RISKS AND CAUSES OF MORTALITIES IN WILD UNGULATES OF TANZANIA

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ABSTRACT

Risks and causes of mortalities in wild ungulates in Mkomazi, Saadani and Selous game reserves and Longido, Gonabis and Doma-Mkata protected areas were studied for effective intervention to conserve wildlife. Factors threatening survival of wildlife, animal strategies for survival and responses to risks were examined and causes of deaths were determined by forensic diagnosis of remaining carcasses, bones, horns, heads and skins thus developing parameters for prediction of survival rates. Ungulate population trends in areas studied could be predicted and intervention and re-population approaches suggested. Species studied were plains zebra Equus burchelli, African buffalo Syncerus caffer, blue wildebeest, Connochaeta taurinus, eland, Taurotragus oryx, hartebeest, Alcelaphus buselaphus, impala, Aepyceros melampus, Thomson's gazelle, Gazella thomsonii, and Grant's gazelle, Gazella granti. The giraffe, Giraffa camelopadalis, waterbuck, Kobus defasa and warthogs were studied for comparative risk responses. Risk factors threatening wild ungulates included lack of feeds due to habitat deterioration, lack of water in dry season, fire, predators, poachers and hunters. Retrospective forensic diagnosis of remains indicated that trauma caused most deaths. Wildebeests and buffaloes were most hunted, poached and the former killed by predators. Hartebeests, elands, zebras and giraffes came second. Most animals found dead, unconsumed and decomposing had strangling wires and traps or bullets. In all wildlife reserves studied feeds were not major risk to cause death but water appeared to be. The prevalence of diseases over the three years study period was extremely low. Ethological studies indicated that animals develop strategies for survival. There was evidence of knowledge of being the target among a group of species. In mixed group of ungulates, elands, hartebeests and buffaloes quit first, living behind zebras, waterbucks, reedbucks and giraffes. Acquired intelligence in animals was indicated by being aware of their protectors, man and predator preferences, habitat range for safety, borders of their reserve, tools held by man. They maintained minimum of 1 –2 Km distance away from strangers, performed sudden, fast irregular movements and vertical jumps to avoid being targeted. Females separate from males. Saadani, Doma-Mkata and Mkomazi areas were of high risks and zebras, wildebeests, buffaloes, elands, warthogs and giraffes appeared stressed, scared, constantly running far away and migrated to other places. Migrations result from increase of risks of death in certain place. Ethology, human and livestock activity, predator population, forensic studies on remains, animal migrations, habitat evaluation, disease incidence rates are useful tools for measurement of causes of death in wild ungulates. This information offers prediction of future trends and development of effective wild life conservation strategies

INTRODUCTION

Wild ungulates of East and Southern Africa have become a great world attraction important economically. In order to conserve this natural heritage both captive breeding and conservation measures in national reserves are being undertaken (Maganga and Mbassa, 1996). Their utilisation as foodstuff and export is increasing fast due to increasing local and international demands. Although Tanzania has allocated 25 % of its land to conservation of wildlife, human population growth rate exceeds by far effectiveness to protect these areas. It is estimated that by year 2050 the human population of Tanzania will reach 89 from the current 30 million (Brown and Flavin, 1999). Most animals now deemed safe will probably be extinct in the next 15 to 20 years due to expansion of pastoralism and hunting. Other factors of impact are drought causing habitat deterioration reducing water and feed availability, and diseases.

Knowledge of health, reproductive biology and stress in African wild ungulates is scanty. There is little information on urogenital organs, gonadal tumorigenesis and serological prevalence of diseases (Masake, 1977, Mbassa, 1988, 1989, 1991). It is generally established that stress in animals is the commonest cause of infertility. Stress induced infertility in wild ungulates whether it is diseases, poachers, predators, lack of nutrition, or weather is not documented. The methods that could be used for assessment of such effects are also lacking. Ethological studies in wild ungulates (as they are seen) or the effect of some disturbances as depicted from their surroundings and remains of dead animals are valuable source of knowledge that could be utilized for success of breeding programmes.

In East Africa there are diseases that affect wild and domestic animals, the former regarded as reservoirs of infections of the latter (Mlengeya et al., 1998). Little is known about susceptibility of wild species to pathogens of domestic animals (Pastoret et.al., 1988) but recently lions have suffered mortalities due to canine distemper, a disease of dogs (Roelke Parker *et al.*, 1996). Anthrax affects buffaloes, wildebeests, Thomson's and Grant's gazelle (Gainer, 1987), impala, elephant, hippopotamus, rhinoceros (Mbise et al., 1994) and wild carnivores (Mollel, 1977). Brucella spp have been isolated from impala, buffalo, eland, oryx and camels (Paling et al., 1988). Mycobacterium spp have been diagnosed in buffaloes and olive baboon scavenging on slaughter slabs. Serological surveys have detected lumpy skin disease caused by allerton-type herpes virus in buffaloes, hippopotamus, giraffe, wildebeest, eland, impala, oryx, bushbuck and waterbuck (Pastoret et al., 1988).

Foot and mouth disease is mild in buffalo (Munene, 1982, Pastoret et al., 1988), which together with greater kudus seem to harbour the virus (Pastoret et al., 1988). Malignant catarrhal fever caused by alcelaphine herpesvirus-1 (Pastoret et al., 1988) is transmitted to cattle via wildebeest and hartebeest placenta contaminated pastures (Munene, 1982), but neither of them shows clinical signs. African swine fever virus, fatal in domestic pigs infects mildly warthogs, bush, wild and forest pigs (Pastoret and others, 1988). Rinderpest is reported to cause mortalities in buffaloes, elands, warthogs, wildebeests, giraffe, bongo, bush pig and warthog and antibodies have been detected in bushbucks, waterbucks, impala, oryx, hyena and jackal (Plowright, 1982). Rabies virus a fatal disease in all warm-blooded animals, primarily domestic dogs, transmit through bites, to cattle, sheep and goats has been reported in wild dogs, jackals, foxes and mongooses (Pastoret et al., 1988).

East coast fever caused by apicomplexan hemotropic protozoa *Theilaria parva* infects cattle through *Rhipicephalus appendiculatus* tick bites is reported to fatally affect buffaloes and elands (Grootenhuis et al., 1980). Trypanosomosis caused by species of Trypanosoma transmitted by Glossina spp tsetse flies affects all mammals (Pastoret et al., 1988). Antibodies to *T. congolense* and *T. brucei* have been detected in buffalo, impala, hartebeest, topi, warthog, waterbuck, wildebeest, zebra, lion, oribi and reedbuck (Kariuki et al., 1989). Other undiagnosed diseases also kill wildlife (Mlengeya et al., 1998).
Massive mortalities due to these diseases have never been reported except for anthrax outbreak in Luangwa valley Zambia (Turnbull et al., 1991) and Lake Manyara National Park Tanzania (Mbise et al., 1994). It is important to have knowledge of their existence and epidemiology in order to control them should their magnitudes threaten wildlife.

Success in wildlife conservation has been achieved through protection by strict force, being enhanced, just by chance by several factors. The existence of large animal numbers slowed down the impact of losses due to diseases, hunting or poaching. The availability of other sources of food and cash through large number of domestic animals reduced the need for wildlife utilization. The ecosystems were also stable favouring habitants and continued survival of animals. Social and literate factors also contributed to wildlife conservation, few people had knowledge of wildlife and wildlife product markets, thus keeping wildlife utilization to minimum levels. All these factors are now reversed, working against wildlife conservation. Resources have decreased while human population tremendously increased.

Repopulation of wildlife requires accelerated breeding programmes, reduction of; competition for food, effects of man, predators and impact of diseases. This requires knowledge on risks and causes of mortalities and reproductive biology in wild animals. The purpose of this investigation was to determine the risks and causes of mortalities of wild ungulates, develop parameters for; prediction of survival rates, population trends, and disaster intervention and repopulation approaches.

MATERIALS AND METHODS

This study was conducted over a three year period (1996-1998) in game reserves of Mkomazi and Saadani and open wildlife conservation areas of Gonabis-Kisaki with its bordering North Selous sector (Matambwe), Doma-Mkata area buffering Mikumi National Park and Longido block Arusha. Animal species studied were Grant's (Bohm's) and Selous (antiquorum) plains zebra (*Equus burchelli bohemi, E. burchelli antiquorum*) or *Hipotigris (Quagga) quagga*, African buffalo (*Syncerus caffer*), blue wildebeest (*Connochaeta taurinus*), eland (*Taurotragus oryx*), hartebeest (*Alcelaphus buselaphus*), impala (*Aepyceros melampus*), Thomson's gazelle (*Gazella thomsonii*) and Grant's gazelle (*Gazella granti*). Four other species were studied for comparative risk responses, the giraffe (*Giraffa camelopadalis*), waterbuck (*Kobus defassa*), warthog (*Phacochoerus aethiopicus*) and reedbuck (*Redunca arundinum*).

Over three year period repeated visits were made to game reserves lasting for seven days in Longido (December, 1996), totalling 21 days in Mkomazi (September 1996, December 1996, December 1997), 10 days in Doma-Mkata (April, 1997, May 1998), 7 in Saadani (August-September 1997), 4 in East Sector of Selous (Kisarawe Lindi), 30 days in Gonabis and the border with North sector Selous (Matambwe) between August 1997 and December 1998.

Stress indicators were identified. These were disturbances that denies an animal of feeding, and mating, more time spent on mental work due to constant threat to life, little time to rest. This involved examination of behaviour of animals towards researchers.

Risk factors threatening survival of animals were determined by assessing the habitat as safe home for free animals providing adequate water and feeds, post mortem of animals found dead, examination of remains of dead animals to identify causes.
Factors threatening survival of wildlife, animal strategies for survival and responses to risks were examined and causes of deaths were determined by forensic diagnosis of remaining carcasses, bones, horns, heads and skins thus developing parameters for prediction of survival rates.

The parameters examined on carcasses included body condition, wounds, discharges, diarrhoea, hair coat condition, bites, scratches, bruises, bullet penetrations, strangulations, distokias, which assisted in deciding on the possible cause of death.

The bones, skins, heads, horns and other body pieces were used to identify the species affected and possible lesions and causal of death. Indicators of high risk perception in animals were high sensitivity and constant running. Indicators of stress were poor body conditions, small herd sizes, migrations, strict hiding, careful selection of grazing and drinking times. The frequency of finding carcasses and remains were recorded categorized to species

Strategies for survival was assessed by routine animal activities, preferred places, timing of day events grazing, drinking, evening collecting places, selection of places for grazing, selection of direction of run, sensitivity to being pursued, assessment of moving objects, shortest approachable distance of moving object.

RESULTS

Resident Ungulates Herds

Of the six game reserves and protected areas investigated Selous and Gonabis had very large populations of ungulates and other animals.

The resident ungulates in Longido conservation area in the order from largest to lowest population were Zebra, impala, Thomson's gazelle, Grant's gazelle, giraffes, impala and wildebeests. The area is Semi arid, open grass land and shrubs, some places of acacia trees, black soils, overgrazed. Maasai cattle herds are permanent in the area.

Mkomazi game reserve is a vast semi arid area, open and shrub grassland, thorn acacia areas, black and red soils, overgrazed, lacks source of water with more or less permanent Maasai cattle herds ranching in. It harbours in the order of large herds to small population impala, Grant's gazelle, hartebeest, zebra, buffalo, eland, lichtenstein's hartebeest *Alcelaphus lichtensteini*, Waller's gazelle or gerenuk *Litocranius valleri*, Clark's gazelle or dibatag, *Ammodorcas clarkei*, greater kudu *Tragelaphus imberbis.* Saadani game reserve is also a vast lowland coast area off Indian ocean, very suitable habitat of varied open grass, wooded areas, black soils, thorn acacia medium trees of different kinds, bordered south by Wami river, very good game reserve, huge village within, salt mines and factories in vicinity. Animals of Saadani in order of descending herd size are blue and black wildebeests (*Connochatae taurinus, Connochaeta connochatae*), defassa or common water buck, *Kobus elipsiprymmus*,

reed buck, *Redunca arundinum*, warthog, Maasai giraffe, white giraffe, Coke's hartebeest, giant eland, *Tragelaphus (Taurotragus) oryx*, Buffalo, plains zebra, *Equus burchelli.* Gonabis is in Kisaki division in Morogoro district, a very low land wet area, east Tanzania, vegetation of tall grass hyperenia, pannicum and Rhodes, generally open and wooded grassland, flat plains, small hills, borders Mikumi National Park southwest, North sector Selous south and east, black soils, very good game area, surrounded by villages, farm field encroachment, numerous animal traps. It has a very large population of ungulates, which are blue wildebeest, *Connochaeta taurinus*, plains zebra, *Equus burchelli*, reed buck, *Redunca arundinum*, African buffalo, *Syncerus caffer*, Impala, *Aepyceros melampus*, Giant eland, *Taurotragus oryx*, giraffe, *Giraffa camelopadalis*, warthog, *Phacochoerus aethiopicus* African elephant, *Loxodonta africana*, sable antelope, *Hippotragus niger*, African hippopotamus, *Hippopotamus amphibious.*

Doma-Mkata is an open wooded grassland area with acacia and miombo trees, hyperenia, pannicum and Rhodes grass, encroached by man, buffer area for Mikumi National Park, excess traumatic mortalities. Its animal population in order of largest herd to smallest are blue wildebeest, Selous zebra, *Equus burchelli antiquorum*, impala, giraffe, buffalo, and hartebeest. Selous is the largest game reserve in Tanzania and probably the world. It is vast low land wet area, east Tanzania, vegetation of tall grass hyperenia, pannicum and Rhodes, generally open and wooded grassland, flat plains, small hills, borders Mikumi National Park on the west. North sector Selous buffered by Gonabis Kisaki protected game area, black soils, and very good game area, surrounded by villages, farm field encroachment. It has very many ungulates, whose order of in number for the eastern and northern sector is blue wildebeest, plains zebra, reed buck, African buffalo, Impala, giant eland, giraffe, warthog, African elephant, sable antelope, African hippopotamus, but there are also many traps.

Risk factors and indications of stress

The major risks observed were due to the necessity for search of feed and water, exposing them to predators and poachers, agriculture and pastoralism interference. In the game areas studied animals were at risk of death when grazing and searching for water in rivers because in these places predators and poachers were waiting. More than 10 poachers camps were discovered and 12 wire traps collected in Gonabis. There were also crocodile attack threats in Mgeta River separating Gonabis and Matambwe area of Selous, one of the silent predators on rivers (table 1).

Water was scarce in Mkomazi and animals had to migrated to Tsavo reserve in Kenya or to a small dam on the border of the two countries. At the time of our visits fires had destroyed most of the pastures in all these areas and this occurs every year. Hiding places in forests of thorny acacia trees were, however, available in some the areas. Interference from agriculture was observed in Gonabis-Kisaki, pastoralists in Mkomazi and Longido, poachers in Gonabis and Selous and charcoal works in Doma-Mkata protected area.

In Saadani, Mkomazi, Doma-Mkata and Longido animals were stressed indicated by high sensitivity (nervousness), constant running, poor body condition, and small herds of frightened animals in hiding. Elands and buffaloes of Mkomazi and Saadani were particularly in strict hiding. There was scarcity of feeds and water in Mkomazi due to habitat deterioration and drought and extensive dry season fires and pastoralist grazing within.

Indications of presence of risks were high sensitivity, strict hiding. Even wildebeests hide in Saadani, Longido and Doma-Mkata to avoid dangerous strays. Very fast runs were observed

in animals of Saadani, Longido, Gonabis and Doma-Mkata, keeping very far away from people and had very high knowledge of enemy including researchers. Impalas, gazelles and wildebeest were very sensitive to being targets in Gonabis, Doma-Mkata, Saadani, and Selous. Sensitivity decreases among animals from the buffalo, which keeps in its own herds, rarely mixing with other ungulates, followed by elands, the most afraid, then hartebeests, impalas, gazelles, wildebeests, zebras, waterbucks, reedbucks, warthogs and giraffes, the least afraid.

Table 1: Risk factors for ungulates in Doma-Mkata, Longido, Mkomazi, Saadani, Gonabis and Selous in 1996-1998.

Game Reserve	Risk factors	Animals affected, in order from most threatened
Longido	Droughts, lack of feeds, lack of water, risk of being cropped, few scattered herds of frightened animals	Zebra, impala, Thomson's gazelle, Grant's gazelle, impala, wildebeests, giraffes
Mkomazi	Droughts, lack of feeds and water, few scattered herds of frightened animals	Impala, Grant's gazelle, hartebeest, zebra, buffalo, eland, hartebeest, Waller's gazelle, Clark's gazelle, greater kudu,
Saadani	Traumatic injuries of various causes, poachers	Buffalo most affected, followed by eland and blue wildebeest
Gonabis	Traumatic injuries of various causes, predators, poachers	Blue wildebeest, buffalo, eland, hartebeest, zebra
Doma-Mkata	Traumatic injuries of various causes, predators, poachers	Blue wildebeest, zebra, impala, giraffe, buffalo, hartebeest
Selous	Traumatic injuries of various causes, predators, poachers	Blue wildebeest, plains zebra, buffalo, impala, giant eland, elephant

Animals found dead

Several animals were found dead either on the same day or several days past, either complete carcase or half consumed by predators or strangled by wire traps or other injuries. Examination helped establish some of the causes of deaths indicated in Table 2. A number of heads and other bones where species of animal affected was identified were also found but the cause of deaths could not be established, as these were only remains of animals, which died in the past (Table 3).

Table 2: Animals found dead and determined cause of death in game reserves and protected areas

Place	Wildebeest	Buffalo	Zebra	Hartebeest	Impala	Others
Longido	0	0	1, lions	0	0	2 ostrich hyena
Doma-Mkata	0	0	0	0	0	1 giraffe wire trap
Mkomazi	0	2, unknown	0	0	0	
Saadani	1, unknown	1, trauma	0	0	0	1 giraffe
Gonabis	12 wire trap	3, trauma (2 bullets found)	3 trauma	4 trauma	0	0

Table 3: Skull and other bone remains of ungulates in game reserve and protected areas

Place	Wildebeest	Buffalo	Zebra	Giraffe
Doma-Mkata	2	3	3	1
Mkomazi	0	2	0	0
Saadani	3	5	0	1
Gonabis	23	9	5	0

Animals found alive but having defects

A lame giant eland was seen in Mkomazi game reserve. A lame hartebeest in Saadani revealed it to have large wound on right hind limb knee on binocular examination. One wildebeest in Saadani appeared sick but could not be confirmed. On another occasion a giraffe with a decapitating wire trap was seen in Mikumi National Park. It was remotely anaesthetized by darting with M99, the wire removed, wound treated and giraffe revived by deprenorphine antidote and set free. It is hoped that it recovered but may be deformed because the ventral and dorsal neck wounds where the wire penetrated were too big and deep. The external jugular vein and carotid arteries had not been affected but the skin and muscles were cut. The wound had been invaded by *Chrysomia bezianna* and other myiasis producing flies, whose pupae were numerous. These were thoroughly removed and wound cleaned with antiseptics and covered with antibiotic powder.

Strategies for survival of wild ungulates

Animals preferred specific places to others, especially in Saadani, Mkomazi and Gonabis, even if the latter place had more abundant pastures. Animals generally preferred areas with short grasses and few trees, especially browsing giant elands. Buffaloes preferred to graze and

drink very early morning or late evening and hide in forests during the day in Mkomazi, Saadani and Gonabis.

Wildebeests, zebras, elands preferred to graze together, but gazelles, sable antelopes, hartebeests and impala preferred their own herds. Reedbucks generally were found everywhere in Saadani and Gonabis mixing with every other animal but were reluctant to follow the runs of others. They tended to hide in grass and bushes, appearing to be aware of being not under threat.

Giraffes and waterbucks preferred their own herds and would run in different direction not along zebras, buffaloes and wildebeests. Elands seemed nervous and hypersensitive not to trust any approaching object and took off first leaving wildebeests and zebras behind, not even stopping over for observations.

All these ungulates, except the buffalo however, came close to the game park rangers camps during the night and left for grazing around seen o'clock in the morning indicating trust to game rangers and perhaps because predators are very active at night. All animals scheduled their drinking late evenings after sun set especially in Saadani and Gonabis.

The estimated distances maintained by animals away from strangers were 200- 500 m giraffes, 500 – 600 m waterbucks, 700-1500 m zebras, gazelles, impala, sable antelopes and wildebeest, 1500- 2000 m for elands, especially in Saadani and Doma-Mkata. Migrations were apparent from Doma-Mkata to Mikumi, Gonabis to Matambwe and vice versa, Mkomazi to Tsavo and vice versa. In the Saadani animals moved within as there was no place to migrate to.

Table 5: Herd characteristics and prediction of ungulate survival

Game reserve	**Herd characteristics and prediction of survival**
Longido	High risk, depopulated, requires repopulation, requires stop of game cropping
Mkomazi	High risk, depopulated, zebra, buffalo, Grant's gazelle, hartebeests, impala, dry, pastoralists invasion, vast area, insecure for animals, migrations away to Tsavo, requires provision of water, too few animals remaining, requires repopulation
Saadani	High risk, good habitat, secure, animals depopulated, requires conservation, and repopulation
Gonabis	High risk, risk of being depopulated, wildebeests, hartebeests, zebra, buffalo, impala, reed bucks, warthogs, very promising game reserve, surrounded by villages, encroached by farms, too many traps, too high wildebeest, zebra, buffalo and hartebeest mortalities, conservation approach controversial, requires stop of game cropping, requires conservation
Doma-Mkata	High risk, good habitat, animals depopulated, requires repopulation and conservation
Selous	High risk, risk of being depopulated, insecure to poachers, too high wildebeest, buffalo, zebra, hartebeest and impala mortalities, vast area, ground surveillance teams inadequate, air surveillance team inadequate, too much human activities, future survival of animals and herd growth poor, requires more conservation, education of man in vicinity, ground and air surveillance

Indications of acquired intelligence in animals

The animals indicated to acquire intelligence in the struggle for survival. They become aware of predators, poachers and protectors. They collect at game rangers camps during the night,. During the day very rarely they become so afraid of rangers cars. They are also keen on tools carried by observers. They know poachers and predator preferences. Ungulates in small herds are the most sensitive and avoid dangerous strays. Animals become aware of their habitat range and borders of protected areas. Chased from outside where they normally stray for grazing they will stop running as soon as they have entered their areas of protection especially zebras and wildebeests. A consistence standing distances were observed for these species, without allowing further closeness (see above). Even with viewing impalas and gazelles perform sudden vertical jumps to avoid being targeted. Wildebeests and zebras performed very fast irregular moves, in sideways, zigzag and quick turns, also to confuse an enemy of the direction of movement. When pursued female buffaloes, wildebeests, elands and zebras will cushion their off springs and separate from males, probably to give an opportunity for enemies to target a male animal. Elands performed fast, extended high long jumps and non-stop trots to clear off from the danger.

Ungulate population trends predicted and repopulation approaches suggested

Assessing the habitats, degree of risks, causes of deaths, herd characteristics, the trends of wild ungulate populations in the areas studied are provided in table 5.

DISCUSSION

It has been for a long time believed that wild animals harbour diseases transmitted to domestic animals and man, and subsequently large volume of information has centred on diseases, for which a brief review is provided below. In East Africa various diseases are reported to affect wild and domestic mammals, anthrax, rinderpest and canine distemper posing the greatest dangers. The diseases are caused by virus, bacteria, parasites and hemotropic protozoa, but there is very little information on metabolic, neoplastic and toxicoses. It is henceforth known that infectious diseases threaten many wild species. Anthrax and canine distemper have caused deaths to wildlife in Lake Manyara, Luangwa, Serengeti and other places (Mollel, 1977; Turnbull et al. 1991; Berry, 1993; Tuchili et al. 1993; Mbise et al., 1994; Roelke Parker et al. 1996, Hugh-Jones, 1999). Other reported infections are lumpy skin disease, foot and mouth disease, malignant catarrhal and African swine fever, rinderpest, rabies in mongoose and jackals (Munene, 1982; Anderson et al.,1990; Plowright, 1982)

Antibodies to *Brucella* spp., *Mycobacterium paratuberculosis, Mycoplasma* spp and *Leptospira* spp have been detected in elands and camels (Paling et al. 1988; Anderson and Rowe 1998). *Toxoplasma gondii* is reported in deers, badgers, bobcats, coyotes, foxes, raccoons, skunks, jackrabbits, brush rabbits, squirrels, birds, domestic cats, feral cats, dogs, sheep, plains zebra, hippopotamus, African elephant, defassa waterbuck, lion, rock hyrax, Arabian gazelles and oryx (Franti et al. 1975, Riemann et al. 1975; Mohammed and Hussein 1994).

Bovine virus diarrhoea, bovine herpes virus type 1 (BHV1), rift valley fever, bovine ephemeral fever and bluetongue are reported in elands, nyala, bushbuck, buffalo, black rhino, white rhino and waterbuck (Karesh et al., 1997; Anderson and Rowe 1998). Crimean-Congo hemorrhagic fever virus has been detected in giraffe, rhinoceros, eland, buffalo, kudu, plains zebra, hares, rodents, wild carnivores and domestic dogs (Shepherd et al. 1987) and antibodies to rinderpest virus in buffaloes, sheep and goats in Tanzania are widely distributed (Anderson et al. 1990). It is also believed that the wildebeest is the reservoir of malignant catarrh fever herpes virus.
Oestrus ovis maggots have been detected in hartebeests (Mbassa, 1986). Buffaloes and sometimes elands are heavily infested with *Amblyomma cohaerens* and *Rhipicephalus appendiculatus* ticks (Mbassa et al. 1998), which engorge also on domestic and other ruminants and transmit diseases (Young et al. 1977a). *Anaplasma marginale* is transmitted, grows and survives in cattle, sheep, goats, water buffalo, white-tailed deer, mule deer, black-tailed deer, pronghorn, Rocky Mountain elk, bighorn sheep, black and blue wildebeest, blesbuck, duiker, buffalo, giraffe, blue wildebeest, Cokes hartebeest, Thompson's gazelle, waterbuck, sable antelope and impala (Kuttler, 1984, Norval et al. 1984). Blood from wildebeests transmitted anaplasmosis to splenectomized calves (Burridge et al. 1975). Anaplasmosis is reported to produce disease in cattle and giraffe while elands are reservoirs (Ngeranwa et al., 1998).

Cowdria ruminatium has been found by DNA probe pCS20 in *Amblyomma gemma* and *A. variegatum* collected from giraffe, hartebeest eland and ostrich (Wesonga et al. 1993) and sheep, cattle and buffalo are carriers (Andrew and Norval. 1989). Earlier Keffen (1985) injected *C. ruminantium* infected blood to buffaloes in the zoo and produced no disease while Peter et al. (1998) infected *Cowdria ruminantium* in the eland, giraffe, kudu and blue wildebeest, which transmitted to naive small ruminants by *Amblyomma hebraeum.* Blood and bone marrow of healthy, free-ranging tsessebe, waterbuck and impala, were positive for *C. ruminantium* map1 gene (Kock et al. 1995). Sable transmitted heartwater to sheep through infected blood (Peter et al. 1999). Recent ultrastructural studies have also revealed *Ehrlichia platys* like organisms in impala platelets (Du Plessis et al. 1997).

Buffaloes are also carriers of *Babesia bigemina*, which is transmitted to cattle while the parasite does not survive in elands (Karbe et al. 1979). *Theileria taurotragi* infections are fatal in elands (Grootenhuis et al. 1980). The incidence rates of *Theileria parva* piroplasms in buffaloes reach 97.1%, with 59 % indirect fluorescent antibody titres to *Haematoxenus* sp. (Young et al. 1978). Cell lines infected with theilerial schizonts are established from lymph node biopsy samples and peripheral blood mononuclear leucocytes from sick elands (Stagg et al. 1976). Grootenhuis et al (1975) and Young et al. (1977b) transmitted theileriosis between impala, eland and cattle while Stagg et al. (1987) established theileria infected cell lines from buffaloes. Buffaloes, blue wildebeest and eland are infected with *Theileria* spp., the first transmits theileriosis and anaplasmosis to cattle. *Theileria parva* from buffaloes differ on monoclonal antibody profile but cloning infected lymphoblastoid cells retain their monoclonal antibody profile (Conrad et al. 1987). In Tanzania buffalo are infected with *Theileria parva, T. mutans*, *B. bigemina*, *A. marginale* and *Haematoxenus veliferus* (Schreuder et al 1977).

Blood stream forms of *Trypanosoma congolense*, *T. vivax* and *T. brucei* multiply in buffaloes, lechwe, kudu, impala, tsessebe, sable and reedbuck and cause parasitaemia as in cattle (Drager and Mehlitz 1978; Olubayo et al. 1990).

It is apparent from this brief review of wildlife diseases that there are numerous risks and causes of mortalities in wild ungulates and their survival is essentially natural selection. However, this information has been obtained from experimental sites and very rarely on free ranging animals. Although the occurrence of these diseases cannot be refuted it can be said with certainty that their prevalence rates are very low. Wild ungulates appear to have high defensive capabilities. Buffalo leukocytes phagocytose trypanosomes (Young et al., 1975), which are quite large and tolerate theileriosis (Mbassa et al., 1998). Wild ungulates have been observed to have increased total surface area for oxygen exchange than those domesticated (Pospisil et al., 1984).

This investigation has attempted to determine the risks which wild ungulates of Tanzania face in their natural habitats. In addition to these the actual causes of mortalities have also been determined. Combining these parameters and assessment of habitats it is possible to predict the survival rates and population trends in an area harbouring games species. The results of this study can help prevent decline in wild ungulate populations and intervene a disaster and in case repopulation of an area is necessary the parameters of consideration are clarified.

Resident ungulate herds in the areas studied were determined, with approximate numbers, so as the risk factors and causes of deaths. There was no abnormal prevalence of any disease among those stated above, but there were real droughts and water scarcity in Mkomazi and Longido, as well as fires in all. Real risks centred on ungulates being prey of others (man and predators). The necessity to search for feeds and water made these actions a risk to life.

Buffaloes, wildebeests, zebras and hartebeests have been found dead, which on close examination revealed that the cause of death was traumatic or strangulation (bullets or snares). The benefit of close surveillance was on the occasion in Mikumi National Park, when a giraffe was sported to have a hanging object on the neck. Examination under anaesthesia revealed a decapitating wire snare. This was successfully removed and saved the life of that animal.

It was said in Mkomazi game reserve that the fires are useful to ungulates helping sprout of new grass, which gazelles and impalas prefer. This is a very marginal benefit at the expense of life. All the hiding places for animals are destroyed by fire, benefiting hunters and predators and this is the reason for setting grasslands on fire. Thus fires increased the risks of deaths to ungulates first by the desiccating effect in the already dry pastureland under very strong sun, second by increasing the areas of search for feeds risking more and thirdly by destroying all the hiding places, making them more vulnerable predators and to deaths.

The scarcities of water and feeds due to droughts and deteriorating habitat also contributed to risk of life for these free ungulates. Mkomazi game reserve has this tendency in dry years and it is advisable to construct dams.

From these studies we established that forensic data could be extracted in order to determine the causes of stress and deaths, and provide solutions. The socio-perceptions of animals appear to be similar to those of humans, showing great acquisition of knowledge from their surroundings. Animals in Mikumi National Park and Gonabis-Kisaki protected area in Tanzania clearly recognise precisely the borders of their areas, even individual humans and the tools they carry such as a camera or guns. This indicates that careful and systematic study of animals enables identification of stressing factors and infertility. This knowledge should be able to facilitate success of breeding programmes.

Stressed animals under various risks show certain characteristics, which were seen in this study, including development of various tactics for survival, the degree of which varied between species. It is a sort of acquired intelligence and education in animals. This acquired intelligence can apparently be perceived and observed. Obviously the animals learn in the course of their tough living. Unfortunately the methods of testing how they learn is not currently available, we hope to acquire it in the future.

Another factor posing a risk was encroachment of game parks by pastoralists and small farmers. It is obvious at this century of technology to know that agricultural production in African cannot be increased shifting from farmland to wildlife reserve lands. A future for the remaining wild ungulates is base on expansion of wildlife land to be occupied by wild species alone. Increased agricultural production is guaranteed by mechanization of agriculture in existing farms.

The current trend is that as human population increases, farm and livestock lands become limited and areas reserved for wildlife are invaded. It will eventually become necessary to as a separate conservation category to combine wild and domestic animals in one ranch in order to use the available land for both. Wildlife and domestic animals are sharing grazing land in Longido, Mkomazi game reserve, Doma-Mkata open area and probably others. Wildlife management in this nature is gaining popularity.

CONCLUSION

Wildlife conservation, it is necessary to know the species specific risks and causes of so that the right programme measures can be taken. Ethology, human and livestock activity, predator population, forensic studies on remains, animal migrations, habitat evaluation and diseases are useful tools for measurement of risks of death in wild ungulates offering information for prediction of future trends and developing effective strategies

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