The importance of weirs as refugia for hippopotami and crocodiles in the Limpopo River, South Africa

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Abstract

The distribution of the South African Red Data species hippopotami and crocodiles along the Limpopo River is discussed in relation to the factors affecting their survival. The severe modifications of this river and its tributaries are responsible for a conservation dilemma. On the one hand such modifications have contributed to the drying-up and impoverishment of the system, but on the other hand permanent water behind storage weirs has been provided, enabling most aquatic biota to survive, particularly in times of drought. The importance of these weirs in the main channel of the Limpopo River is discussed in comparison to the contribution made by natural pools towards the survival of hippopotami and crocodiles. Fifty per cent of the former and 72% of the latter occurred along those stretches of river where weirs are prevalent. Problems and possible solutions to safeguard the survival of these species along the Limpopo River are discussed.

Introduction

The conservation of all biota is dependent on the quality and quantity of the habitat. Due to the low rainfall and sporadic but severe droughts in South Africa, its rivers are amongst the most limited and threatened habitats. These naturally adverse conditions have been exacerbated by the various demands placed on the rivers by a burgeoning human population. South African rivers have been extensively degraded (Huntley, 1978; O'Keefe et al., 1989) influencing the survival of aquatic biota such as fish (Skelton, 1987), hippopotamus *Hippopotamus amphibius* (Smithers, 1986) and the Nile crocodile *Crocodylus niloticus* (Jacobsen, 1988). Both of the latter species are listed in the South African Red Data Books, the former as rare (Smithers, 1986) and the crocodile as vulnerable (Jacobsen, 1988). These species still occur in the Transvaal, but their continued survival outside of the Kruger National Park is now precariously dependent on an adequate supply of water and an assured food supply.

The Limpopo River is one of the largest rivers of the Transvaal and forms the border between the Republic of South Africa and its northern neighbours. The large-scale abstraction of water from the system was enhanced through the construction of weirs and dams in its catchment and has had a negative impact on the flow regime of this river. Weirs, primarily for storage purposes, have also been constructed in the main river channel. These are now perhaps vital for the continued survival of aquatic biota including hippopotami and crocodiles in large sections of an otherwise very impoverished system. The purpose of this study was to assess the importance of these weirs as refugia for these animals.

The study area

The study area comprises the Limpopo River from the confluence of the Crocodile and Marico Rivers (900 m a.m.s.l.) for a distance of 645 km to the western Kruger National Park border (200 m a.m.s.l.). The most important South African tributaries of the Limpopo are the Crocodile, Marico, Mokolo, Lephalala, Mogalakwena and Sand Rivers while the Notwane and Motloutse Rivers contribute flow from Botswana and the Umzingwane and Bubye Rivers from Zimbabwe. The Shashe River, which forms part of the border between Botswana and Zimbabwe, is the largest tributary of the Limpopo (Fig. 1).

Despite its large catchment and numerous tributaries, the Limpopo is a highly seasonal river with 90 % of the mean annual runoff (MAR) occurring during the months of December to April. Flow during October, November and May to September is extremely erratic and low with no-flow conditions occurring mostly during these months. The longest recorded period of flow in the river at Beit Bridge is 8 months and the shortest, 2 months. The MAR at Beit Bridge has been estimated at 1 904,77 x 10^6 m^3 (min. = 35 x 10^6 m^3; max.= 6 876 x 10^6 m^3) (Nel, 1989).

Precipitation is the highest in the southern section of the catchment (600 to 800 mm/a), decreasing to the northwest (400 to 600 mm/a) and reaching a low along the northern parts of the Limpopo Valley (200 to 400 mm/a). Evaporation varies from 1 800 to 2 000 mm/a in the southern parts to 2 000 to 2 200 mm/a in the northern parts of the Limpopo Valley (Anon, 1986).

Downstream from the confluence of the Crocodile and Marico Rivers, the Limpopo flows in a deep channel of 30 to 50 m wide with tall trees (predominantly *Acacia karoo, Faidherbia albida* and *Combretum erythrophyllum*), shrubs and grass lining the banks. In the dry season pools are found on the outside of bends in the river, most of which are ephemeral. The river bed in this area consists mainly of sand and mud. Crocodiles and hippopotami are found along this stretch (Jacobsen, 1984). Downstream from this point and particularly after the confluence with the Mokolo River, the Limpopo gradually widens to 40 to 60 m and the banks are less steep. Well-vegetated islands occur sporadically along the river. Although the river bed still consists mainly of sand, many permanent pools form behind natural flow barriers, like fault lines and dykes, which traverse the river and provide a habitat for crocodiles and hippopotami, e.g. an extensive rocky bed area with pools found for some distance downstream from the confluence with the Mogalakwena River. In addition to forming pools when the river flows, these natural flow barriers also cause water in the sand bed to rise to the surface during the no-flow season. Riparian vegetation along this river section consists mainly of tall trees (*F. albida, Ficus sycomorus* and *C. erythrophyllum*), shrubs, grass and sporadically occurring reed patches (*Phragmites* spp.). The Limpopo maintains these characteristics up to its confluence with the Motloutse River. From here to the confluence with the Shashe River the Limpopo widens to 60 to 80 m in width and pools formed

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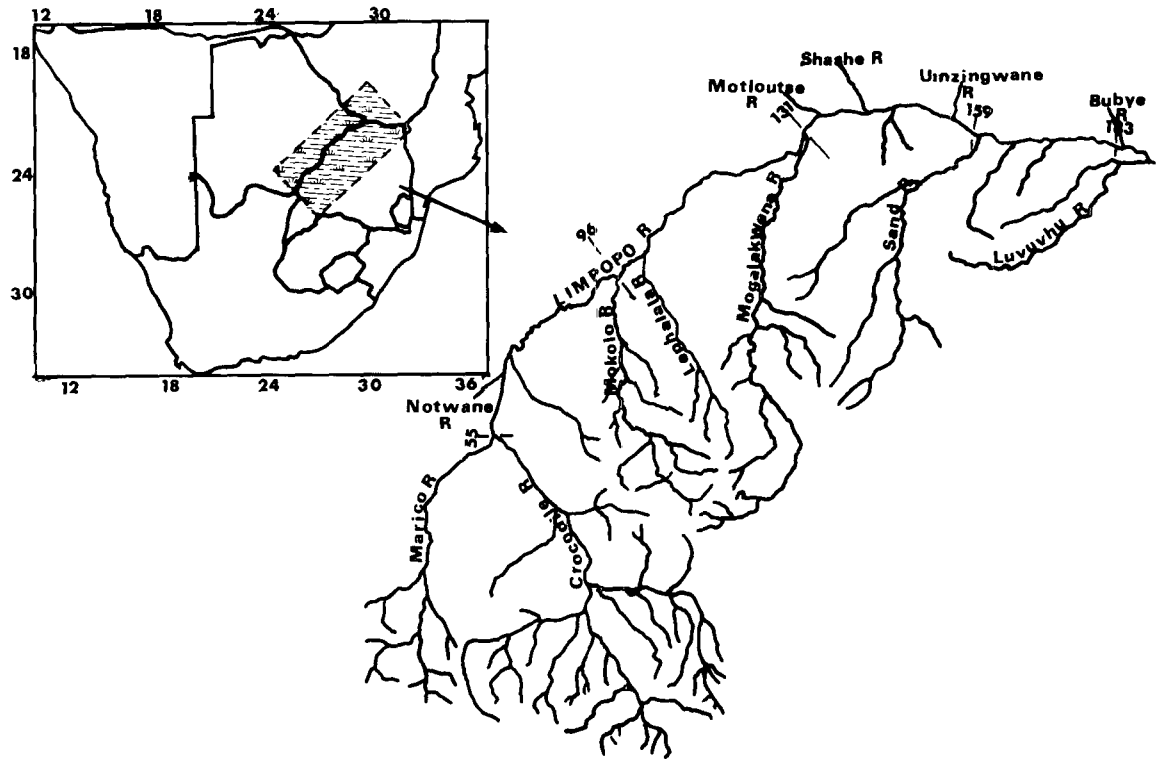

Figure 1
The Limpopo River catchment showing the number of segments at the confluence of some of the tributaries as points of reference

due to natural barriers occur only sporadically. Downstream from the confluence with the Shashe River, the character of the Limpopo changes considerably, becoming up to 600 m wide with an extensive sandbed which can be 10 to 20 m deep. Relatively large, densely vegetated islands occur in this section. Riparian vegetation along this section in particular, often tends to forest with large specimens of *F. albida, A. xanthoploea, Combretum imberbe, Croton megalobotrys, F. sycomorus* and *Xanthocercis zambesiaca* being common. As in the other sections, reeds only occur sporadically in small patches. The only permanent water from here to the Mocambique border is found near the confluence with the Shashe River (Poacher's Corner dolomitic dyke pools), eroded rock pools near the Umzingwane River confluence, at Beit Bridge, and large bedrock pools downstream from Beit Bridge at Malala Drift, Madimbo and Mabiligwe. It is in these pools that hippopotami, crocodiles and other aquatic fauna survive during the long dry season or in times of drought.

Upstream from the Shashe confluence (the upper Limpopo Basin), the Limpopo River is characterised by a large number of farm weirs which were constructed mainly for water abstraction for crop irrigation. Irrigation forms a prominent land-use practice along the South African side of the river, but is very limited on the Botswanan side where cattle farming and game reserves are predominant.

Downstream from the Shashe confluence (the lower Limpopo Basin), only a limited number of weirs occur, most of which are completely filled up with sand. Water is abstracted here from wells in the sand-bed and from the river banks to irrigate crops on the South African side. Limited irrigation occurs on the Zimbabwean side of the river and land use is predominantly devoted to livestock farming on tribal lands.

A prominent feature of the Limpopo is the presence of a barbed-wire fence of 1,8 m high which extends along the entire length of the South African bank of the river. This fence was erected for veterinary purposes to prevent the spread of foot- and-mouth disease from cattle in Botswana and Zimbabwe to South Africa and on average it is situated 10 to 30 m from the river bed. This restricts the movement of most large mammals including hippopotami but does not prevent cattle from one side of the fence coming into contact with cattle from the other side.

Methods

The crocodile and hippopotami populations were counted by helicopter with a crew consisting of a pilot, navigator and 2 observers. For the purpose of repeatability the Limpopo River was divided into 5 km segments and animals recorded for each of 129 such segments from the Marico/Crocodile confluence to the Kruger National Park boundary. Censuses were conducted during August 1989 when water levels were low and leaf cover at a minimum. This ensured that the animals were concentrated in the remaining pools. Flights began at 08:00 giving the maximum number of crocodiles and hippopotami the opportunity to haul out of the water and lie basking on sandbanks, rocks or islands in the middle of the pools. However, all counts must be regarded as minimum. Flight speed was maintained at 60 km/h and height approximately 50 m above the river. This height is considered a compromise between visibility and safety. Flying too low or too high may also reduce visibility and result in the undercounting of animals. The clarity of

TABLE 1
NUMBER OF CROCODILES AND HIPPOPOTAMI ALONG THE LIMPOPO RIVER

River section	No. crocodiles	No. hippopotami	Distance	Crocodiles /km	Hippopotami /km
KNP to Beit Bridge	80	49	120	0,67	0,41
Beit Bridge to Shashe River	50	8	75	0,67	0,11
Shashe River to Mogalakwena River	27	1	65	0,41	0,01
Mogalakwena River to Mokolo River	358	36	175	2,04	0,21
Mokolo River to Crocodile/ Marico confluence	52	6	210	0,25	0,03
Total	567	100	645	0,88	0,15

the water enabled the observers flying over pools to see crocodiles suspended in the water. If a herd of hippopotami was sighted in the water then the pilot would circle over them in an attempt to obtain an accurate count.

Together with the census of animals, notes were made of the conservation state per segment of river including the presence and position of weirs, pumps and the amount of irrigation taking place. All data were recorded on a pocket tape recorder and transcribed during the evening. In order to determine the effect of weirs on the Limpopo River catchment, surveys of all the South African tributaries and of the Lephalala in particular were conducted by one of the authors (CJK).

Results

A total of 567 crocodiles and 100 hippopotami were counted along the 645 km of Limpopo River from the Crocodile/Marico River junction to the Kruger National Park boundary which is an average of 0,88 crocodiles and 0,15 hippopotami per kilometre. The crocodiles and hippopotami were, however, not evenly distributed along the entire stretch of river. For convenience the river is discussed in easily recognisable "geographic" sections. Table 1 gives a breakdown of the number and density of crocodiles and hippopotami per section of river.

Of the 129 census segments into which the Limpopo River was divided 56 were without crocodiles (18 were completely dry). Crocodiles were therefore recorded along 73 (57%) segments of the Limpopo River and hippopotami in 22 (17%) segments. The crocodiles and hippopotami were found singly, in aggregations or in the case of the latter, in family groups. Figures 2 and 3 illustrate the frequency occurrence of crocodiles and hippopotami along the segments. Most crocodiles (75%) occurred singly or in groups of <10 individuals although congregations of >40 were found on 2 occasions.

A total of 87 weirs were counted along the Limpopo River. This is on average 1 weir per 7,4 km of river or 0,68 per 5 km segment. The pools found behind the weirs vary greatly in size and extent and 14 (16%) were found to be dry. Figure 4 shows the frequency of weirs per segment which ranges from 0 to 4.

Of the 73 segments along which crocodiles were recorded, 41 segments contained weirs only or weirs and natural pools. Similarly of the 21 segments in which hippo were recorded 14 incorporated weirs or weirs and natural pools. The weirs are not evenly distributed along the river. Most weirs (55 or 63%) are concentrated between segments 98 to 134 (Fig. 1) over 180 km of river between the Mokolo confluence and the farm Kruidfontein just north of the Mogalakwena confluence. Along this stretch of river were found 371 crocodiles or 66% of all the animals counted and 36 hippopotami or 36% of all animals seen.

Fifty-six segments of the river had only natural pools of water of which 24 (43%) appeared to have little water and were therefore unsuitable for occupation by crocodiles and hippopotami. Consequently only 32 segments contained crocodiles while 7 contained hippo, most of the latter being found along the lower Limpopo River between Beit Bridge and the Kruger National Park boundary. This stretch of river with its bedrock fault-line pools housed 49 hippopotami as well as 80 crocodiles.

Discussion

The Limpopo River has been extensively degraded by the great amount of water abstraction that has taken place. This is especially so in the catchment due to the construction of dams and weirs. Along the Limpopo River itself the building of storage weirs has often been a direct result of irrigation. This has resulted in the degradation of the riparian vegetation in some instances. It also negatively influences the hippopotamus populations in these areas as these animals may raid such croplands particularly during the winter months when forage becomes scarce.

If one compares the number of crocodiles (409) in the 41 segments with weirs and pools with those (158) in the 32 segments with only natural pools, then the benefit of weirs in the conserva-

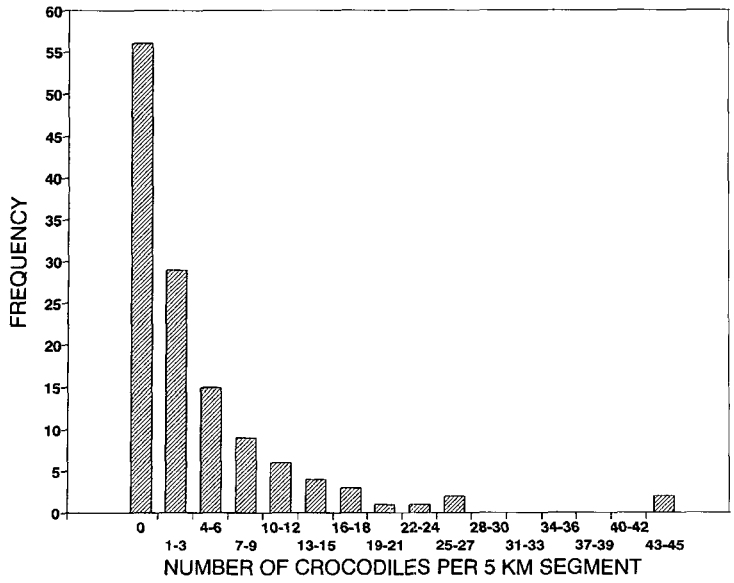

Figure 2
The frequency occurrence of crocodiles per 5 km segment along the Limpopo River

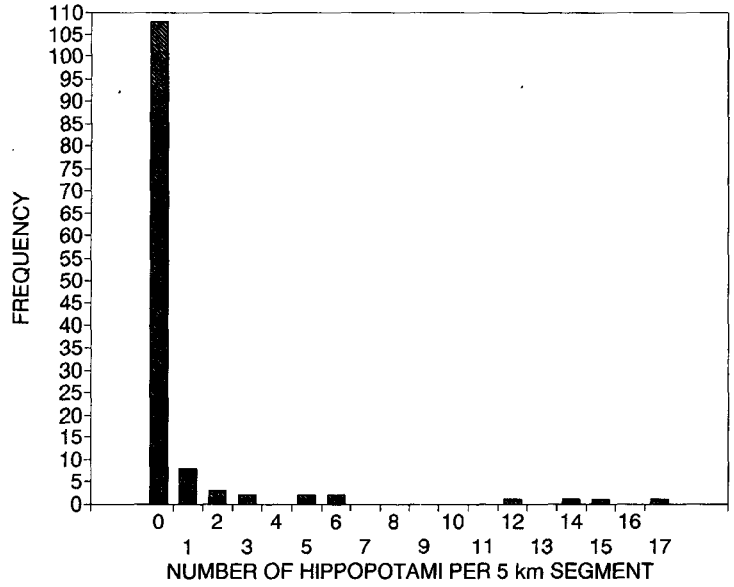

Figure 3
The frequency occurrence of hippopotami per 5 km segment along the Limpopo River

tion of crocodiles cannot be disputed. The former have twice as many crocodiles (9,97) per segment as that of the latter (4,94). The highest concentrations of crocodiles, 43 and 45 respectively, were along segments 111 and 116 which had 2 weirs each. Similarly the distribution of hippopotami is closely linked to the presence of weirs. Fifty (50%) of the animals counted were associated with weirs while 50 (50%) were found at natural pools. Most of the latter occurred between Beit Bridge and the Kruger National Park boundary where the only surface water is in fault- line pools. Similarly 80 crocodiles or 50% of those found in natural pools were found here, the remaining 78 being found in the remainder of the river. It may therefore be true to say that weirs are essential to the survival of hippo and crocodiles in the upper Limpopo River, i.e. above the Shashe confluence.

However, the duration of river flow has been drastically reduced due to the presence of weirs and dams in the catchment area which has led to the drying-up of most natural pools along the main channel of the Limpopo River. Taking the Lephalala River as an example, under natural conditions this river contributed water flow to the Limpopo River for 64% of all months . Under current developed conditions and with more than 500 weirs in its catchment, the Lephalala only contributes water to the Limpopo River

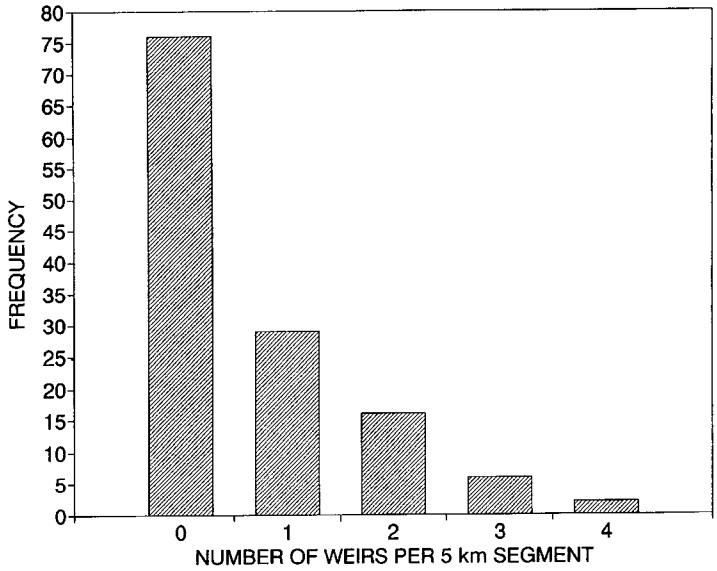

Figure 4
The frequency occurrence of weirs per 5 km segment along the Limpopo River

for 40% of all the months (Chunnett, Fourie and Partners, 1992). This is a reduction of almost 50% in water reaching the Limpopo River. From August to November such water is essential to recharge and maintain the water level in the Limpopo River. The depletion of water by the presence of these upstream weirs now results in an impoverished system in the main channel of the river. The situation is compounded by similar development in all of the tributaries which make up the Limpopo system. There are also 13 major impoundments, varying in capacity from 4,293 to 194,626 x 10^6 m^3 (Anon, 1986) within the Limpopo River system.

In contrast the weirs along the main channel of the Limpopo River now provide permanent water in areas which may well have dried up as a result of the reduction in water flow from the catchment. They provide the refugia needed by hippopotami, crocodiles, fish and other freshwater biota. Such refugia need to be identified, classified and ranked according to their importance as epicentres for recolonisation of the rest of the river (Cairns, 1990). Their viability in providing a permanent habitat for crocodiles, hippopotami and other freshwater biota should be evaluated.

A complication is that these weirs mostly concentrate these animals and this may result in a rapid depletion of available food which at least in the case of hippopotami may lead to starvation if the rainy season does not commence early. Hippopotami also defaecate in the water which may lead to a change in water quality with detrimental effects on other biota. Game or cattle ranching is the most common land use along the river although irrigation is widely practised. The 1,8 m high veterinary fence on the South African side largely prevents hippopotami from grazing there. The Botswanan and Zimbabwean sides of the river are mostly overgrazed primarily by cattle and in some areas game animals. The hippopotami must therefore compete for the available grass and reeds. This situation is enhanced by the localisation of pools to which the animals are bound. A partial but artificial solution to the problem is to feed these animals until the commencement of the rainy season. But how many animals can be afforded financially and can they be afforded from year to year in possibly increasing numbers? A more feasible approach could be to investigate the possibility of increasing the number of suitable water bodies along the river and therefore making more grazing available to these animals over as wide a front as possible. In this way food resources would be available for longer periods and the animals only have to be fed for short periods. At the same time research must be initiated which is aimed at determining the carrying capacity of the system in its current degraded state. A management plan based on such research can enable private farmers on whose property hippopotami and crocodiles are found to benefit from the harvesting of these animals or their products. Hopefully this will lead to greater awareness and conservation of these animals and of the river system.

Conclusion

The importance of weirs for the survival of hippopotami and crocodiles cannot be underestimated and it may be necessary to create weirs or off-channel storage dams in other areas along the main channel of the Limpopo River. This may broaden the survival options of these animals and permit a more even and greater carrying capacity, provided this is in agreement with the local farming community and that there is adequate food available. Simultaneously it is important to evaluate the weirs in the catchment of the river with a view towards a rationalisation of water utilisation in these areas. This could involve the removal of some weirs so that more water is available downstream or a reduction in the area of land under irrigation. The allocation of water from dams on the tributaries of the Limpopo river towards the maintainance of minimum flow (including subsurface and bed flow) should also be considered and incorporated in a management plan for the river. This will ensure the survival of all aquatic biota including crocodiles and hippopotami.

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