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The Zambezi Society and The Biodiversity Foundation for Africa are working as partners within the African Wildlife Foundation's Four Corners TBNRM project. The Biodiversity Foundation for Africa is responsible for acquiring technical information on the biodiversity of the project area. The Zambezi Society will be interpreting this information into user-friendly formats for stakeholders in the Four Corners area, and then disseminating it to these stakeholders.

THE BIODIVERSITY FOUNDATION FOR AFRICA (BFA is a non-profit making Trust, formed in Bulawayo in 1992 by a group of concerned scientists and environmentalists. Individual BFA members have expertise in biological groups including plants, vegetation, mammals, birds, reptiles, fish, insects, aquatic invertebrates and ecosystems. The major objective of the BFA is to undertake biological research into the biodiversity of sub-Saharan Africa, and to make the resulting information more accessible. Towards this end it provides technical, ecological and biosystematic expertise.

THE ZAMBEZI SOCIETY was established in 1982. Its goals include the conservation of biological diversity and wilderness in the Zambezi Basin through the application of sustainable, scientifically sound natural resource management strategies. Through its skills and experience in advocacy and information dissemination, it interprets biodiversity information collected by specialists like the Biodiversity Foundation for Africa and uses it to provide a technically sound basis for the implementation of conservation projects within the Zambezi Basin.

THE PARTNERSHIP between these two agencies was formed in 1996 as a result of mutual recognition of their complementarity. They have previously worked together on several major projects, including the biodiversity component of IUCN's Zambezi Basin Wetland project and the evaluation of biodiversity in Tete province described in detail in the first Four Corners TBNRM Biodiversity Information Package.

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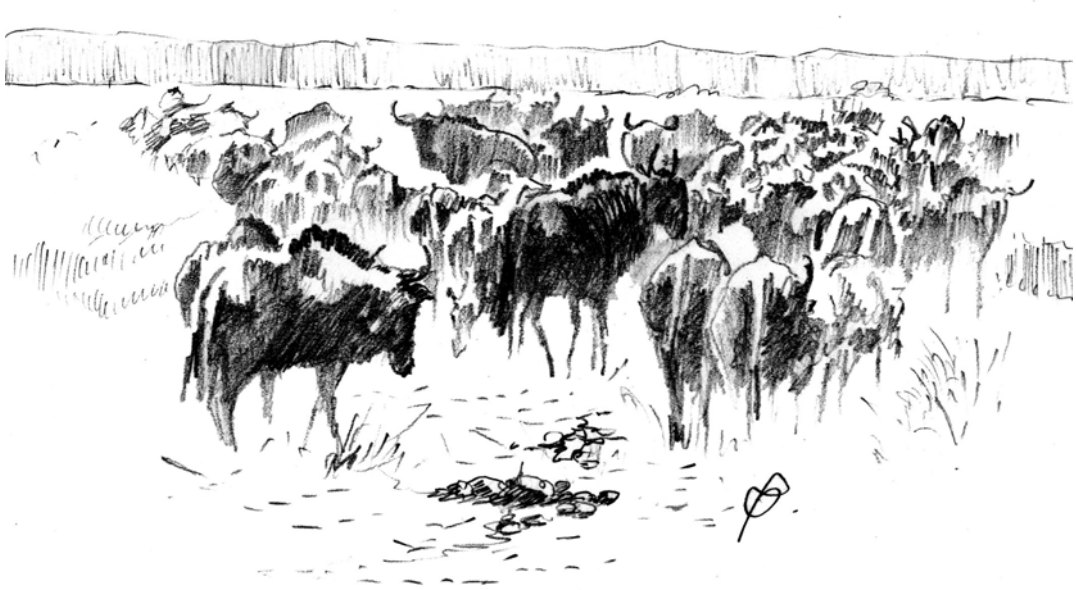


CHAPTER 13. MOVEMENTS AND MIGRATIONS OF LARGE MAMMALS IN THE FOUR CORNERS AREA

D H M Cumming

13.1 INTRODUCTION

One of the eight conservation targets identified for the Transfrontier Conservation Area (TFCA) at the Four Corners Science Meeting in Victoria Falls in June 2001, was to identify and protect (or re-establish) wildlife corridors and dispersal areas. This chapter reviews the extent of current knowledge of movements and migrations of large mammals, other than elephant (see Chapter 14 on elephant movements), in the Four Corners area. The large mammal species (i.e. those with adult body mass >10 kg) known to occur within the area are listed in Table 13.1.

There has been remarkably little research on movements and migrations of large mammals other than elephants in the Four Corners area, and most of it has been carried out in Botswana (see Table 13.1). This report reviews the current state of knowledge on the movements of large mammals as reflected in the published literature, unpublished research reports, personal communications and reviewers' comments.

Migrations are defined here as the regular annual movement of most, if not all, of the individuals in a population between two widely separated areas in which they reside at different seasons of the year. Migrations are distinguished from ***periodic large-scale movements*** that may occur at irregular intervals of several years in some species populations, such as in times of drought, and from ***local movements*** that involve seasonal changes in habitat or local shifts up and down a landscape catena.

13.2 MIGRATIONS

Within the Four Corners area the only species that show regular large scale movements that might be considered migrations are wildebeest and zebra. These migrations occur within two discrete and limited parts of the area, namely, in the north of Botswana between the Savuti and Linyanti/Chobe, and in the south between the Boteti and Makgadikgadi Pan areas (Figure 13.1).

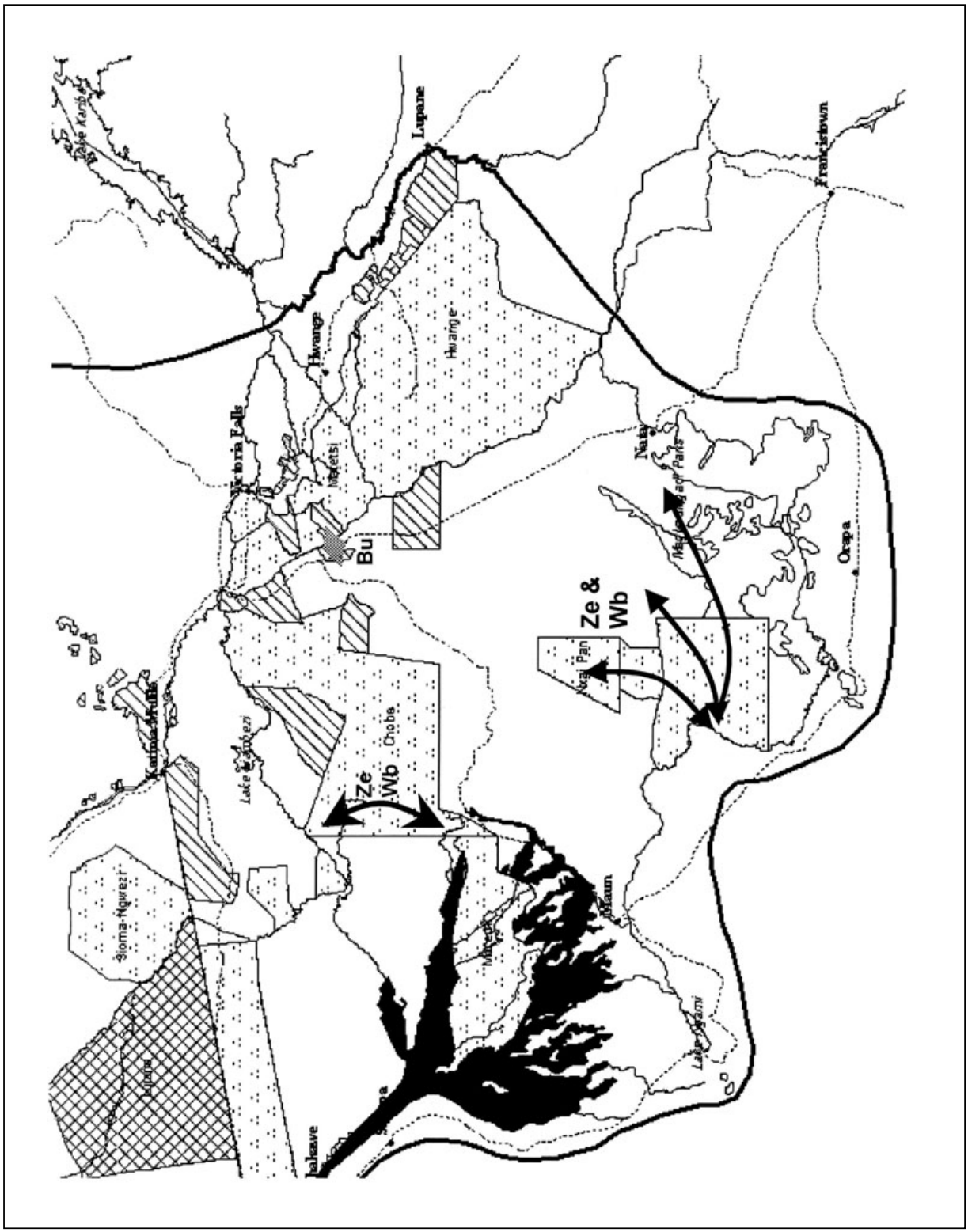
During the mid-1980s in northeastern Botswana about 20,000 **zebra** congregated in the Savuti swamp shortly after the onset of the rains and moved into the tall grass habitats of the adjacent sandveld at the end of the rains. They then moved north to their dry season range along the Linyanti and Chobe rivers (Joos-Vandewalle 1988). Smaller numbers of **wildebeest** arrived later in the season at the Savuti swamps than did zebra, and departed later. Later work by Vandewalle (2000) confirmed the migration pattern with a distance of 140 km between wet and dry season ranges of zebra and 100 km for wildebeest. The overall area covered by zebra was 7285 km^2, while wildebeest covered about half this area. The difference was a result of zebra using the Mababe region as part of their wet season range. The cumulative rainfall and its timing during a season, together with forage abundance, were the primary drivers of zebra and wildebeest migrations, although the availability of surface water also influenced wildebeest movement. Zebra preferred tall annual grasslands while wildebeest used short, perennial grasslands (Vandewalle 2000). With changing patterns of water flow and hydrology, and the drying of the Linyanti, zebra are beginning to move across the Linyanti into Namibia for water (M. Vanderwalle, pers. comm. March 2003).

Table 13.1. Summary of available published information on large mammal movements in the Four Corners area.
Historical movements are shown as (x).

Species	Movement in countries					Movement between countries					
	An	Bw	Na	Zm	Zw	An-Zm	An-Na	Bw-Na	Bw-Zw	Na-Zm	Zm-Zw
Elephant	-	X	-	-	X	-	-	X	X	-	-
White Rhino	-	-	-	-	-	-	-	-	-	-	-
Black Rhino	-	-	-	-	-	-	-	-	-	-	-
Hippo	-	-	-	-	-	-	-	-	-	-	-
Warthog	-	-	-	-	-	-	-	-	-	-	-
Bushpig	-	-	-	-	-	-	-	-	-	-	-
Burchell's Zebra	-	X	-	-	-	-	-	-	-	-	-
Giraffe	-	-	-	-	-	-	-	-	-	-	-
Buffalo	-	X	-	-	X	-	-	-	X	-	-
Bushbuck	-	X	-	-	-	-	-	-	-	-	-
Sitatunga	-	X	-	-	-	-	-	-	-	-	-
Greater Kudu	-	-	-	-	-	-	-	-	-	-	-
Eland	-	X	-	-	-	-	-	-	-	-	-
Sthn Reedbuck	-	-	-	-	-	-	-	-	-	-	-
Puku	-	X	-	-	-	-	-	-	-	-	-
Waterbuck	-	-	-	-	-	-	-	-	-	-	-
Kafue Lechwe	-	-	-	X	-	-	-	-	-	-	-
Red Lechwe	-	X	X	-	-	-	-	-	-	-	-
Red Hartebeest	-	-	-	-	-	-	-	-	-	-	-
Lichtenstein's Hb	-	-	-	-	-	-	-	-	-	-	-
Tsessebe	-	-	-	-	-	-	-	-	-	-	-
Blue Wildebeest	-	X	-	-	-	-	-	-	(x)	-	-
Roan	-	-	-	-	-	-	-	-	-	-	-
Sable	-	-	-	-	-	-	-	-	-	-	-
Gemsbok	-	-	-	-	-	-	-	-	-	-	-
Impala	-	-	-	-	-	-	-	-	-	-	-
Springbok	-	-	-	-	-	-	-	-	-	-	-
Lion	-	X	-	-	X	-	-	-	-	-	-
Leopard	-	-	-	-	-	-	-	-	-	-	-
Spotted hyaena	-	-	-	-	-	-	-	-	-	-	-
Brown hyaena	-	X	-	-	-	-	-	-	-	-	-
Wild dog	-	-	-	-	X	-	-	-	-	-	-

An = Angola, Bw = Botswana; Na = Namibia; Zm = Zambia; Zw = Zimbabwe

Figure 13.1. Map showing the Four Corners area and those areas in which wildebeest and zebra migrations are reported to occur. Buffalo movements occur across the Botswana/Zimbabwe border in the vicinity of Kazuma Pan.



In the south-western part of the Four Corners area regular seasonal movements of zebra and wildebeest occur. The animals move from a dry season grazing and watering area along the Boteti River and Lake Xau region to wet season dispersal areas (Child 1972, Williamson *et al*. 1988, Kgathi & Kalikawe 1993, Verlinden 1998). Currently, wet season dispersal from the Boteti river involves the movement of about 5000 zebra north to the Nxai Pan, and 15,000 zebra and 4000 wildebeest eastwards to the Makgadikgadi grasslands (Brooks, pers. comm. April 2003). Earlier migrations or periodic movements, or both, extended from the Makgadikgadi along the Nata River to the Zimbabwe border (Brooks, pers. comm. April 2003). New game fences are planned along the Boteti River that may disrupt the scale and extent of the annual Makgadikgadi zebra/wildebeest migration (L.Patterson, pers. comm. March 2003).

The Government of Botswana-Swedplan (1989) report contains a map indicating several seasonal migrations, or seasonal movements, of buffalo, eland, elephant, lechwe, wildebeest and zebra. However, these are not clearly substantiated by references or data.

13.3 PERIODIC LARGE-SCALE MOVEMENTS

In response to severe droughts, major periodic large-scale movements of wildebeest (and other species?) occurred south of the Okavango swamps before the veterinary fences were established. These movements were associated with periodic droughts and related dry season die-offs of wildebeest in the region of Lake Xau (Child 1972, Williamson *et al*. 1988). Major die-offs were reported in 1930-31 on the south of the Boteti River, and again in 1964 when an estimated 15,000 died over a period of four months (Bachman 1964 in Child 1972). Williamson *et al*. (1988) consider Lake Xau to be a "terminus" linking the discrete Makgadikgadi wildebeest population to the formerly large Kalahari wildebeest population that moved in large numbers from the south-west to the Boteti - Lake Xau region during periods of drought. The construction of veterinary fences exacerbated mass mortality of wildebeest and other species during drought related movements (Campbell 1981). However, Child (*in litt*, Estes 1968) noted that major die-offs of wildebeest in the 1930s occurred before any fences were constructed.

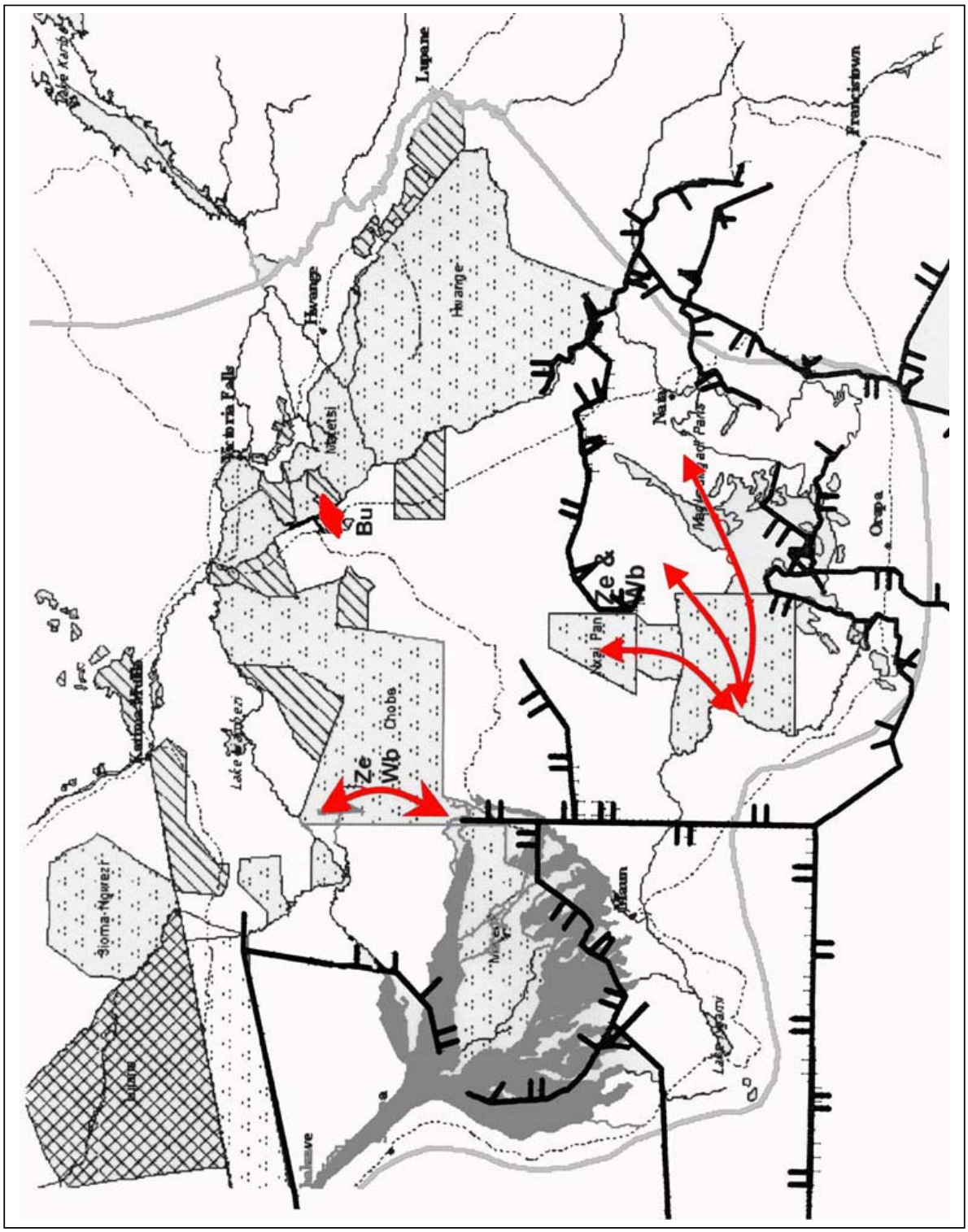
A major movement of wildebeest in 1933 into the then Wankie Game Reserve coincided with a die-off of wildebeest in the Makgadikgadi Pan area. This movement formed the nucleus of the present day population on the Ngamo plains in the southeastern corner of Hwange National Park (Williamson 1978). Wildebeest did not occur in the eastern part of Hwange National Park when it was first gazetted in 1928; the last wildebeest was apparently shot on the Kennedy vlei in 1926 (Williamson 1978). Small herds did, however, occur in the southwestern Dzivanini area of the park on the Botswana-Zimbabwe boundary. Estes (1968) reported a second movement of wildebeest from the Makgadikgadi Pan area up the Sehume and Linkwasha drainages in Hwange National Park in 1959. The veterinary fences now in place (Figure 13.2) would block such transboundary movement.

13.4 LOCAL MOVEMENTS

13.4.1 Antelope in Riparian Zones

Four species whose distribution is generally limited to swamps, floodplain grasslands or riparian woodlands and thickets show regular, but short range, seasonal shifts in home ranges or location that are in keeping with seasonal flood regimes of the Chobe, Okavango or Zambezi rivers. These are bushbuck, lechwe, sitatunga and waterbuck. Puku are present in some of these areas but regular seasonal movements have not been reported.

Figure 13.2. Map showing areas and directions of seasonal movements of large mammals in Botswana together with approximate alignments of veterinary control fences and cross boundary movements to and from neighbouring countries.



Chobe Bushbuck (*Tragelaphus scriptus ornatus* Pocock, 1900) occurs along rivers and in riparian habitats within the study area. Simpson (1974a, 1974b) reported that the species was limited to the riparian fringe of the Chobe River, but that small scale seasonal shifts away from the river occurred during the rains. In a study along the Zambezi river in the Victoria Falls National Park, Thomson (1973) reported that bushbuck moved from riparian habitat along the river to the adjacent *Baikiaea* woodland at the onset of the rains.

Sitatunga (*Tragelaphus spekei* Speke, 1863) occurs in the Okavango delta and Chobe swamps. Games (1983a, 1983b, 1984), in a study of the species in Okavango delta, found them to be very localised in their movements but recorded seasonal shifts in response to the annual flooding regime. As livestock grazed in the wake of receding floodwaters sitatunga moved back into the central flood plain and swamps of the Okavango.

Lechwe (*Kobus leche* Gray 1850). Two subspecies occur within the Four Corners area, the Kafue lechwe (*K. l. kafuensis* Haltenorth 1963) and the red lechwe (*K. l. leche* Gray, 1850), the latter occurs in the Okavango Delta and along the Linyanti-Chobe rivers. Seasonal movements of lechwe follow the rise and fall of floodwaters in the grassy floodplains they occupy (Scheppe & Osborne 1971, Rees 1978, Williamson 1979, 1990). The presence of cattle herds and fishing camps influenced the movements of lechwe on the Kafue flats (Scheppe & Osborne 1971). Lechwe moved north of the Chobe ahead of the floodwaters and into the Caprivi during the flood season from March to July and during the peak floods of 1957-58 they moved more than 75 km (Child & von Richter 1969).

Waterbuck (*Kobus ellypsiprimnus* Ogilby, 1833 - with two subspecies *K. e. ellypsiprymnus* and *K. e. defassa*). Waterbuck occur along the major rivers in the study area and occupy the drier grasslands and woodland fringes. In a study of home range behaviour in the Four Corners area Hanks *et al*. (1969) noted seasonal shifts in home range of *K. e. defassa* in relation to patterns of burning in the Ngoma area of Kafue National Park. Child and von Richter (1969) found waterbuck and puku to be resident throughout the year along the Chobe River front with no marked seasonal shifts in habitat.

13.4.2 Other Large Herbivores

Buffalo (*Syncerus caffer* Sparrman 1779). Buffalo movements across the Botswana-Zimbabwe border in the Kazuma Pan-Pandamatenga area were studied by Hunter (1996) and Hunter and Kerley (1999), using radio-collared herds and monthly aerial tracking flights. They found that buffalo moved back and forth across the border in response to changes in the availability of water and grazing and were particularly attracted to unfenced croplands on basalt soils in the Botswana component of the Kazuma depression. They considered the Kazuma depression to be a key passageway for buffalo movement and recommended the construction of a raised by-pass for road traffic (a major source of mortality) to facilitate the movement of animals and water along the wetland. Movement of water in the depression is presently constrained by a raised highway.

In the Chobe-Savuti system buffalo move from a dry season range along the river to the woodlands and bushlands 10 to 40 km away from the riverfront during the wet season (Halley *et al*. 2002). Child (1972) reported similar seasonal shifts. Additional opportunistic short and long distance movements (15-130 km) were recorded when buffalo cows switched herds. These switches occurred between Chobe and Okavango herds and help to explain the low genetic variation in buffalo at a regional scale in Southern Africa (Halley *et al*. 2002). In Hwange National Park Duckworth (1972) found that buffalo concentrated on permanent water along the north-eastern boundary of the park, from Dete to Ngamo, during the dry season. At the onset of

the rains they moved southwards towards Ngamo and then westwards into the central portion of the park as the rains progressed. In a later study in Hwange, Duckworth (1979) reported buffalo herds coalescing into larger herds during the dry season and then dispersing into smaller herds during the rains.

13.4.3 Predators

Wild dog (*Lycaon pictus* Temminck 1820). Wild dogs range over large areas and home ranges of up to 4500 km^2 have been reported (Skinner & Smithers 1990). The species occurs widely within the Four Corners area. The strongest population is in Hwange National Park, while unstable or transient populations occur in Botswana and Zambia where they tend to be persecuted or subjected to diseases (G. Rasmussen, pers. comm. April 2002). They appear to be absent from the Caprivi (G. Rasmussen, pers. comm. 2002) and their status in Angola is not known. Because of their large home ranges they almost certainly range across international borders between Botswana/Namibia and Botswana/ Zimbabwe. The Zambezi River is unlikely to be a barrier to movement of wild dogs between Zimbabwe, Namibia and Angola (G. Rasmusssen, pers. comm. 2002). They have been observed swimming across the Sanyati Gorge on Lake Kariba in Zimbabwe (Anon 1993). Davies (1993) reported home ranges of between 103 and 776 km^2 for wild dog in Hwange National Park.

Brown hyaena (*Hyaena brunnea* Thunberg, 1820). Home range and movements of brown hyaena are being studied in the Makgadikgadi area. A September 2002 project progress report reveals home range sizes of between 270 to 625 km^2 for three animals for which there was sufficient information (Maude 2002). Brown hyaenas are usually territorial and remain within clan areas and although young males may disperse into neighbouring clans within the Makgadikgadi system they are unlikely to disperse across international borders. (G. Maude, pers. comm. March 2003). Clearly animals living near the Botswana-Zimbabwe border are likely, because of their large home ranges, to move back and forth across the border, but there is no information on brown hyaena movement along this boundary.

Lion (*Panthera leo* Linnaeus, 1758). The ecology and movements of lions in the Makgadikgadi area in relation to conflict between predators and the surrounding human populations were studied between 1999 and 2002 using GPS radio collars. Some lionesses in the population tracked the wildebeest and zebra migrations and these showed the largest home ranges (>1500 km^2) while those on the edge of the park tended to have smaller home ranges of about 100 km^2 (G. Hemson, pers. comm. April 2002). Males were found to have core areas of about 500 km^2 but explored areas extending up to 1500 km^2. Studies on lion ecology and movements in Hwange National Park are also underway (Loveridge *et al*. 2001). A key question is the interaction between the protected population in the National Park and the hunted populations in adjacent Safari and Forestry Areas. A third study of lions in the Okavango is being conducted but, as in the case of the Hwange study, information on movements is not yet available.

13.5 CROSS-BORDER MOVEMENTS/MIGRATIONS

Cross border movement of animals whose home ranges coincide with, or cross, international boundaries occur where fences or rivers do not impede their movements. No regular annual migrations across international borders have been described for the Four Corners area. That fences, particularly those within Botswana, have affected local, periodic or opportunistic movements of a wide range of large herbivores has been well catalogued and highlighted, particularly when high mortality of large herbivores has occurred along newly erected fences (Albertson 1998).

13.6 HABITAT FRAGMENTATION IN THE FOUR CORNERS AREA

Habitat fragmentation affects large mammals when their movement between patches or areas of suitable habitat is impeded or prevented. Barriers may result from changes in land use or land cover through settlement, cultivation or overgrazing, which mammals do not enter or cross. Movements can also be impeded by the erection of fences, which do not necessarily result in a fragmented habitat *per se*, but do effectively separate populations and impede or block movements. The creation of isolated sub-populations through habit fragmentation and the maintenance of game fences could be important in the context of the Four Corners area in that it may have serious implications for the long term conservation of a wide range of species in the area, and also affect ecological and evolutionary processes. Constraints on the seasonal movements and migrations of species can have major implications on their abundance (Ben-Shahar 1993, Fryxell 1988) and thus on other species and ecological processes in the area they inhabit.

13.6.1 Land Cover Change and Fragmentation

No reports on habitat fragmentation within the study area were found.

13.6.2 Fences

Veterinary disease control fences within countries and those on international boundaries have been constructed to control the movement of wildlife and livestock. The fences thus clearly impede seasonal movements and migrations of wildlife. Where fences occur on international boundaries they curtail the movement of wildlife across these boundaries. The major veterinary fences in the Four Corners area are shown in Figure 13.2. Most fences occur within, or on the boundaries of Botswana and were erected to control foot and mouth disease (FMD). Within Zimbabwe a FMD fence runs along the southern boundary of Hwange National Park and continues into the Sebungwe (Figure 13.2). The impacts of fences on the movements of large mammals have been examined for some species in some areas (e.g. wildebeest to the south of the Okavango delta - Williamson *et al*. 1988). Albertson (1998) assessed the effects on wildlife movements and mortality of several recently constructed fences in Ngamiland in northern Botswana. The species and numbers of animals affected by the fences varied depending on where they were situated. Albertson's major conclusions were as follows:

- “Disruption of seasonal movement of wildlife, including rare and endangered species such as roan antelope, sable antelope, elephant and wild dog.
- Death or stressing of these animals due to entanglement, group fragmentation, isolation and denial of access to water and seasonal habitats.
- Secondary effects noted: Improved access to poachers, vehicle disturbance of already stressed animals, increased human-wildlife conflicts, wildlife concentration and resultant habitat destruction, habitat loss from fence cut-line construction.
- Negative local community perceptions and, in some cases, severe impact on their subsistence bases and resource management " (Albertson 1998).

13.6.3 Climate Change and Animal Movements

Increasing mean annual temperatures across southern Africa and shifts in the patterns of rainfall distribution will almost certainly alter the distribution and range of habitats within the study area (e.g. Hulme 1996). In this context habitat fragmentation and the erection of permanent barriers to animal movement, such as disease control barriers, will serve to constrain adaptive responses to climate change by both wildlife populations and the enterprises that depend on them. Apart from the study by Hulme (1996) this area of research appears to have been entirely neglected.

13.7 CONCLUDING COMMENTS

Remarkably little research has been carried out on animal movements in the Four Corners area, and even less on the long-term ecological and economic implications of the effects of disrupting movements and migrations of large mammals through habitat fragmentation and fencing to support marginal livestock and agricultural enterprises. Assessing the impacts of current land use polices and practices on the long-term sustainability of the Four Corners ecosystems will require in depth studies at larger spatial and temporal scales than has been the case to date.

The results of research on large mammal movements in the Four Corners area do not suggest that the creation of a TFCA will make much difference to patterns of movement or restore mythical migrations that are often cited as a major reason for establishing transboundary conservation areas. The major impacts of fences and land use fragmentation on animal movements are to be found within Botswana. However, the establishment of a TFCA may well encourage and foster the management of large mammals and their habitats at the larger and more appropriate scales at which these systems function most efficiently and under which they evolved (Du Toit & Cumming 1999, Du Toit & Fritz 2003).

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