus aethiops</i>	Vervet monkey (II)
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Pholidota:

Manidae

<i>Manis temminckii</i>	Pangolin (P,V,I)
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Lagomorpha:

Leporidae

<i>Lepus capensis</i>	Cape hare
<i>Lepus saxatilis</i>	Scrub hare

Table 1: Fish Species Of The Okavango River System (After SMEC, 1989)

Location Code:

- | | |
|---------------------------|------------------------|
| 1. Angolan Headwaters | 5. Seasonal Swamp |
| 2. Okavango R. in Namibia | 6. Outflow Rivers |
| 3. Okavango R. Panhandle | 7. Lake Ngami |
| 4. Permanent Swamp | 8. Lake Xau/Mopipi Dam |

LOCATION:		1	2	3	4	5	6	7	8
MORMYRIDAE									
<i>Hippopotamyrus ansorgii</i>	Slender stonebasher		x	x	x	x			
<i>H. discorhynchus</i>	Zambezi parrotfish	x	x	x	x	x	x	x	
<i>Marcusenius macrolepidotus</i>	Bulldog	x	x	x	x	x	x	x	
<i>Mormyrus lacerda</i>	Western bottlenose		x	x	x	x	x	x	x
<i>Petrocephalus catostoma</i>	Churchill	x	x	x	x	x	x	x	x
<i>Pollimyrus castelnaui</i>	Dwarf stonebasher	x	x	x	x	x	x	x	x
KNERIIDAE									
<i>Parakneria fortuita</i>	Cubango kneria		x						
CHARACIDAE									
<i>Brycinus lateralis</i>	Striped robber	x	x	x	x	x	x	x	x
<i>Hydrocynus forskahlii</i>	Tigerfish		x	x	x	x	x	x	
<i>Micralestes acutidens</i>	Silver robber	x	x	x	x	x	x	x	x
HEPSETIDAE									
<i>Hepsetus odoe</i>	African pike		x	x	x	x	x	x	x
DISTICHODONTIDAE									
<i>Hemigrammocharax machadoi</i>	Dwarf citharine		x	x	x	x	x	x	x
<i>H. monardi</i>	Monard's citharine		x						
<i>H. multifasciatus</i>	Multibar citharine	x	x	x	x	x	x	x	
<i>Nannocharax macropterus</i>	Broadbarred citharine		x	x					
CYPRINIDAE									
<i>Barbus afrovernayi</i>	Spot-tailed barb			x	x	x	x	x	x
<i>B. barotseensis</i>	Barotse barb		x	x					
<i>B. barnardi</i>	Blackbeard barb		x	x	x	x	x	x	x
<i>B. bifrenatus</i>	Hyphen barb		x	x	x	x	x	x	x
<i>B. codringtoni</i>	Upper Zambezi yellowfish	x	x						
<i>B. eutaenia</i>	Orangefin barb		x	x	x	x			
<i>B. fasciolatus</i>	Red barb		x	x	x	x	x	x	
<i>B. haasianus</i>	Sicklefin barb			x	x	x			
<i>B. lineomaculatus</i>	Line-spotted barb	x							
<i>B. multilineatus</i>	Copperstripe barb	x	x	x	x	x	x		
<i>B. paludinosus</i>	Straightfin barb		x	x	x	x	x	x	x
<i>B. poechii</i>	Dashtail barb		x	x	x	x	x	x	
<i>B. radiatus</i>	Beira barb	x	x	x	x	x	x	x	
<i>B. tangandensis</i>	Redspot barb			x	x				
<i>B. thamalakanensis</i>	Thamalakanane barb		x	x	x	x	x	x	
<i>B. unitaeniatus</i>	Longbeard barb		x	x	x		x	x	x
<i>B. sp</i> (unnamed)			x						
<i>Coptostomabarbus wittei</i>	Upjaw barb			x	x	x	x		
<i>Labeo cylindricus</i>	Redeye labeo	x	x	x	x				
<i>L. lunatus</i>	Upper Zambezi labeo	x	x	x	x	x	x		
<i>Mesobola brevianalis</i>	River sardine	x	x	x					
<i>Opsaridium zambezense</i>	Barred minnow		x	x	x				

BAGRIDAE

<i>Auchenoglanis ngamensis</i>	Zambezi grunter	x	x	x	x	x	x	x	x
<i>Leptoglanis rotundiceps</i>	Spotted sand catlet	x	x	x		x	x		
<i>L. sp.</i> (unnamed)			x						

SCHILBEIDAE

<i>Schilbe mystus</i>	Silver catfish	x	x	x	x	x	x	x	x
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AMPHILIIDAE

<i>Amphilius uranoscopus</i>	Stargazer mountain catfish	x	x						
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CLARIIDAE

<i>Clarias dumerilii</i>	Okavango catfish	x	x						
<i>C. gariepinus</i>	Sharptooth catfish	x	x	x	x	x	x	x	x
<i>C. ngamensis</i>	Blunt-tooth catfish	x	x	x	x	x	x	x	x
<i>C. theodorae</i>	Snake catfish	x	x	x	x	x	x		
<i>Clariallabes platyprosopos</i>	Broadhead catfish		x						

MOCHOKIDAE

<i>Chiloglanis fasciatus</i>	Striped rock catlet	x	x	x					
<i>Synodontis leopardinus</i>	Leopard squeaker	x	x	x	x	x	x	x	x
<i>S. macrostigma</i>	Large-spot squeaker	x	x	x	x	x	x	x	x
<i>S. nigromaculatu</i>	Spotted squeaker	x	x	x	x	x	x	x	x
<i>S. woosnami</i>	Upper Zambezi squeaker	x	x	x	x	x	x	x	x

CYPRINODONTIDAE

<i>Aplocheilichthyes huterai</i>	Mesh-scaled topminnow	x	x	x	x	x	x	x	
<i>A. johnstoni</i>	Johnston's topminnow	x	x	x	x	x	x	x	x
<i>A. katangae</i>	Striped topminnow	x	x	x	x	x	x	x	

CICHLIDAE

<i>Hemichromis elongatus</i>	Barred jewelfish	x	x	x	x	x	x	x	
<i>Oreochromis andersoni</i>	Threespot tilapia	x	x	x	x	x	x	x	x
<i>O. macrochir</i>	Greenhead tilapia	x	x	x	x	x	x	x	
<i>Pharyngochromis darlingi</i>	Zambezi happy	x	x	x	x	x	x	x	
<i>Pseudocrenilabrus philandee</i>	Southern mouthbrooder	x	x	x	x	x	x	x	
<i>Serranochromis carlottae</i>	Rainbow happy		x	x	x	x	x		
<i>S. codringtonii</i>	Green happy			x	x	x	x	x	
<i>S. giardi</i>	Pink happy			x	x	x	x	x	x
<i>S. greenwoodi</i>	Greenwood's happy						x		
<i>S. gracilis</i>	Slender happy	x							
<i>S. angusticeps</i>	Thinface largemouth	x	x	x	x	x	x		
<i>S. longimanus</i>	Longfin largemouth				x	x	x	x	
<i>S. robustus</i>	Nembwe			x	x	x	x	x	x
<i>S. macrocephalus</i>	Purpleface largemouth	x	x	x	x	x	x	x	
<i>S. thumbergi</i>	Brownspot largemouth	x	x	x	x	x	x	x	
<i>Tilapia rendalli</i>	Northern redbreast tilapia	x	x	x	x	x	x	x	x
<i>T. ruweti</i>	Okavango tilapia			x	x	x	x	x	
<i>T. sparrmanii</i>	Banded tilapia	x	x	x	x	x	x	x	

ANABANTIDAE

<i>Ctenopoma ctenotis</i>	Blackspot climbing perch				x	x	x		
<i>C. multispinus</i>	Manyspined climbing perch	x	x	x	x	x	x	x	x

MASTACEMBELIDAE

<i>Afromastacembelus frenatus</i>	Short-tailed spiny eel	x	x	x	x	x			
<i>A. vanderwaali</i>	Ocellated spiny eel		x	x					

Table 1: Number of bird species and their major activities in a variety of habitats in the Okavango River and Delta systems (after Swedeplan, 1989).

Habitat	Number of Species			Total
	Resident	Breeding	Feeding	
DELTA				
Open water with aquatics	14	1	75	90
Perm. flooded, aquatics, sedges	5	1	36	42
Seasonally flooded in depressions	4	4	44	52
Papyrus beds, perm. wet	4	0	6	10
Phragmites (reeds)	14	21	7	42
Swamp fig fringing islands	1	26	4	31
Miscanthidium junceum beds	18	5	14	37
Flooded tall grass	22	9	26	57
Flooded short grass	19	1	70	90
Short dry grassland	27	1	40	68
Island grassland	47	3	43	93
Palm woodland	147	9	16	172
Riverain woodland	159	10	19	188
Camel thorn woodland	133	2	18	153
Tall mopane with understory	88	0	15	103
Scrub mopane	1	0	0	1
RIVERS (incl. ancient beds)				
Riverain woodland 148	121	6	21	
Channel grassland, grazed, floods 46	8	2	36	
Open water incl. margins & reeds 81	14	4	63	
LAKE NGAMI				
Open water incl. margins 85	12	1	72	
Sesbania stands (< 2 m) 13	1	3	9	
Panicum repens grassland 63	17	14	32	
Cynodon dactylon grassland 72	20	12	40	
Acacia tortilis woodland 105	79	1	25	
Camel thorn woodland 126	114	2	10	
Acacia mellifera thicket 24	10	0	14	
Sand ridge separating lake-savanna 57	50	0	7	
SAVANNA				
Tall mopane 74	62	0	12	
Scrub mopane 0	0	0	0	

Terminalia sericea, Kalahari sand 83	63	0	20
Acacia species, Kalahari sand 119	105	0	14
Acacia tortilis 108	80	1	27
Acacia erioloba 129	114	2	13
Acacia mellifera 20	10	0	10
URBAN 1) 17	12	0	5
AERIAL 2) 12	0	0	12

- 1) Built-up areas where buildings, roads and exotic garden plants have largely displaced the original vegetation.
- 2) To provide for those species who feed on the wing over almost any terrestrial habitat.

TABLE 1: A Checklist of 28 Amphibians and 67 Reptiles of the Okavango Delta, with comments on localities of occurrence (after SMEC/KCS, 1989).

	Common Name	Comments on Localities
AMPHIBIA		
PIPIDAE		
<i>Xenopus laevis petersii</i>	Common platanna	edge of Delta
<i>Xenopus muelleri</i>	Tropical platanna	Delta proper
BUFONIDAE		
<i>Bufo gutturalis</i>	Guttural toad	widespread
<i>Bufo garmani</i>	Olive toad	widespread
<i>Bufo maculatus</i>	Flat-backed toad	NE Delta
<i>Bufo lemairii</i>	Lemair's toad	Panhandle and NE Delta
RANIDAE		
<i>Pyxicephalus a. adspersus</i>	Bullfrog	Delta fringe
<i>Pyxicephalus a. edulis</i>	Lesser bullfrog	Xugana
<i>Tomopterna cryptotis</i>	Tremolo sand frog	SE Delta
<i>Tomopterna krugerensis</i>	Knocking sand frog	Toteng
<i>Ptychadena subpunctata</i>	Spot-bellied grass frog	widespread
<i>Ptychadena oxyrhynchus</i>	Sharp-nosed grass frog	E Delta
<i>Ptychadena anchietae</i>	Plain grass frog	Cakanaca
<i>Ptychadena m. mascareniensis</i>	Mascarene grass frog	widespread
<i>Ptychadena taenioscelis</i>	Dwarf grass frog	NE Delta
<i>Ptychadena guibeii</i>	Guibe's grass frog	Gumare
<i>Ptychadena mossambica</i>	Broad banded grass frog	Maun
<i>Phrynobatrachus natalensis</i>	Snoring puddle frog	NE Delta
<i>Phrynobatrachus mababiensis</i>	Dwarf puddle frog	Cacaba, Xugana
<i>Phrynobatrachus parvulus</i>	Small puddle frog	Khwai R.
HEMISOTIDAE		
<i>Hemisis m. marmoratum</i>	Mottled shovel-nosed frog	NE Delta
<i>Hemisis guineensis microps</i>	Guinea shovel-nosed frog	Central-N Delta
MICROHYLIDAE		
<i>Phrynomerus b. bifasciatus</i>	Banded rubber frog	widespread
<i>Breviceps adspersus</i>	Bushveld rain frog	S and W fringe
HYPEROLIIDAE		
<i>Kassina senegalensis</i>	Bubbling kassina	S and NE Delta
<i>Hyperolius nasutus</i>	Long reed frog	Central and NE Delta
<i>Hyperolius benguellensis</i>	Benguella reed frog	Xo Flats-Piajio
<i>Hyperolius marmoratus angolensis</i>	Painted reed frog	widespread
REPTILIA		
TESTUDINIDAE		
<i>Geochelone pardalis babcocki</i>	Leopard tortoise	S and W fringe
<i>Psammobates oculifer</i>	Kalahari geometric tortoise	Sepupa and Sandveld Tongue
<i>Kinixys belliana spekii</i>	Bell's hinged tortoise	Chief's Island

PELOMEDUSIDAE		
<i>Pelomedusa subrufa</i>	Cape terrapin	Central, S and NE Delta
<i>Pelusios subniger</i>	Pan hinged terrapin	S and E Delta
<i>Pelusios b. bechuanicus</i>	Okavango hinged terrapin	widespread
<i>Pelusios rhodesianus</i>	Chestnut hinged terrapin	Maun, Chief's Island
CROCODYLIDAE		
<i>Crocodylus niloticus</i>	Nile crocodile	widespread
GEKKONIDAE		
<i>Hemidactylus m. mabouia</i>	Tropical house gecko	Xugana
<i>Pachydactylus c. capensis</i>	Cape thick-toed gecko	Tsao
<i>Pachydactylus bibronii</i>	Bibron's thick-toed gecko	S and W fringe
<i>Lygodactylus c. capensis</i>	Common dwarf gecko	S and E Delta
<i>Lygodactylus chobiensis</i>	Chobe dwarf gecko	NW and E Delta
AGAMIDAE		
<i>Agama atricollis</i>	Black-necked tree agama	Sepupa
<i>Agama a. aculeata</i>	Spiny agama	Southern fringe
<i>Agama aculeata armata</i>	Spiny agama	Khwai, Maqwee
CHAMAELEONIDAE		
<i>Chamaeleo d. dilepis</i>	Flap-necked chameleon	Maun, Kudumane, Chief's Island
SCINCIDAE		
<i>Typhlacontias gracilis rohani</i>	Gracile legless skink	Maun, Shakawe
<i>Typhlosaurus l. lineatus</i>	Striped legless skink	Maun
<i>Mabuya striata wahlbergii</i>	Common striped skink	widespread
<i>Mabuya varia</i>	Variable skink	widespread
<i>Lygosoma s. sundevallii</i>	Sundevall's writhing skink	widespread
<i>Panaspis (Afroblepharus) wahlbergii</i>	Wahlberg's snake-eyed skink	widespread in North
CORDYLIDAE		
<i>Gerrhosaurus multilineatus auritus</i>	Many-lined plated lizard	Delta fringes
<i>Gerrhosaurus n. nigrolineatus</i>	Black-lined plated lizard	Nokaneng, Toteng
LACERTIDAE		
<i>Heliobolus lugubris</i>	Black and yellow sand lizard	Delta fringes
<i>Pedioplanis l. lineocellata</i>	Ocellated sand lizard	Shorobe
<i>Ichnotropis squamulosa</i>	Tropical rough scaled sand lizard	widespread, not Panhandle
VARANIDAE		
<i>Varanus exanthematicus albigularis</i>	Savanna monitor	Delta fringes, Chief's Island
<i>Varanus n. niloticus</i>	Nile monitor	Delta fringes, Chief's Island
AMPHISBAENIDAE		
<i>Zygaspis quadrifrons</i>	Eastern worm lizard	widespread
<i>Monopeltis anchietae</i>	Anchieta's worm lizard	Khwai, Shorobe
<i>Monopeltis sphenorhynchus mauricei</i>	Wedge-snouted worm lizard	SE and E Delta
<i>Dalophia pistillum</i>	Horny-tailed worm lizard	widespread, not Panhandle

TYPHLOPIDAE

Typhlops schlegelii petersii Schlegel's blind snake NE Delta

LEPTOTYPHLOPIDAE

Leptotyphlops s. scutifrons Peter's thread snake S and E fringe

BOIDAE

Python sebae natalensis Southern African python E and S Delta, Chief's Island

COLUBRIDAE

Lamprophis fuliginosus Brown house snake Maun, Toteng, Xugana
Lycophidion c. capense Cape wolf snake Maun
Pseudaspis cana Mole snake widespread
Natriciteres olivacea Olive marsh snake Maun, Seronga, Shakawe
Limnophis bicolor bangweolicus Eastern striped swamp snake Maun, Xugana
Psammophylax tritaeniatus Striped skaapesteker S Delta
Rhamphiophis oxyrhynchus rostratus Eastern rufous beaked snake Central and NE Delta
Psammophis s. subtaeniatus Western stripe-bellied sand snake W, S and E fringe
Psammophis phillipsii Olive grass snake widespread
Psammophis angolensis Angola sand snake Maun, Shakawe, Seronga, Xugana
Amblyodipsas p. polylepis Common purple-glossed snake W, S and E Delta
Xenocalamus b. bicolor Variable quill-snouted snake SE and Central Delta
Xenocalamus mechowii inornatus Elongate quill-snouted snake E, Central, SE Delta
Atractaspis bibronii Southern stiletto snake W and S fringe
Philothamnus ornatus Ornate green snake Sepupa, Xugana
Philothamnus angolensis Angolan green snake widespread in Delta
Philothamnus s. semivariatus Spotted bush snake widespread
Crotaphopeltis hotamboeia Herald snake Xugana
Crotaphopeltis barotseensis Barotse water snake Sepupa, Xugana
Telescopus s. semiannulatus Eastern tiger snake widespread on fringe
Dispholidus t. typus Boomslang widespread in S and E
Thelotornis capensis oatesii Vine snake widespread
Dasyptis scabra Common egg-eater widespread

ELAPIDAE

Elapsoidea semiannulata boulengeri Zambezi garter snake E and SE fringe
Aspidelaps s. scutatus Shield snake S and W fringe
Naja haje anchietae Anchieta's cobra NW and E fringes
Naja mossambica Mocambique spitting cobra W and Central Delta
Dendroaspis polylepis Black mamba widespread

VIPERIDAE

Causus rhombeatus Rhombic night adder widespread
Bitis a. arietans Puff adder widespread

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