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The wild dog—Africa's vanishing carnivore

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This paper presents a synopsis of the current status and distribution of the African wild dog Lycaon pictus, *outlines reasons for its decline and discusses recommendations to halt or reverse this decline. A recent review of the status of the species provides evidence that it has disappeared or is in decline throughout its range (sub-Saharan Africa). Relict populations with little or no chance of long-term survival are found in several countries including Algeria and Senegal. Countries believed to contain potentially viable populations are, from north to south, Kenya, Tanzania, Zambia, Zimbabwe, Botswana, and South Africa (only the Kruger National Park).*

Background and biology

There are probably fewer adult African wild dogs *Lycaon pictus* in protected areas than black rhinos *Diceros bicornis* remaining in Africa (Frame and Fanshawe, in press; Cumming *et al.*, 1990). The reduction in the distribution and abundance of *Lycaon pictus*, a monotypic canid restricted to sub-Saharan Africa, must receive greater attention, study, and finances if extinction of the species is to be avoided.

It is unlikely that there are more than 5000 individuals in all of sub-Saharan Africa. Many of these individuals are members of widely scattered packs in unprotected, prey-depleted areas, and are certainly doomed; the estimate is thus reduced to 3000. As 90 per cent of all pups are likely to die before reaching maturity (Schaller, 1972), the remaining population of adult African wild dogs may be as low as 2000 (Frame and Fanshawe, in press).

Wild dogs are social, communally hunting carnivores, which live in small cohesive packs typically composed of a dominant breeding pair, a number of non-breeding adults, and their dependent offspring. Adult males are related to one another, but not to the females, which immigrate from other packs. Group size varies locally, with a mean of 9.8 in the Serengeti (Frame *et al.*, 1979; Malcolm and Marten, 1982), 8.4 in the Zambesi Valley (Childes, 1988), and 11 in both Zimbabwe's Hwange National Park (Childes, 1988) and South Africa's Kruger (Reich, 1978). Group size is quite variable and, depending on pack fecundity and pup survival, as many as 45 dogs are occasionally recorded. Litter size averages 10 pups. Denning, which lasts 2 or 3 months, is the only time in the year when these nomadic animals stay in one place. Birth sex ratio is skewed towards males in both captive and wild populations (Frame *et al.*, 1979; Malcolm and Marten, 1982); in the adult population of the Serengeti, males outnumber females by a ratio of 2:1 (Frame *et al.*, 1979; Malcolm, 1979).

Lycaon is a truly nomadic animal. Pack home range size varies considerably, from 500 sq km at its smallest (Reich, 1981) up to 1500 sq km in both plains (Serengeti: Frame *et al.*, 1979) and bush habitats (Hwange: Ginsberg, unpubl. data). Ranges overlap from 50 to 80 per cent. When they are not at the den with young pups, packs rarely sleep in the same place on consecutive nights.

Immense home ranges, low densities and its extreme mobility engender grave conservation problems for *Lycaon*: few protected areas are large enough for populations of 200–300 individuals (East, 1981a); fragmentation and expansion of human populations lead the dogs into increased contact with humans, their domestic animals (Butynski, 1974), and the diseases they carry (Dobson and Hudson, 1987); an increasing number of roads bisecting

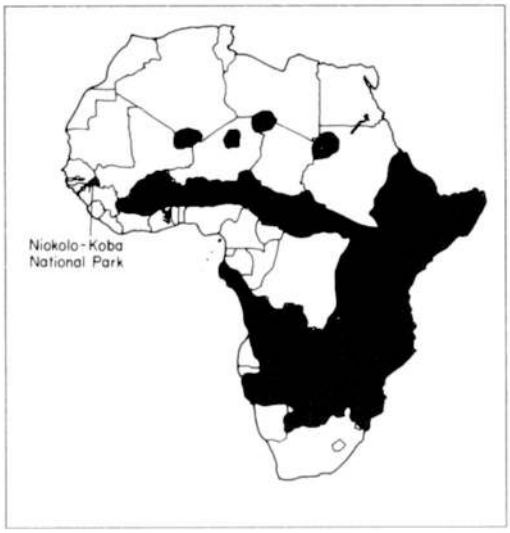

Figure 1a. Distribution of African wild dogs 1980 (after Smithers, 1983).

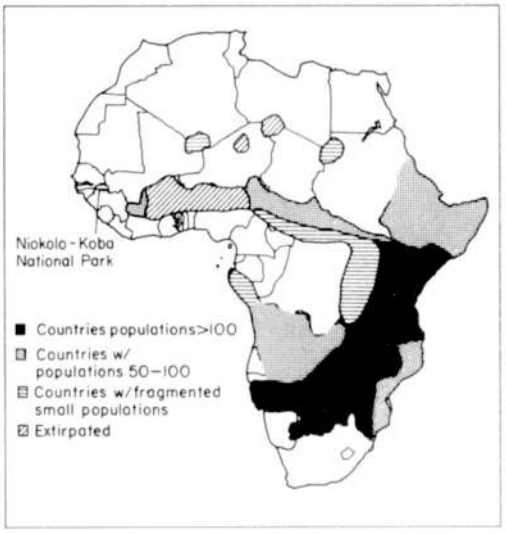

Figure 1b. Distribution of African wild dogs 1988 (data from Frame and Fanshawe, in press).

their habitat threaten the species with greater mortality from four-wheeled predators (Mech, 1989).

Current status and distribution

Early accounts support a hypothesis that wild dogs were once widespread where they have now been eradicated (Frame and Fanshawe, in press), both in protected areas (e.g. Nigeria's Yankari Game Reserve: Sikes, 1964) and entire countries (e.g. Uganda: Frame and Fanshawe, in press). South of the Sahara, it seems likely that wild dogs were once found in every habitat except for rain forest and some desert areas. There are records for habitats as unlikely as the mountain snows of Kilimanjaro (Thesiger, 1970). The species's range must have pushed far into arid lands to the north, because a relict population still exists in Algeria (K. de Smet, pers. comm.)

Frame and Fanshawe (in press) give a country-by-country summary of the status and population numbers of the wild dog. African wild dogs once occurred in 34 sub-Saharan African countries (Smithers, 1983. The species is now extirpated, or nearly so, in 19 of these. Small or relict populations (n<100) persist in nine countries. Potentially viable populations persist in only six, and these populations are relatively small and often declining (Figure 1). Even in those countries in which wild dogs exist in relatively large numbers, such as Zimbabwe, populations are fragmented and concentrated in protected areas (Childes, 1988) and rarely are seen outside of these regions.

Causes of decline

A number of factors are believed to have contributed to the decline of wild dogs: habitat loss; conflict with man (Malcolm, 1979; Childes, 1988); disease (Schaller, 1972; P. Kat, in litt.); competition with other predators (Frame, 1986); and loss to vehicle accidents (Fanshawe, 1989). All these factors are interrelated, each being more or less important depending upon the population being considered.

Habitat loss

In common with large mammal species throughout the continent, wild dogs are facing annual losses of habitat. Because of their large home ranges and low population densities, the dogs are more susceptible to fragmenta-

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tion of continuous habitat than any other African large mammals except, perhaps, the cheetah *Acinonyx jubatus* (East, 1981b).

With the exception of the efforts focused on animals such as the African elephant *Loxodonta africana* and black rhino, conservation efforts are shifting from saving single species to projects aimed at the integration of people and wildlife, and the protection of unique habitats. Species like wild dogs and cheetahs, however, can be viewed as 'flagships'. As East (1981b) notes, 'reserves large enough to support minimum viable populations of cheetah and wild dogs should ensure the long-term survival of entire large mammal communities'.

Fragmentation of habitat leads to numerous direct and indirect effects. Isolation of subpopulations will result in smaller effective population sizes and greater potential for extinction (papers in Soulé, 1987); encroachment and settlement leads to more contact with man and his domestic animals. This has three effects: increased persecution by farmers in 'defense' of domestic stock and wildlife; increased contact with domestic dogs and their diseases; fragmented habitats are usually traversed by a greater number of better roads than pristine areas, bringing the dogs into greater contact with faster, more numerous, and dangerous traffic (see below).

Persecution

Public perception. Arguably, disembowelling one's dinner is not the prettiest way of killing, but it can hardly be called unnatural. Despite the work of Goodall and van Lawick in the Serengeti (1970, 1973), wild dogs rarely fare well in the public eye when compared with other carnivores such as the lion. This jaundiced public perception of *Lycaon* has persisted throughout this century:

'Let us consider for a moment that abomination—that blot upon the many interesting wild things—the murderous Wild Dog. It will be an excellent day for African game and its preservation when means can be devised for its complete extermination' (Maugham, 1914).

'(I)n the shade of the tailgate lay one sullen dog, yellow-eyed, mud-colored, thick-footed, head on its forepaws—an eerie embodiment of the hound of hell' (Alexander, 1986).

In contrast, these authors treat lions rather benignly:

'In appearance the lion of the Zambesi valley is a splendid and most majestic creature' (Maugham, 1914).

'I saw him—a big male lion with black-tipped mane and tail, a kingly creature of habit on his morning stroll, cleaving the tawny savanna' (Alexander, 1986).

Lions are kingly, majestic: wild dogs savage, murderous. Lions cleave the savanna, wild dogs wallow sullenly. Yet lions kill cattle and people, they commit infanticide, and scavenge food from other predators, a behaviour rarely exhibited by wild dogs. Although the language of popular writing may only reflect public perception, it also influences and reinforces the attitudes of the public. If wild dogs are to survive, it is imperative that the entirely false perception of the animal as a wanton killer be replaced by a more accurate and, perhaps, more sympathetic view.

Government extermination programmes. As recently as the late 1960s, wild dogs existed in many protected areas where their presence was often met with persistent antagonism. Managers working both inside and outside these areas treated them as vermin (Davison, 1930; Childes, 1988).

Although there are few data documenting the extent of predator control projects, Zimbabwe provides a good example of the pressures *Lycaon* faced at the height of its persecution in that country. Before 1975, the number of wild dogs is unknown; however, in 1975, only 500 individuals remained (Cummings, cited in Childes, 1988). A minimum of 3404 were killed from 1956–1975, including those shot in Hwange National Park, with fewer being shot in successive years, probably as a result of population declines (Childes, 1988).

Fortunately, attitudes among wildlife managers have changed, as witnessed by the writings of former Director and Chief Warden of Uganda National Parks, Rennie Bere:

'Wild dogs hunt in packs, killing wantonly far more than they need for food, and by methods of the utmost cruelty: *Lycaon* does not kill quickly as the lion but often starts to devour the antelope ... before life is extinct' (Bere, 1956).

'Wild dogs are very successful and efficient hunters and, in spite of their reputation, are no more 'cruel' than any other large beasts of prey' (Bere, 1975).

Sadly, private landowners whose properties border protected areas have not changed their view of *Lycaon*. Many farmers still treat wild dogs as vermin, with reports of private individuals shooting them being disconcertingly common (Childes, 1988; Ginsberg and Macdonald, 1990; Frame and Fanshawe, in press).

Predators of domestic stock and privately owned wildlife. Given the opportunity, there is no doubt that wild dogs will occasionally kill and eat domestic stock. However, little evidence has been found for depredation of Masai cattle, sheep and goats by wild dogs in Kenya (Njungiri, 1990; P. Kat, pers. comm.). With an estimated 350 dogs in Zimbabwe, cattle losses are negligible (Childes, 1988). In most species in which studies have been made, losses to canid predators are usually exaggerated (Ginsberg and Macdonald, 1990).

In areas such as north-west Zimbabwe habitat encroachment has been reversed by a shift from a cattle-based economy to one based on wildlife (hunting/ranching/photo safaris). This provides distinct advantages by increasing areas of natural habitat, improving prey availability outside protected areas, and providing corridors among protected areas. Surprisingly, wildlife ranchers are even less tolerant of wild dogs than cattle ranchers (Childes, 1988). In interviews with ranchers, three complaints were repeated: wild dogs take prey that could otherwise be sold for hunting or meat; packs, particularly when denning, scare prey into thick bush and render hunting difficult or impossible; and even where wild dogs eat relatively inconsequential proportions of the total prey available, they appear to preferentially select rare game, like reedbuck *Redunca arundinum* and waterbuck *Kobus ellipsiprymnus* (J. R. Ginsberg, unpubl. data).

Sport hunting and totems. It appears that sport hunting of wild dogs has never been popular. Although clients could shoot them as trophies in Tanzania until 1987 (when their hunting was banned; Fanshawe, 1989), few did so. Trophy fees were low so professional hunters discouraged their shooting. In addition, skinners disliked handling the carcasses of wild dogs.

Disease

Lycaon appears particularly sensitive to disease. Under some circumstances, pathogens may be a factor regulating wild dog numbers (Schaller, 1972; Dobson and Hudson, 1986). A variety of diseases has been isolated, including rabies, distemper, parvo-virus, and anthrax, *Babesia* (van Heerden, 1980) and canine ehrlichiosis (van Heerden, 1979). In all cases of infection, it appears that wild dogs are the victims, not vectors, of disease transmission (van Heerden, 1979, 1980). In recent years, an increasingly determined effort has been made by researchers in Kenya, Tanzania, Zimbabwe and South Africa to isolate the diseases infecting wild dogs.

Rabies illustrates how dramatically disease can affect these social carnivores. In 1989, 20 of 22 dogs in a single Masai Mara pack died of rabies (P. Kat, pers. comm.). An outbreak of rabies in domestic dogs living to the north-west of the reserve occurred simultaneously with this event. Although no rabies could be isolated in a pack that died in the Serengeti in 1986 (J. Nyange, in litt.), the dogs showed symptoms very similar to those of the Kenyan dogs. Population declines in north-west Zimbabwe in the early 1980s (Childes, 1988) were correlated with (but not linked causally to) an outbreak of rabies in that area (Kennedy, 1988).

Canine distemper has long been suspected to be common in wild dogs (Schaller, 1972), but its isolation from free-ranging animals has never been successful. In captivity, they appear highly susceptible, contracting distem-

per when inoculated with live vaccines, and showing virtually no antibody response to dead-virus vaccines (van Heerden *et al.*, 1980).

In a recent outbreak of anthrax in the Luangwa Valley in Zambia, several packs of wild dogs were found to be infected (K. Saigawa, pers. comm.). In one pack of five adults and eight pups, anthrax killed four of the adults and three of the pups. In a separate pack, at least two adults contracted the disease.

Competition

Loss of kills to larger carnivores such as lions and hyaenas possibly poses a threat in some areas. The absence of wild dogs from Ngorongoro Crater in Tanzania is often thought to result from a high density of spotted hyaena *Crocuta crocuta* (Estes and Goddard, 1967). Competition with hyaenas has been suggested as a variable responsible for limiting *Lycaon* numbers in the Serengeti (Frame, 1986). In particular, in the Serengeti, competition with hyaenas during the late dry season, a time in which food is already limited, may limit population growth of *Lycaon*.

Recent results suggest that wild dogs can defend their kills from hyaenas, but not lions (Fanshawe and FitzGibbon, unpubl. data). In this study in the Serengeti, hyaenas were present at 85 per cent of kills, but only gained carcasses when the dogs had finished feeding. In the Masai Mara, hyaenas are more common at the kills of smaller packs. Hyaenas were present at 92 per cent of all kills made by a pack of three adults and five pups; 66 per cent of the kills were parasitized, but only after the dogs had eaten extensively (T. Fuller and P. Kat, pers. comm.). In a small sample of 40 kills from Hwange National Park, hyaena were seen to attend only 10 per cent of kills (J. R. Ginsberg, unpubl. data). Once again, carcasses were only yielded to the scavengers when feeding was essentially over.

Road kills

Throughout their range wild dogs are killed by vehicles, particularly where major routes cross protected areas. For example: the Dar es Salaam–Morogoro highway, which bisects Mikumi National Park in Tanzania (Frame and Fanshawe, in press); the Bulawayo–Victoria Falls road, which runs parallel to Hwange in Zimbabwe, has claimed at least 12 dogs since 1988 (J. R. Ginsberg, unpubl. data). Accidents also occur in parks without major highways, such as the Serengeti, where three dogs (of a known population of nine individuals) were killed in 1986 (Fanshawe, 1989). As *Lycaon*, like wolves, frequently use roads for hunting and transit (Reich, 1981), growing road networks will lead inevitably to more deaths; only if areas of high road density abut large areas of roadless wilderness will wild dogs survive (Mech, 1989). Ironically, it has been such accidents that have led to a better knowledge of the wild dog's range in some areas of Kenya (Frame and Fanshawe, in press).

Genetics

Living at low densities and in dispersed populations, wild dogs may be prone to low levels of genetic heterozygosity. This may, in turn, render them more susceptible to various diseases and parasites (O'Brien *et al.*, 1985). Furthermore, eastern and southern subpopulations are genetically distinct (R. Wayne, in litt.). This divergence has both evolutionary and conservation implications and is particularly important to projects contemplating reintroduction. For instance, probably all individuals in captivity in the USA are of southern African origin (B. Brewer, North American *Lycaon* Studbook Keeper, pers. comm.). Yet those areas in which reintroductions are likely to occur are in eastern and western Africa. Particularly in areas where relict populations persist, reintroduction of a distinctly different subspecies may be inadvisable.

Current conservation status and research

In a recent review of all Canids (Ginsberg and Macdonald, 1990), the African wild dog ranks among the most endangered. The species is

classified as Vulnerable by the IUCN World Conservation Union, but reclassification as Endangered has been recommended (Ginsberg and Macdonald, 1990; Frame and Fanshawe, in press).

Lycaon research has become a growth industry in recent years. Five field-based projects are under way, two others are planned, and laboratory research on wild dog genetics is also being conducted. Brief details are given here (from north to south), but they are fully discussed in Ginsberg and Macdonald (1990): (i) Kenya: genetic, ecological and disease monitoring of a population in the Mara Region (Dr Pieter Kat); (ii) Tanzania: continuation of the long-term monitoring in the Serengeti (Dr Markus Borner, Karen Laurenson, Roger and Jan Burrows and Stephen Lelo); (iii) Tanzania (proposed): dog reintroduction to Mkomazi Game Reserve (Tony Fitzjohn); (iv) Tanzania (funded, to begin 6/91): research into the little known but potentially important population in Selous Game Reserve (Scott and Nancy Creel); (v) Zimbabwe: genetic, disease, ecological, and behavioural research, especially in terms of conflicts between people and wild dogs (Dr Joshua Ginsberg, Clare Davies); (vi) Botswana: assessment of wild dogs throughout, but concentrating in the northern Chobe and Ngamiland Districts (Dr John Bulger and Professor Bill Hamilton); (vii) South Africa: long-term monitoring in Kruger National Park (Dr Gus Mills and Anthony Maddock); (viii) Namibia: reintroduction of dogs into Etosha National Park (Philip Stander; J. L. Scheepers); and, (ix) genetic analyses are being carried out on blood specimens collected throughout Africa (Dr Robert Wayne).

Conservation options

In late 1991 a Population Viability Assessment Workshop will be held to discuss the problems facing the conservation of the wild dog. The meeting will be attended by representatives from each of the range states that support potentially viable wild dog populations, scientists studying wild dogs, and experts concerned with disease and genetics of wild dogs. The proceedings of the meeting will elaborate the conservation options discussed below in greater detail.

Captive breeding, translocation, rehabilitation and reintroduction

For animals that have complex social systems and require learning (hunting, learning extensive home range areas, etc.), primary conservation efforts should concentrate on the maintenance of adequate habitat for populations that remain in the wild (Imboden, 1989). Returning captive-bred dogs to the wild, or translocating animals from healthy populations, is often mooted, and has been tried for several populations (Frame and Fanshawe, in press), and with only some success, notably in the Umfolozi Reserve, South Africa (Ginsberg and Macdonald, 1990). In fact, pressure is now increasing to recognize the limitations that reintroductions can have in the successful management of mammal populations (Stanley-Price, 1991).

If reintroduction is to be attempted, many issues need to be resolved. No wild population numbers more than 200 or 300 adults (Frame and Fanshawe, in press); hence, no wild population appears to be large enough to enable translocation of more than several packs. Given this constraint, the only obvious source is captive-bred dogs. The greatest need for reintroduction is in western, central, and eastern Africa, yet most captive dogs are southern in origin. Because there are significant genetic differences between southern and eastern populations (R. Wayne, in litt.), these dogs should not be used for reintroduction. Additional areas of concern that must be addressed by any well-planned reintroduction include: the risk of introducing disease and parasites; the potential for conflict with neighbouring human populations; the uncertainty surrounding the ability of reintroduced packs to learn hunting techniques; and the need to carefully assess sites for their suitability to support a population over a long period.

Wild dogs are frequently bred in captivity but there is great variance in the success of breeding attempts. The reasons for this large

variation in breeding success among zoos are poorly understood (Ginsberg and Macdonald, 1990) but are being investigated (J. R. Ginsberg, unpubl. data). Although captive populations may be self-sustaining numerically (Frankel and Soulé, 1981), only a few zoos breed wild dogs with any success, so fewer and fewer founder animals will be represented in captive groups. A regional studbook for zoos in North America is near completion (B. Brewer, Brookfield Zoo, pers. comm.). This studbook should clarify the effective population size of captive populations in North America.

Disease control

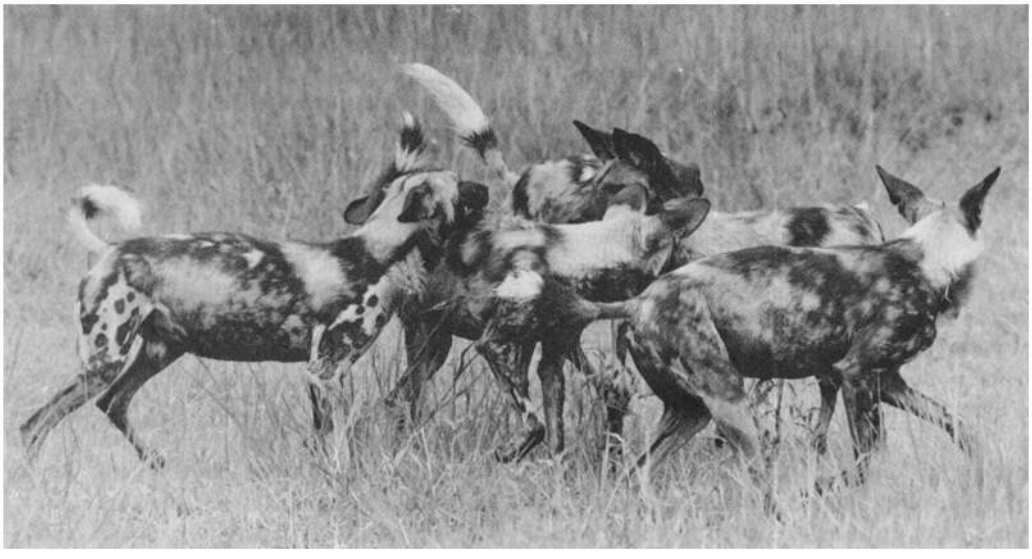
With such an intensely social nature, wild dogs are very susceptible to the rapid passage of disease within a group. Three management options are open to combat disease: control pathogens in sympatric domestic dog populations; remove sick individuals before they infect other pack members; or inoculate the wild dogs directly.

Throughout much of Africa, the costs and logistics of controlling disease in domestic dogs would be prohibitive. If, however, efforts are focused on areas bordering protected lands, such programmes could, potentially, reduce the rate and frequency of infection. As packs appear to succumb rapidly once a single dog is infected, removal might be considered. Achieving this before infection spreads is unlikely. Morever, if a beneficial genetic resistance to disease exists in some individuals, their removal would have negative long-term effects.

Direct inoculation of *Lycaon* appears to be the best option, but data from zoos suggest that finding vaccines that are efficacious and safe may be difficult. This is especially true of distemper (van Heerden *et al.*, 1980). Testing of new vaccines, such as recombinant rabies vaccine, must be carried out under controlled conditions before widespread inoculations are attempted. If promising vaccines are found, tests should be made in field projects planned to allow for proper assessment.

Legislation

In recent years, wild dogs have been afforded at least limited protection in all the countries where they occur in relatively large numbers (n=200–500). Hunting has been banned in Tanzania and Botswana, and near-complete protection has been enacted in Zimbabwe. At



African wild dogs during a pre-hunt greeting (*J. R. Ginsberg*).

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national level, a legal framework for the protection of endangered species is a critical tool towards their conservation.

Internationally, placing the wild dog on the list of endangered mammals has been proposed (Ginsberg and Macdonald, 1990; Frame and Fanshawe, in press). Wild dogs are clearly endangered, and such a reclassification will aid in soliciting support for conservation efforts. A second proposal, to list the dogs on CITES (Convention on Trade in Endangered Species) under Appendix II has far less value. This Convention is confined to regulating trade in endangered species and there is no evidence for even a small international trade in wild dog products.

Education

Perhaps the act that would have the greatest immediate impact on the conservation of wild dogs would be to improve their image, both in Africa and internationally. As most populations of wild dogs move in and out of protected areas, local people's attitudes and perceptions must be encouraged towards a benign view. Various methods, including talks in churches and schools, popular articles published locally (e.g. Njunjiri, 1990), and meetings with local farmers and ranchers, must be pursued. The tourist value of the dogs should also be promoted. Visitors to a den in the Serengeti spent an average of 38 minutes with the pack (J. H. Fanshawe, unpubl. data), compared with an average of 10 minutes with lions (Schaller, 1972).

Genetics

Given that there appear to be large genetic differences among wild dogs occurring in different parts of Africa, greater research is needed on the population genetics of this species. In particular, samples from populations in western Africa are needed. In addition, an understanding of the intrapopulation genetics of relatively healthy populations of wild dogs would be of great assistance to those contemplating reintroduction in areas where wild dogs have been extirpated.

Recommendations

The following recommendations amplify those made in Ginsberg and Macdonald (1990).

1. The status of the African wild dog should be changed to Endangered by the IUCN, World Conservation Union. Reclassification will have little effect in stopping illegal hunting or vermin control, or in arresting disease. It will, however, lend support to improving legislation and enforcement in range states. Furthermore, it will assist efforts to enact programmes (education and disease prevention) that may lead to an improved potential for the survival of the species.

2. Efforts should be made to ensure adequate support for populations in the target countries of Kenya, Tanzania, Zambia, Zimbabwe, Botswana and in South Africa's Kruger National Park. The role of wild dogs in tourism, and their value as a tourist attraction in these countries, must be exploited. Funding for protection and research needs to be provided, especially if the effects of disease are to be successfully countered. Large parks are vital for *Lycaon* and parks that are large enough to protect the species will also serve to conserve the entire faunal and floral community there.

3. Surveys of the species should be made urgently in areas that are very poorly known, but where wild dogs are believed to exist at reasonable densities, e.g. the Selous in southern Tanzania; Luangwa and Kafue National Parks, Zambia.

4. Relict populations must be assessed for long-term survival. No healthy West African population (>100) is known and surveys need to be undertaken in large reserves where wild dogs still eke out a precarious existence, e.g. Niokolo-Koba National Park in Senegal (Figure 1b); the Bouda-Ndiida Reserve National Park in Cameroon; Bamingui-Bangoran National Park in the Central African Republic; and Ouadi Rimé-Ouadi Achim Forest Reserve in Tchad.

5. As the great majority of *Lycaon* in captivity are of southern origin, consideration should be given to including dogs from western and

eastern Africa in captive stock. The size of these captive populations, or in fact the ability to collect individuals for captive breeding, will depend on population sizes in the wild. Groups of differing genetic origin should be bred separately, and the Studbook in the USA should be expanded to include collections world-wide.

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Request

Although we are beginning to appreciate the extent of *Lycaon*'s decline, the data available for many countries, in West and Central Africa especially, are few and far between. Any readers who feel they can contribute information are welcome to contact Joshua Ginsberg, Deputy Chairman IUCN Canid Specialist Group, Wildlife Conservation Research Unit, Department of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS, UK.

References

Alexander, S. 1986. The Serengeti: The Glory of Life. *Nat. Geo.* **169**, 585–601.

Bere, R.M. 1956. The African Wild Dog. *Oryx*, **3**, 180–182.

Bere, R.M. 1975. *Mammals of East and Central Africa.* Longman, London.

Butynski, T.M. 1974. An encounter between African Wild Dog and domestic dog. *E. Afr. Wildl. J.* **12**, 243.

Childes, S.L. 1985. The past history, present status and distribution of the hunting dog *Lycaon pictus* in Zimbabwe. *Biol. Conserv.* **44**, 301–316.

Cumming, M., du Toit, D.H. and Stuart, S.N. 1990. *African Elephants and Rhinos: Status Survey and Conservation Action Plan.* IUCN, Gland, Switzerland.

Davison, T. 1930. Report on Wankie Game Reserve, October 1928–March 1930. *Wankie National Park Notes*, **21**, 1978.

Dobson, A.P. and Hudson, P.J. 1986. Parasites, disease and the structure of ecological communities. *TREE*, **1**, 111–15.

East, R. 1981a. Area requirements and conservation status of large African mammals. *Nyala*, **7** (1), 3–20.

East, R. 1981b. Species-area curves and populations of large mammals in African savanna reserves. *Biol. Conserv.* **21**, 111–126.

Estes, R.D. and Goddard, J. 1967. Prey selection and hunting behavior of the African Wild Dog. *J. Wildl. Manage.* **31**, 52–70.

Fanshawe, J.H. 1989. Serengeti's Painted Wolves. *Natural History*, 56–67.

Frame, G.W. 1986. Carnivore competition and resource use in the Serengeti ecosystem of Tanzania. *PhD Thesis*, Utah State University, Logan, Utah.

Frame, L.H. and Fanshawe, J.H. In press. *African Wild Dog* Lycaon pictus*: a Survey of Status and Distribution 1985–1988.* IUCN/SSC, Canid Specialist Group Report, IUCN, Gland, Switzerland.

Frame, L.H. and Frame, G.W. 1976. Female African Wild Dogs emigrate. *Nature*, **263**, 227–229.

Frame, L.H., Malcolm, J.R., Frame, G.W. and van Lawick, L.H. 1979. The Social Organisation of African Wild Dogs (*Lycaon pictus*) on the Serengeti Plains, Tanzania, 1967–78. *Z. Tierpsychol.* **50**, 225–249.

Frankel, O.H. and Soulé, M.E. 1981. *Conservation and Evolution.* Cambridge University Press, Cambridge.

Ginsberg, J.R. and Macdonald D.M. 1990. *Foxes, Wolves and Jackals: An Action Plan for the Conservation of Canids.* IUCN, Gland, Switzerland.

Goodall, J.M. and van Lawick, H. 1970. *Innocent Killers.* Collins, London.

van Heerden, J. 1979. The transmission of canine ehrlichiosis to the Wild Dog *Lycaon pictus* (Temminck) and Black-backed Jackal *Canis mesomelas* Schreber. *J. S. Afr. Vet. Ass.* **50**, 245–248.

van Heerden, J. 1980. The transmission of *Babesia canis* to the Wild Dog *Lycaon pictus* (Temminck) and black-backed jackal *Canis mesomelas* Schreber. *J. S. Afr. Vet. Ass.* **51**, 119–120.

van Heerden, J. 1981. The role of integumental glands in the social and mating behaviour of the hunting dog *Lycaon pictus* (Temminck, 1820). *Onderstepoort J. Vet. Res.* **48**, 19–21.

van Heerden, J., Swart, W.H. and Meltzer, D.G.A. 1980. Serum antibody levels before and after administration of live canine distemper vaccine to the Wild Dog *Lycaon pictus*. *J. S. Afr. Vet. Ass.* **51**, 283–284.

Imboden, C. 1989. Parrots, trade and captive breeding. *World Birdwatch*, **11**, 2.

Kennedy, D.J. 1988. An outbreak of rabies in North-Western Zimbabwe 1980–1983. *Vet. Record*, **122**, 129–133.

Kruuk, H. and Turner, M. 1967. Comparative notes on predation by lion, leopard, cheetah and Wild

Dog in the Serengeti area, East Africa. *Mammalia*, **31**, 1–27.

van Lawick, H. 1973. *Solo: The Story of an African Wild Dog*. Collins, London.

Malcolm, J.R. 1979. Social organisation and communal rearing in African Wild Dogs. *PhD Thesis*, Harvard University, Cambridge.

Malcolm, J.R. and Marten, K. 1982. Natural selection and the communal rearing of pups in African Wild Dogs (*Lycaon pictus*). *Behav. Ecol. Sociobiol.* **10**, 1–13.

Malcolm, J.R. and van Lawick, H. 1975. Notes on Wild Dogs hunting zebras. *Mammalia*, **39**, 231–240.

Maugham, R.C.F. 1914. *Wild Game in Zambesia*. John Murray, London.

Mech, L.D. 1989. Wolf population survival in areas of high road density. *Am. Midl. Nat.* **121**, 387–389.

Njungiri, P. 1990. The dogs in danger. *The Standard, Nairobi*, 4/4/1990, p. 14.

O'Brien, S.J., Roelke, M.E., Newman, A., Winkler, C.A., Meltzer, K.D., Colly, L., Evermann, J.F., Bush, M. and Wildt, D.E. 1985. Genetic basis for species vulnerability in the cheetah. *Science*, **227**, 1101–1103.

Reich, A. 1978. The behavior and ecology of the African Wild Dog (*Lycaon pictus*) in the Kruger National Park. *PhD Thesis*, Yale University, New Haven, Connecticut.

Sikes, S.K. 1964. A Game Survey of the Yankari Reserve of Northern Nigeria. *Nigerian Field*, **29**, 54–82, 127–141.

Smithers, R.H.N. 1983. *Mammals of the Southern African Sub-region*. University of Pretoria, Republic of South Africa.

Soulé, M.E. 1987. *Viable Populations for Conservation*. Cambridge University Press, Cambridge.

Schaller, G.B. 1972. *The Serengeti Lion*. Chicago University Press, Chicago.

Stanley-Price, M.R. 1991. In press. A review of mammal reintroductions, and the role of the Reintroductions Specialist Group of IUCN/SSC. *Symp. Zool. Soc. (Lond)*. 62.

Thesiger, W. 1970. Wild dog at 5894 m (19,340 ft). *E. Afr. Wildl. J.* **8**, 202.

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