CANID NEWS

Newsletter of the Canid Specialist Group

No. 3, August 1995

Edited by

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at the

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WILDCRU Wildlife Conservation Research Unit

IUCN

PEOPLE'S TRUST FOR ENDANGERED SPECIES

CONTENTS..

The aim of this newsletter is to provide a forum for the exchange and publication of information, ideas and opportunities among all those concerned for the welfare and conservation of canid species. The views expressed are those of the authors and do not necessarily reflect those of the IUCN or the Canid Specialist Group.

The line drawings in the Issue were produced by **Mr. Wayne Clack**, at the Zoology Department, Oxford University.

COVER PHOTO: North American red wolf, *Canis rufus* (photo courtesy of USFWS).

This Newsletter was produced using IMPRESSION and Artworks on an Acorn A5000 computer.

Editorial

Our goal is that Canid News should include high quality articles that not only convey the excitement of canid biology, but also inform upon, and contribute to the resolution of, conservation problems. We do not diminish our thanks to other contributors to Issue 3 by saying that this goal could not be better fulfilled than by the trio of outstanding articles that Ron Nowak, Mike Phillips and Bob Wayne have prepared on the North American red wolf. Each article is absorbing reading, and together they make an excellent summary of a major issue in canid conservation. We are grateful for their work, and also to Dave Mech and the IUCN/SSC Wolf Specialist Group for agreeing that Canid News can carry occasional wolf articles as and when they are offered. Indeed, this third issue of Canid News is rather heavily wolfy as we thought it sensible to include in one wolf-oriented issue all the grey wolf news that contributors had sent us.

It is our pleasure to announce the appointment of Dr Claudio Sillero-Zubiri as full-time Conservation Officer for the Canid Specialist Group. This unique post has been sponsored by the Born Free Foundation, and represents a major contribution on their behalf to canid conservation and to fostering the IUCN/SSC's goals. Dr Sillero-Zubiri will concentrate on African issues and is currently working on problems facing Ethiopian Wolves and the Sénégalese populations of African Wild Dogs (in the latter we have been generously supported by the Licaone Fund). We are also delighted to acknowledge that the People's Trust for Endangered Species has agreed to continue part-funding of Laura Handoca's post as Canid Group Actioner and co-editor of this journal. All these sponsors must surely realise how vital is their support, and how greatly it is appreciated.

We hope readers will find much of interest in this issue. In issue 4 we will be focusing on topics touching upon the welfare of canids, together with articles on little-known South American canids.

West Africa Wild Dog Survey

In 1985 – 1988 John Fanshawe and Lory Frame carried out a mail survey concerning the status and distribution of the African wild dog (*Lycaon pictus*). Their survey has been instrumental in improving our understanding of the plight of this animal. We know now that the species is heading towards extinction over much of its range and only concerted efforts to save the species will reverse this trend. Although advances have been made in identifying and protecting wild dog populations in eastern and southern Africa, an adequate understanding of the distribution and abundance of this species in western Africa is still lacking.

The *IUCN Canid Specialist Group*, sponsored by the *Licaone Fund* and the Born Free Foundation, is now undertaking a more detailed survey of countries in western Africa where wild dogs might still be present. If you have ever seen wild dogs in West or Central Africa, or know people who have seen wild dogs, we would be extremely grateful if you could contact us.

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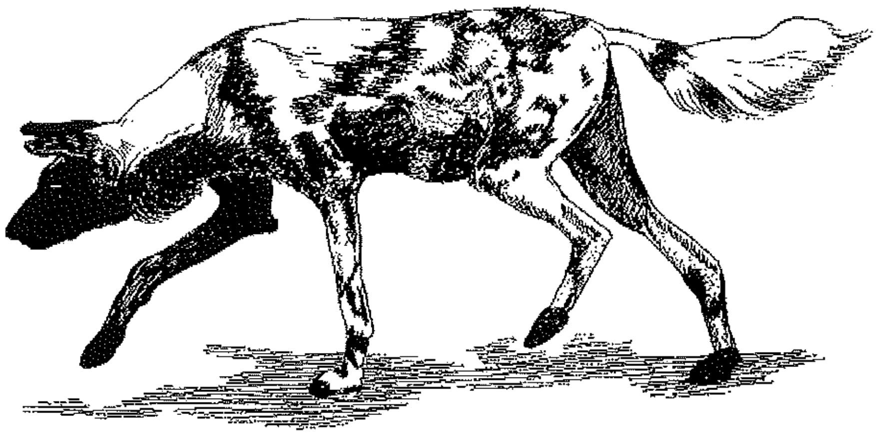


Hybridization: the Double-edged Threat Ron Nowak

This article explores the use of morphology and geographical evidence to assess possible hybridization events in the history of North American canids.

The wolves of North America are under a severe new threat from an influential group; not the lumber companies, fur trappers, or stockmen, but the zoologists, or at least some among them who are keen to publish claims that wolf populations have hybridized with other species. These scientists are unwittingly playing into the hands of certain commercial interests, which will seize upon any suggestion that a species is no longer taxonomically valid, in order to argue that conservation efforts are not warranted and that the species and its habitat may be exploited.

The last few years have seen the widespread promulgation of various interesting but controversial notions. These include proposals that a vast wolf (*Canis lupus*)-coyote (*C. latrans*) hybrid zone has engulfed central North America, that the arctic wolf (*C. lupus arctos*) has been substantially altered through genetic introgression from the domestic dog (*C. familiaris*), and that the southeastern red wolf (*C. rufus*) is nothing more than a hybrid of the grey wolf and coyote. None of these ideas has been accepted by the scientific community, but some are being related as fact in the media and are being turned against the wolf. Formal petitions to remove both the grey and red wolf from the List of Endangered and Threatened Wildlife were received and extensively reviewed by the U.S. Fish and Wildlife Service, although eventually these were denied (Henry, 1992; Refsnider, 1990).

Ron Nowak has advocated conservation of the red wolf for 30 years. His Ph.D. dissertation (U. Kansas, 1973) covered systematics of fossil and modern North American *Canis*. He also authored the current edition of Walker's "Mammals of the World".

The above is not intended to downplay concern that hybridization, induced by human disruption of natural populations and their environment, is a serious problem to wildlife and plants (Rieseberg, 1991; Williams & Nowak, 1992). My own research (Nowak, 1979) indicates that the near disappearance of the red wolf was indeed caused in large part by interbreeding with the coyote. The grey wolf and coyote have also apparently hybridized in southeastern Canada, where the small subspecies *C. lupus lycaon* now occupies a restricted range and could be jeopardized by genetic swamping. There has been a recent proliferation of commercially bred wolf-dog hybrids, some of which are being turned loose into areas where wolves occur naturally.

Based on an analysis of mitochondrial DNA, Wayne and Jenks (1991) went well beyond the long-recognized view that the red wolf and coyote had interbred. They suggested that *C. rufus* actually originated as a hybrid and had never been a valid species or subspecies. Their study was simultaneously utilized by Gittleman and Pimm (1991) to criticize efforts being made to reintroduce the red wolf in the wild. These papers were immediately challenged, both on the basis of genetics (Dowling *et al.*, 1992a; 1992b) and paleontology and morphology (Nowak, 1992).

Examination of fossil and modern skulls (Nowak, 1979; 1992; in press; Nowak *et al.*, in press) indicates that *C. rufus* has existed in southeastern North America, in much the same form as now, for at least 700,000 years. *C. lupus* did not even arise until much later and never penetrated far into the southeast. *C. latrans* did not enter the southeast during this entire period, except for a brief incursion about 10,000 years ago and again within the last few decades. Hybridization between *C. rufus* and *C. latrans* began about 100 years ago in central Texas and subsequently spread through much of the former range of the red wolf. *C. lupus* was also present in Texas at that time, but was completely distinct from the other two species and the hybrids. A small population of *C. rufus* on the Texas coast evidently escaped substantive interbreeding; a few individuals from this group were taken into captivity and served as the founding stock for current reintroduction efforts.

The proponents of hybrid origin for the red wolf have largely ignored the above evidence, claiming that large grey wolf and coyote populations must somehow have moved into the southeast and interbred to form the red wolf. Since mitochondrial DNA analysis has revealed little basis for taxonomic division of wolf populations in most of North America, they have argued that it would be unlikely for a separate species to exist in the southeast, especially since there were no barriers to prevent the entry of the large and mobile grey wolf. They have even suggested that instead of using the captive red wolf population for current reintroduction efforts in the southeast, it would be better to bring in grey wolves from Canada, Alaska, or Mexico (Jenks & Wayne, 1992).

In the attempt to prove hybrid origin for the red wolf, both Jenks & Wayne (1992) and Wayne (1992) have published a composite of two figures from my own work (Nowak, 1979: 22, 32). Each of the figures depicts the same graphical distribution of large samples of known skulls of female *C. lupus*,

female *C. latrans*, and *C. familiaris*, based on a canonical analysis of 15 measurements. One of the figures also shows the graphical positions of 52 female *C. rufus*, and the other figure shows the positions of 5 suspected female hybrids of *C. lupus* and *C. latrans* from southeastern Cauada. The composite figure indicates that most of the suspected hybrids fall within the graphical range of *C. rufus* (which itself is largely between the ranges of *C. lupus* and *C. latrans*), and thus was used to argue that the red wolf is essentially the same thing as a grey wolf-coyote hybrid.

The composite figure, as utilized by Jenks & Wayne (1992) and Wayne (1992), demonstrates a misunderstanding of both phylogenetics and multistatistical procedures. The two original figures were based on a procedure that was not intended to distinguish red wolves and grey wolf-coyote hybrids, but to show how individuals of each group compared to three known samples, including the domestic dog. Considering that *C. rufus* is a primitive wolf, representing a stage in the evolution of *Canis* intermediate to *C. latrans* and *C. lupus*, its position on the graph is not surprising. Likewise, hybrids of the grey wolf and coyote could reasonably be expected to fall between their parent species.

In order to illustrate the principle, I carried out a new canonical discriminant analysis of 10 skull measurements (those numbered 1, 2, 4, 5, 6, 8, 11, 12, 14, and 15 in Nowak 1979), using the Statistical Analysis System (SAS Institute, 1987). Three known groups were examined: 18 female *C. latrans* from eastern Wyoming, 20 female *C. lupus* from Minnesota (18) and Isle Royale (2), and 20 domestic dogs. The wolf and coyote samples were chosen based on their geographical proximity to the areas of interest and their lack of any morphological evidence of hybridization; there was no selectivity and all available specimens were used. The dog sample, however, was selected to achieve a size range comparable to that of the two wild species, and was taken from a larger series already chosen so as to avoid extremes of domestication. In addition, 9 female red wolves collected in southeastern Missouri in 1923-1925 were compared as individuals to the three known groups. The red wolf sample comprises all available females taken before 1930 in the area and was chosen because: (1) the presence of a distinguishable sympatric coyote population in the same area of Missouri (Nowak, 1979) demonstrates that red wolf-coyote hybridization was not then a factor; and (2) this red wolf sample is the one closest to the area of suspected grey wolf-coyote hybridization. Also compared as individuals were the same 5 suspected female grey wolf-coyote hybrids from southeastern Canada that are discussed above.

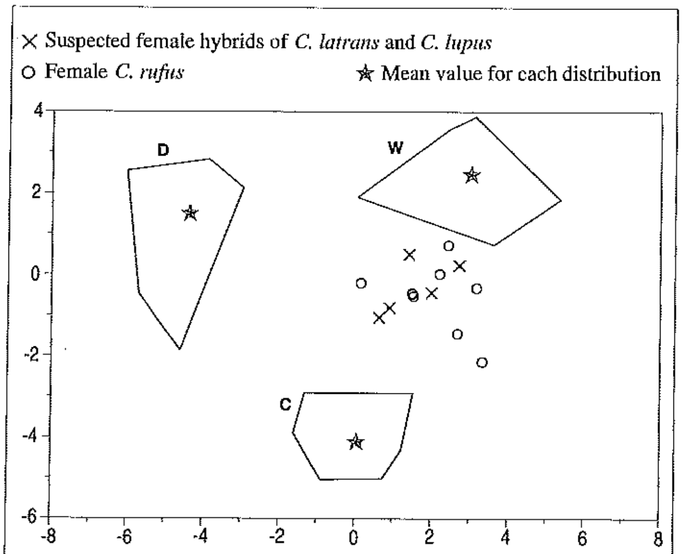


***Figure 1.** Multistatistical distribution of five groups of Canis, based on the first (horizontal axis) and second (vertical axis) canonical variables. D shows the limits for C. familiaris, C shows limits for female C. latrans, and W shows limits for female C. lupus. The mean for each distribution is given by a star. Data points for female C. rufus (circles) and suspected female hybrids of C. latrans and C. lupus (crosses) are also shown.*

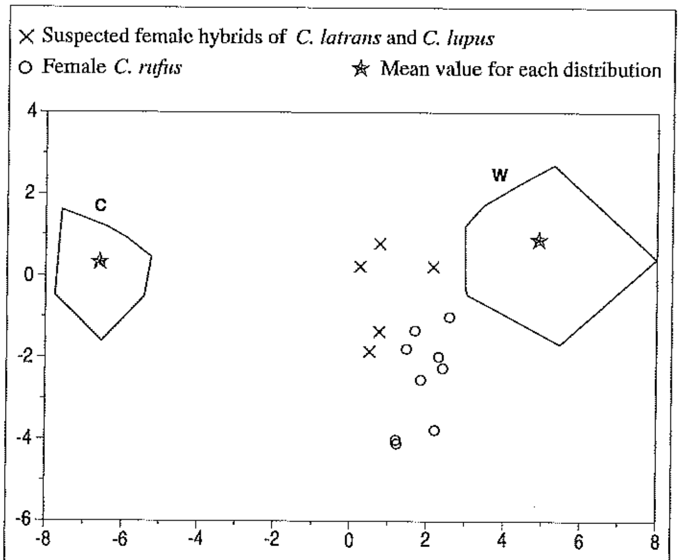


***Figure 2.** Multistatistical distribution of four groups of female Canis, based on the first (horizontal axis) and second (vertical axis) canonical variables. C shows the limits for C. latrans and W shows limits for C. lupus. The mean for each distribution is given by a star. Data points for female C. rufus (circles) and suspected female hybrids of C. latrans and C. lupus (crosses) are also shown.*

Graphical results (Fig. 1) show the three known samples – *C. latrans*, *C. lupus*, and *C. familiaris* – to be distinct from one another. The groups of individual red wolves and suspected hybrids are separate from the three known samples but are both distributed between the limits of grey wolf and coyote and overlap one another extensively. The analysis thus yields the same result as shown in the composite prepared by Jenks & Wayne (1992) and Wayne (1992). However, I then did a second analysis, in which the sample of domestic dogs was eliminated and the samples of red wolves and suspected hybrids were entered as independent groups. Graphical results (Fig. 2) still show complete distinction of the grey wolf and coyote, but now the red wolf and the suspected grey wolf-coyote hybrids also form distinct clusters. I do not claim that larger samples of red wolves and hybrids would not overlap, but multistatistical analysis does show that the two do not have identical characteristics.

The publications of Wayne and Jenks followed closely on reports of another "hybrid zone" in the Great Lakes region, said to involve the spread of coyote mitochondrial DNA to 62% of grey wolves in Miunesota and to 100% of those on Isle Royale (Lehman *et al.*, 1991). As usually understood, a hybrid zone refers to an area where the ranges of two related species meet, interbreeding occurs, and a new population is produced that bridges the morphological, behavioural, and ecological gap between the parent species. In fact, nothing of the sort has developed in Minnesota or Isle Royale, where observations by field personnel and analysis of specimens indicate no change in the original characters of *C. lupus* (Nowak, 1991; 1992).

Isle Royale is of particular interest because if the students of the mitochondrial DNA approach had been provided only blood or tissue samples from the area, and had no other knowledge of the situation there, they would have concluded that the island is occupied solely by a population of coyotes. Actually, the only wild *Canis* on Isle Royale are packs of grey wolves, the main prey of which is moose. Skulls taken over the years (and loaned to me through the kindness of Durward L. Allen and John A. Vucetich, Jr.) show no hint of an approach to the coyote in size or other characters; indeed the wolves of Isle Royale may be getting larger. Considering dental size, perhaps a more conservative expression of relationship than is over-all skull size and proportion, the Isle Royale animals have not changed at all. The five available skulls of male wolves, collected on Isle Royale through 1971, have upper carnassials (fourth premolar teeth) nearly identical in size to those of the five available males collected from 1980 to 1991 (Fig. 3).

A recent reduction in size has been claimed for *C. lupus arctos*, a subspecies found on most of the Canadian Arctic islands, not because of hybridization with the coyote, but through introgression from escaped sled dogs (Clutton-Brock, Kitchener & Lynch, 1994). Skulls in a series taken between 1930-1950 and after 1950 reportedly averaged smaller size than

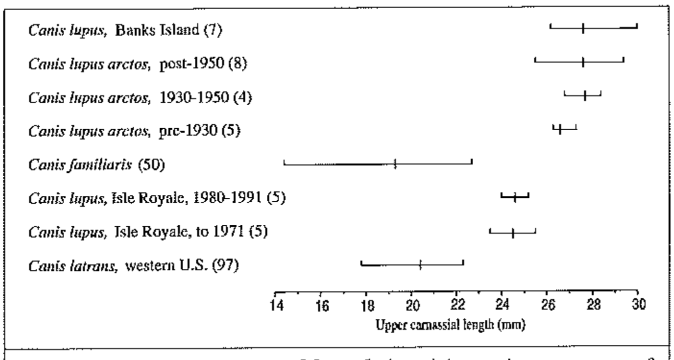


Figure 3. *Upper carnassial length (mm) in various groups of male Canis discussed in the text, and of C. familiaris (sample sizes in brackets). The horizontal bar shows the range for each sample, intersected by the mean value.*

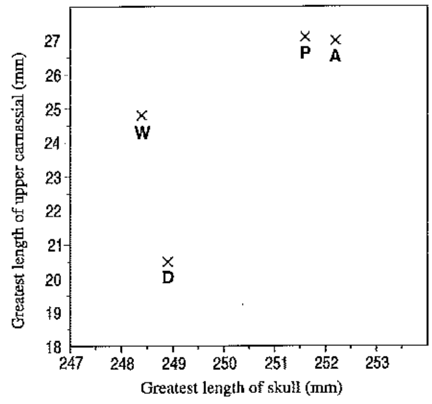


Figure 4. *Bivariate analysis comparing the mean positions of measurements of greatest length of skull and upper carnassial in 94 C. lupus from the mountainous region of the western conterminous US (W), 29 C. lupus arctos from the Canadian high Arctic and Banks Island (A), 9 late Pleistocene C. lupus from the Rancho La Brea and Maricopa Brea tar pits of southern California (P), and 18 large (skull exceeding 225 mm) C. familiaris (D). Each series consists of both sexes.*

those taken before 1930. However, the pre-1930 sample consists only of five specimens, four being known males and one a probable male. The two subsequent series have somewhat more specimens, but contain both sexes. Since the males of any given population of *Canis* are significantly larger than the females (Nowak, 1979), it is likely that a series consisting predominantly of males will have larger average measurements than will series with a normal sex ratio.

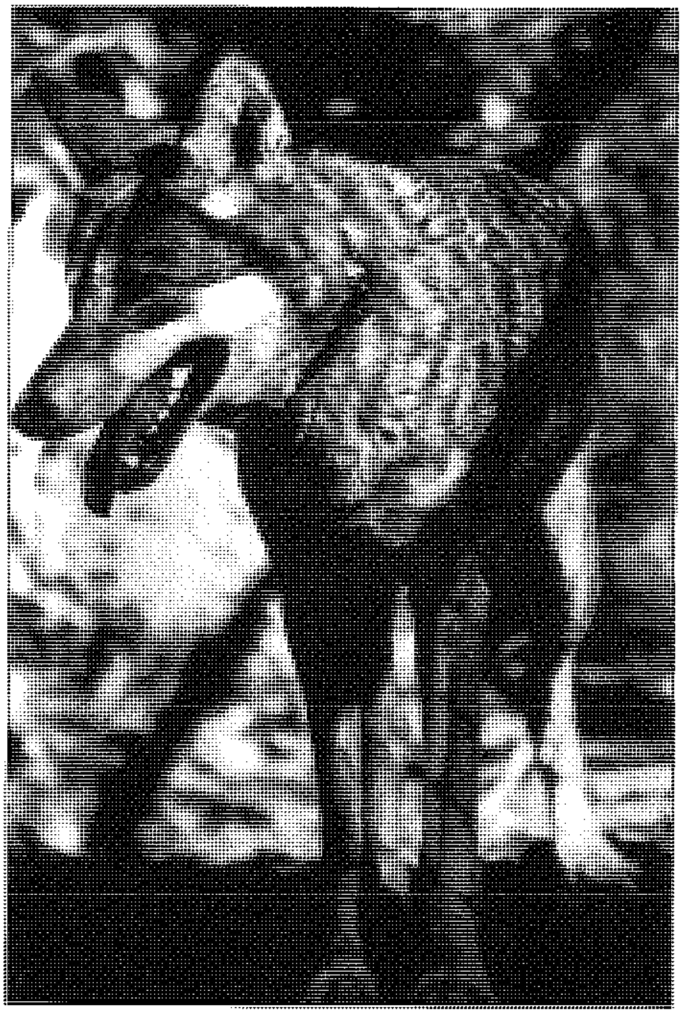
In any case, I have examined most of the same collections and have not observed a reduction in size over time or any other indication of substantive dog introgression. One of the most useful characters in distinguishing the skull of a large dog from that of a wolf is the relatively tiny and well-spaced teeth of the former. The conservative dentition has not kept up with the bones of the skull in the development of large breeds of *C. familiaris*. The most useful individual teeth are the carnassials. *C. lupus arctos* has especially huge carnassials, and series of available specimens **of males only** demonstrate no decline in size over the years (Fig. 3).

In addition to a size reduction, Clutton-Brock, Kitchener & Lynch (1994) referred to the relatively broad rostra and crowded teeth of the more recent Arctic wolves as characters suggesting introgression from dogs. I would note also that both *C. familiaris* and *C. lupus arctos* commonly share a relatively broad frontal shield (forehead). However, I do not think that these characters indicate genetic relationship. The same features show up in various other wolf populations, and reach extreme development in a series of skulls taken in the 1950s on Banks Island, where *arctos* apparently spread following extirpation of the original population. The Banks Island skulls maintain a very large carnassial (Fig. 3) and show no particular evidence of dog hybridization. A series of male *C. lupus albus* from the Taymyr Peninsula of northwestern Siberia have the same basic characters (Nowak, in press).

Broad rostra, broad frontal shields, crowded teeth, huge carnassials, and certain other features of modern Arctic wolves are also characteristic of some late Pleistocene *C. lupus* from the tar pits of southern California and from the Yukon (Nowak, 1979). The commonality of characters suggests phylogenetic affinity between these Ice Age wolves and those now found in northern Eurasia, on Banks Island, and in the Canadian high Arctic (Fig. 4). Another interpretation would be that the various populations are not related, but all underwent a similar phenotypic response to environmental conditions. The least likely alternative is that hybridization with the domestic dog occurred in all these times and places and affected wolf populations in the same way.

According to Mengel (1971), hybrids of *C. familiaris* and *C. lupus* breed annually, like wild wolves, but the timing is shifted so that on average the hybrids breed approximately three months earlier. Therefore, the offspring of hybrids are born during the winter and would have little chance of survival in the wild. If Mengel's views are correct, the Arctic would be the last place on earth where we would expect introgression from dogs into a wild wolf population.

Although Mengel's position is based on limited experimentation, it is supported by abundant circumstantial evidence from throughout North America. Walker & Frison (1982) found canid remains at archaeological sites indicating that prehistoric Amerindians of the western United States, like modern Eskimos, had crossed their large dogs with wolves. There also have been a handful of documented instances in which wild wolves apparently mated of their own volition with domestic dogs and produced offspring (Young & Goldman, 1944). However, there is no evidence of gene flow in the other direction.



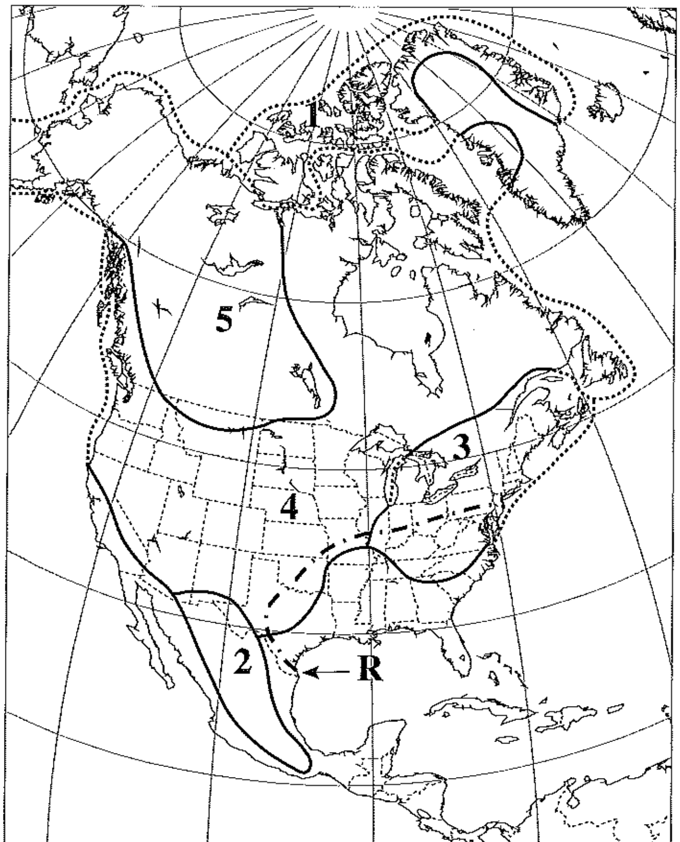


Figure 5. *Original geographical distribution of wolves in North Americ, showing the five subspecies of Canis lupus recognized here: (1) arctos, (2) baileyi, (3) lycaon, (4) nubilis, (5) occidentalis. The red wolf occupied the southeastern quarter of the continent, the approximate northern and western limits of its range being marked by the dashed line labelled R.*

Following analyses of hundreds of wolf skulls from North America (Nowak, 1979; in press), I reported fewer than 10 that seemed to represent wolf-dog hybridization. Much of my study centered on large collections from the western United States assembled in the early 20th century, when the region was filling up with humans and dogs and when wolf populations were in severe decline. If ever there was a set of conditions that might be expected to foster wolf-dog hybridization and introgression, it existed then, and yet there is no evidence that such a process developed.

Wolves have continued to live in close proximity with people and dogs throughout western Canada and Alaska, but without any hint of size reduction or other signs of introgression. Of particular note is the Peace River district of Alberta, where wolves occur regularly on the fringe of agricultural development. Specimens recently taken there are consistently large in all measurements and, indeed, include the largest skulls of *C. lupus* ever reported (Gunson & Nowak, 1979). Likewise, specimens from the wolf population now expanding southward into the western United States are all large and fully wolflike (Nowak, 1983; in press).

The view that wolf and dog are the same species has recently gained popularity and was accepted in Wilson & Reeder (1993). I still recognize the two as separate species, especially considering the ease with which adult skulls can be distinguished and the extreme rarity of natural interbreeding. The two have shared a vast part of North America for centuries, and it might have become difficult for wolves to pair with their own kind as their numbers dwindled, as their range was fragmented, and as individuals were forced to disperse into settled country. That the wolf has remained completely distinctive under such conditions is something for which canid conservationists should be grateful.

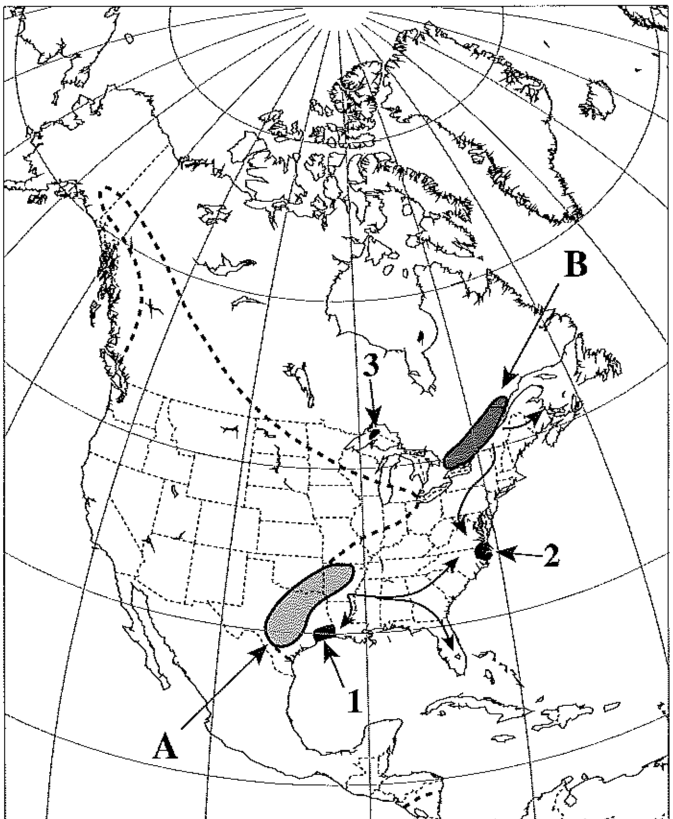


Figure 6. Map showing original geographical range of the coyote (limits shown by dashed lines), area where coyote and red wolf hybridized c. 1890–1930 (A), and area where grey wolf and coyote hybridized shortly thereafter in southeastern Canada (B). Arrows indicate subsequent expansion of modified coyote populations. Also shown are the last relatively pure wild red wolf population c. 1970 (1), the reintroduced red wolf population 1987 to present (2), and Isle Royale (3).

Literature Cited

Clutton-Brock, J., Kitchener, A. C. & Lynch, J. M. 1994. Changes in the skull morphology of the Arctic wolf, *Canis lupus arctos*, during the twentieth century. J. Zool., 233: 19-36.

Dowling, T. E., DeMarais, B. D., Minckley, W. L., Douglas, M. E. & Marsh, P. C. 1992a. Use of genetic characters in conservation biology. Conserv. Biol., 6: 7-8.

Dowling, T. E., Minckley, W. L., M. E. Douglas, P. C. Marsh, and B. D. DeMarais. 1992b. Response to Wayne, Nowak, and Phillips and Henry: use of molecular characters in conservation biology. Conserv. Biol., 6: 600-603.

Gittleman, J. L. & Pimm, S. L. 1991. Crying wolf in North America. Nature, 351: 524-525.

Gunson, J. R. & Nowak, R. M. 1979. Largest grey wolf skulls found in Alberta. Can. Field-Nat., 93: 308-309.

Henry, V. G. 1992. Finding on a petition to delist the red wolf (*Canis rufus*). Federal Register, 57: 1246-1250.

Jenks, S. M. &Wayne, R. K. 1992. Problems and policy for species threatened by hybridization: the red wolf as a case study. In: Wildlife 2001: populations, pp. 237-251. Eds. D. R. McCullough & R. H. Barrett. Elsevier Applied Science, London.

Lehman, N. A., Eisenhawer, K., Hansen, L. D., Mech, R.O., Peterson, P. J., Gogan, P. & Wayne, R. K. 1991. Introgression of coyote mitochondrial DNA into sympatric North American grey wolf populations. Evolution, 45: 104-119.

Mengel, R. M. 1971. A study of dog-coyote hybrids and implications concerning hybridization in *Canis*. J. Mammal., 52: 316-336.

Nowak, R. M. 1979. North American Quaternary *Canis*. Monogr. Mus. Nat. Hist. Univ. Kansas, no. 6, 154 pp.

Nowak, R. M. 1983. A perspective on the taxonomy of wolves in North America. In: Wolves in Canada and Alaska, pp. 10-19. Ed. L. N. Carbyn. Can. Wildl. Serv. Rept. Ser., no. 45.

Nowak, R. M. 1991. Species hybridization and protection of endaugered animals (letter). Science, 253: 250-251.

Nowak, R. M. 1992. The red wolf is not a hybrid. Conserv. Biol., 6: 593-595.

Nowak, R. M. In press. Another look at wolf taxonomy. In: Ecology and conservation of wolves in a changing world, Proceedings of the Second North American Wolf Symposium, 24-27 August 1992, Can. Circumpolar Inst., Univ. Alberta, Edmonton.

Nowak, R. M., Phillips, M. K., Henry, V. G., Hunter, W. C. & Smith, R. In press. The origin and fate of the red wolf. In: Ecology and conservation of wolves in a changing world, Proceedings of the Second North American Wolf Symposium, 24–27 August 1992, Can. Circumpolar Inst., Univ. Alberta, Edmonton.

Refsnider, R. L. 1990. Notice of a finding on a petition to delist the grey wolf (*Canis lupus*). Federal Register, 55: 49656-49659.

Rieseberg, L. H. 1991. Hybridization in rare plants: insights from case studies in *Cercocarpus* and *Helianthus*. In: Genetics and conservation of rare plants, pp. 171-181. Eds. D. A. Falk & K. E. Holsinger. Oxford Univ. Press, New York.

SAS Institute. 1987. SAS/STAT guide for personal computers. Version 6 edition. SAS Institute Inc., Cary, North Carolina.

Walker, D. N. & Frison, G. C. 1982. Studies on Amerindian dogs, 3: prehistoric wolf/dog hybrids from the northwestern plains. J. Archaeol. Sci., 9: 125-172.

Wayne, R. K. 1992. On the use of morphologic and molecular genetic characters to investigate species status. Conserv. Biol., 6: 590-592.

Wayne, R. K. & Jenks, S. M. 1991. Mitochondrial DNA analysis implying extensive hybridization of the endangered red wolf. Nature, 351: 565-568.

Williams, J. D. & Nowak, R. M. 1993. Vanishing species in our own backyard: extinct fish and wildlife of the United States and Canada. In: The last extinction, pp. 115-148. Eds. L. Kaufman & K. Mallory. MIT Press, Cambridge, Massachusetts.

Wilson, D. E. & Reeder, D. M. Eds. Mammal species of the world. A taxonomic and geographic reference. Smithsonian Inst. Press, Washington, D.C., xviii + 1206 pp.

Young, S. P. & Goldman, E. A. 1944. The wolves of North America. Amer. Wildl. Inst., Washington, D.C., xx + 636 pp.

[Red wolf photographs courtesy of the U.S. Fish & Wildlife Service]

Red Wolves: to Conserve or not to Conserve Robert Wayne

Genetic evidence suggests that the red wolf is a hybrid form, not a distinct species. Should we continue to preserve it?

The Conservation Problem

Conservationists today are doomed to struggle against an advancing tide of habitat destruction, human population growth, and persecution and exploitation of plant and animal species worldwide. They must face the unpleasant responsibility of prioritizing and allocating effort, in the certain knowledge that there are insufficient resources available to save and protect all of nature's diversity. That a triage-like system for prioritizing species' conservation is necessary is evidenced by one important failure of the Endangered Species Act (ESA) in the USA. Although nearly 1000 species are listed under the Act, only a few percent of them have received Federal support for research and conservation. The criteria for prioritizing species are multifarious, but one of considerable importance is the genetic uniqueness of candidates for conservation. The giant panda (*Ailuropoda melanoleuca*), for example, is the only surviving representative of a distinct subfamily of bears, and would thus seem to deserve the disproportionate attention and effort currently dedicated to its continued survival.

Bob Wayne's training in molecular genetics began at the National Camcer Institute, followed by his tenure as Head of Conservation Genetics at London's Institute of Zoology. He is currently a professor at the University of California in Los Angeles. His molecular studies have made a major contribution to understanding canid taxonomy and shed light on many associated conservation issues.

The genetic criterion is, however, only as reliable as the data available concerning the genetic uniqueness or value of an organism. Where the issue is unresolved couservation efforts may encounter problems of selection and justification of allocation of resources. A prime example of such a situation is the case of the North American red wolf, *Canis rufus*.

The Red Wolf Problem

The red wolf was once fairly widespread in the southeastern USA, but predator control programmes and the conversion of mature woodland habitat to agriculture resulted in a reduction in both range and population size. By the 1970s the species had dwindled to a single population in eastern Texas, and this population was threatened by interbreeding with the red wolf's close relative, the coyote (*Canis latrans*). The U.S. Fish and Wildlife Service (USFWS) initiated a last minute recovery plan to save the species from extinction. Fourteen animals, thought to be pure red wolves, were selected from a much larger sample of canids captured in east Texas and used to establish a captive breeding programme (Phillips & Parker, 1988).

The captive breeding and subsequent reintroductions to the wild have been successful beyond expectation, and can justifiably be viewed as a model for rescuing highly endangered species from the brink of extinction. Nevertheless, such success is not without price: the USFWS has a five year budget of around $4.5 million to cover field studies and captive breeding facilities. Does the genetic uniqueness of the red wolf warrant this level of resources? Since the recovery programme began the taxonomic status of the red wolf has been investigated using both morphological and genetic methods, giving rise to contradictory results. Due to the economic and political importance of the red wolf project, these contradictions have resulted in considerable controversy. I present here a summary of the findings of genetic research.

Why Examine the Genes?

Efforts to use morphological criteria as a basis to classify the red wolf as a distinct species are problematic. Multivariate analysis of morphological measurements, such as done by Nowak (1979), express the overall similarity in cranial and dental form of red wolves to other canids. Indeed, his data indicate red wolves are distinct and intermediate in form between grey wolves (*Canis lupus*) and coyotes. Although acknowledging hybrid origin for the red wolf as a possibility, Nowak suggests that "the most reasonable explanation is that *C. rufus* represents a primitive line of wolves that has undergone less change than *C. lupus*, and has retained more characters found in the ancestral stock from which both wolves and coyotes arose".

The quantitative distinction of the red wolf has been used by Nowak to argue for separate species status. The use of quantitative differences alone to define a species is controversial (see O'Brien & Mayr, 1991; McKitrick & Zink, 1988; Avise & Ball, 1990; Mallet, 1995). For the red wolf, however, the phenotypic argument may be circular because hybrids between grey wolves and coyotes are expected to be intermediate in morphology. The phenotype of the red wolf may thus reflect either recent hybridization between grey wolves and coyotes in the southeast USA or, as Nowak suggests, an ancient origin and long distinct evolutionary heritage.

In fact, Nowak's multivariate morphological position of supposed grey wolf-coyote hybrids overlaps with the position of red wolves (Fig. 1). Because of the possibility of a hybrid origin for the red wolf, discrete character state differences uniquely shared by red wolves, such as the shared presence of a specialized cusp or cranial foramen are needed to define them as a separate taxon. Molecular data provide such discrete character data, whose analysis using cladistic principles is consistent with modern systematic thinking. (Jenks & Wayne, 1992; Wayne, 1992). If the red wolf **is** a long distinct species, it should have unique genetic attributes, jnst as coyotes and grey wolves do today. The evolutionary heritage of the red wolf should be recorded in genes just a faithfully as it is in fossils. In reality, the fragmentary fossil remains of wolf-like canids and the conservative natnre of canid dentition makes the interpretation of the sparse fossil record difficult.

Mitochondrial DNA Analysis

The mitochondrial DNA (mtDNA) genome is a small circular loop of DNA only 16–18 thousand base pairs in length. It is a useful tool for the evolutionary geneticist since it has a rapid evolutionary rate, many times faster than the average nuclear gene. Closely related species whose nuclear DNA has diverged very little may thus be clearly distinguishable from differences in their mtDNA. In addition, mtDNA is inherited maternally and without recombination, so the evolution of sequences within a species defines a maternal phylogeny distiuct from that in other species (see Avise, 1994). Given these properties, mtDNA analysis was a suitable tool to begin a study of the relationships between coyote, grey wolf and red wolf.

Initial investigations showed that *Canis* species are generally closely related, and form a distinct evolutionary group (Lehman *et al.*, 1991; Wayne and Jenks, 1991; Girman *et al.*, 1992; Gottelli *et al.*, 1994). Within this group, restriction site and direct sequencing analysis of the mtDNA revealed appreciable differences between most species: jackals, for example, differed by 8% from wolves and coyotes. However, mtDNA from extant red wolves appeared to be identical to that found in coyotes from Louisiana (Wayne & Jenks, 1991).

The Grey Wolf/Coyote Factor

Iuterpretation of this result was facilitated by earlier investigations of mtDNA from wolves and coyotes (Lehman *et al.*, 1991). Wolves from a contiguous region in Minnesota, Ontario and Quebec had exhibited a high frequency (over 50%) of coyote type mtDNA, although mtDNA sequences of wolves from other more northern and western areas were grouped in a distinct cluster or clade (Fig. 2). For most of this century wolves declined in the Minnesota area due to predator control programmes and loss of prime habitat. Coyotes, meanwhile, expanded their range, and where they encountered wolves dispersing in the fragmented habitat, interspecific mating opportunities arose. Our data indicated that repeated hybridization between the two species resulted in the introgression of several coyote mtDNA genotypes into wolf populatious. Mating between male wolves and female coyotes produced hybrid offspring carrying coyote mtDNA, which was then transferred into the wolf populations through backcrossing of female hybrids with male wolves. Such an event occurred at least six times. The analysis also revealed an asymmetry in the gene flow between the two species: although coyote mtDNA was found in many wolves, wolf mtDNA was not discovered in any coyotes.

Our results concerning the current captive bred red wolf popnlation led us to propose that a similar explanation could be invoked, namely that coyote mtDNA found in red wolves reflected prior hybridization between the two species. Indeed, Ron Nowak's morphological analysis had indicated that as red wolves became rare in the southeast, they underwent hybridization with the abundant and expanding coyote population. Although great care was taken in choosing the 14 individuals for the captive breeding programme, our mtDNA showed that captive red wolves had a mtDNA genotype indistinguishable from that found in coyotes from Louisiana. This result indicated that an ancestor of captive red wolves paired with a female coyote, potentially some time before the captive breeding effort commenced.

Investigating Historical Specimens

A logical next step was to widen the search for diagnosable 'red wolf' characters. We therefore analysed mtDNA from 77 canids captured between 1974–76 as part of the captive breeding programme. These canids had previously been classified on morphological grounds as either red wolves, coyotes, or hybrids of the two species. It thus came as rather a surprise when our mtDNA analysis revealed only genotypes otherwise found in southern coyotes or in grey wolves. We even found a grey wolf genotype characteristic of Mexican

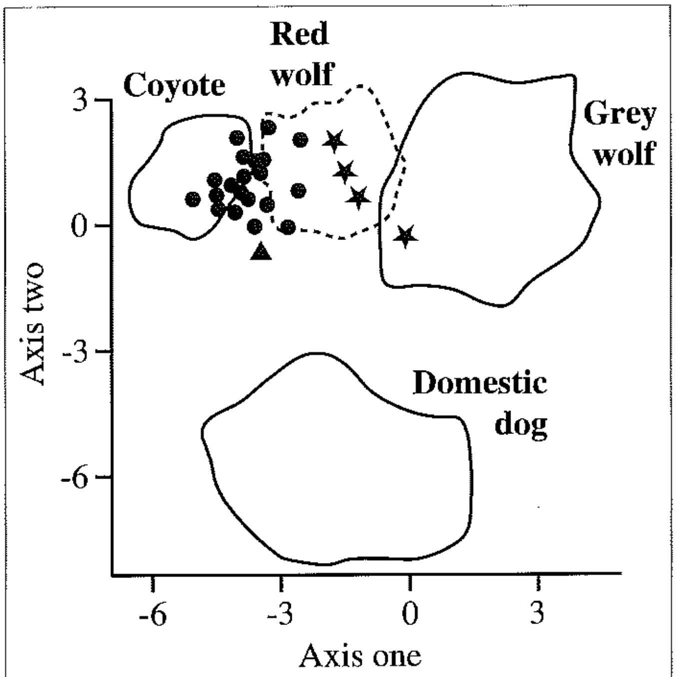


Figure 1. *Multivariate analysis of 15 cranial measurements of wolf-like canids (Nowak, 1979). Figures 10 and 15 from Nowak have been superimposed in this figure. The positions of suspected grey wolf-coyote hybrids from southeastern Canada (stars), a specimen from the Royal Ontario Museum, thought to be a grey wolf-coyote hybrid (triangle), and New England canids (dots) are indicated (from Wayne, 1992).*

grey wolves that formerly inhabited parts of Texas (Wayne & Jenks, 1991).

Given the appreciably larger sample size of this investigation, the lack of a discernible 'red wolf' genotype required some explanation. It was possible that our sample had still failed to include examples of red wolves with unique genotypes, but we proposed an alternative hypothesis. Previous studies had shown that coyotes can hybridize with both red and grey wolves. Grey wolves frequently disperse 50km or more, and theoretical models suggest that hybrid zones up to 50 times as large as an individual's dispersal distance are possible (Barton & Hewitt, 1989). Moreover the recent grey wolf/coyote hybrid zone in Minnesota and Eastern Canada comprises roughly half of the historical distribution of the red wolf. It would thus seem reasonable to propose that three centuries of human settlement in southeastern USA could have given rise to a grey wolf/coyote hybrid zone at least as large as the red wolf's range. Perhaps, then the red wolf might not be a distinct species, but rather represent a zone of various crosses or intergrades between grey wolf and coyote. Such an explanation would be in accordance with the recorded difficulties of classification using morphology alone.

This hypothesis could best be tested by a direct investigation of the evolution of the proposed hybrid zone, requiring analysis of historical specimens. The development of the polymerase chain reaction (PCR) made possible amplification of DNA from museum specimens, and this could then be seqnenced directly, a technique which provides more information than restriction site analysis.

We analysed a sequence of 400 base pairs from the mitochondrial cytochrome b gene taken from six red wolf specimens in the Smithsonian Institution's fur vault. These specimens had been gathered from five US states between 1905–1930: before the hybridization with coyotes was thought to be widespread (Nowak, 1979). Our analysis revealed that all six individuals had genotypes which could be classified with either grey wolves of coyotes. No unique sequence was found, supporting our hypothesis of a hybrid swarm, and throwing considerable doubt on the accepted view of the red wolf as a long distinct taxon.

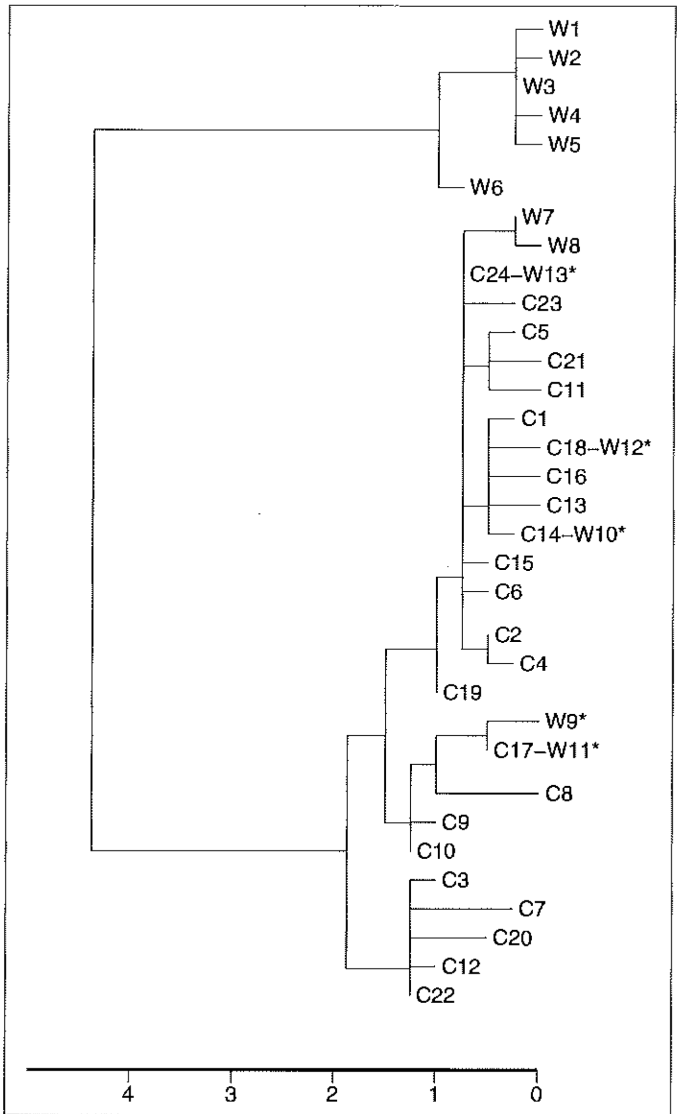


__Figure 2.__ A phylogenetic tree relating the grey wolf and coyote mtDNA genotypes. The tree was generated using the global-branch-swapping option of PAUP. Note the tight clustering of the true wolf genotypes (W1 to W6 incl.) and their dissimilarity to the other wolf genotypes (W7 to W13 incl.; with asterisks) found in the coyote-type clade. Genotype W10, found in wolves, is identical to coyote genotype C14, W11 to C17, W12 to C18, and W13 to C24. Scale is percent sequence divergence using the shared site estimate of Nei & Li, 1979 (from Lehman et al., 1991).

Hybrid or Species?

The hybrid hypothesis was not well received by the USFWS. The red wolf recovery programme was proving extremely successful but expensive, and thus politically sensitive. Furthermore the molecular data were admittedly inconclusive. Our pre-1930 sample was limited, and although mtDNA has many advantages, its uniparental and clonal mode of inheritance promote rapid loss of diversity, and may provide a biased representation of gene flow. The molecular evidence would be far more convincing if distinct red wolf marker genes (alleles) could be shown to be absent in the nuclear genotype.

Nuclear DNA Analysis

The majority of the nuclear genome evolves slowly, and differences between closely related species are usually too small to generate diagnostic nuclear markers. However, some parts of the genome consist of short sections of simple repeated sequences. These 'microsatellite' loci have extremely high mutation rates, and can be amplified using PCR. Repeat loci are frequently so variable that a unique individual genetic "fingerprint" can be constructed often from typing just a few loci. Moreover, microsatellites can be amplified by PCR and scored using standard techniques. Thus microsatellites from both extant and historic samples can be sequenced and analysed and corresponding alleles compared between species.

Initial studies of over 300 coyotes and grey wolves confirmed earlier mtDNA results concerning the magnitude and asymmetry of the recent hybridization in Minnesota and eastern Canada (Roy *et al.*, 1994a). In addition, the evidence from microsatellite analysis indicated that hybridization is only successful between male grey wolves and female coyotes, not vica versa. Considering the disparity in size between the two species, it seems unlikely that small male coyotes would be able to dominate the larger wolf females successfully in mating encounters.

Having shown that the microsatellite analysis appeared to correctly reflect the recent hybridization events, microsatellite polymorphisms in 40 red wolves from the captive population were evaluated (Roy *et al.*, 1994a) The alleles found in this sample were compared with those from grey wolves and coyotes but no uuique alleles characteristic of red wolves were discovered. All 53 alleles discovered in the red wolf sample were also found in coyotes.

Although not favourable to the ancient origiu hypothesis, this result was not conclusive. The current red wolf stock was descended from so few founders that unique alleles could conceivably have been lost from the captive population, or indeed during the rapid decline of the species in its dwindling range. However, captive stocks of Mexican grey wolves, a subspecies that suffered a decline similar to the red wolf and were founded by only four individuals, had been shown to have a unique mtDNA genotype and unique microsatellite alleles (Wayne *et al.*, 1992; García-Moreno *et al.*, in press). The investigation therefore continued, as before, with a study of historic specimens. With the aid of Ron Nowak, 16 red wolf skins were selected from the Smithsonian vault, and their mtDNA and microsatellites amplified using the PCR. However, analysis of this additional sample also failed to reveal any unique mtDNA genotypes or microsatellite alleles when compared with those from grey wolves and coyotes (Roy *et al.*, in review).

In an attempt to clarify the issue further, we then examined the genetic similarities between historic and recent red wolves, and between these and other wolf-like canids, using overall frequency similarities of microsatellite alleles as measured by genetic distance values among populations (Roy *et al.*, 1994a; 1994b). Historic red wolves were shown to differ little from captive red wolves, indicating that the founder population was an excellent representative sample of the existing gene pool. This, however, was the extent of the genetic support for the species recovery programme; relationships between red wolves and other *Canis* species served only to reinforce the hybrid swarm hypothesis. Red wolves appeared to be closely related to populatious of grey wolves that are known to hybridize with coyotes, and had allele frequencies generally intermediate between non-hybridizing populations of coyotes and grey wolves (Fig. 3).

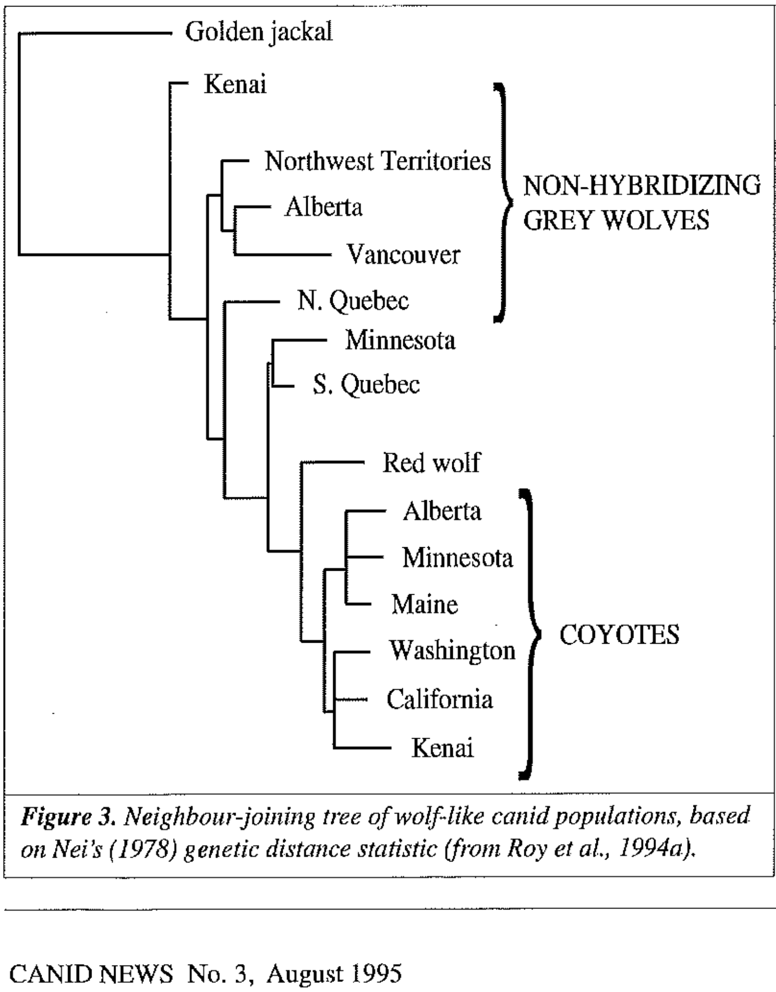


Figure 3. *Neighbour-joining tree of wolf-like canid populations, based on Nei's (1978) genetic distance statistic (from Roy et al., 1994a).*

This analysis uncovered other important information. Both the current and historic red wolf samples showed snrprisingly high levels of genetic variability. In the sample from the captive population, heterozygosity was over 60%, and several different alleles were discovered at most loci. Small populations tend to be characterized by low levels of variability, indeed two other endangered canids the Ethiopian wolf (*Canis simensis*) and the Mexican grey wolf, had previously been shown to have significantly lower heterozygosity (Gottelli *et al.*, 1994, García-Moreno *et al.*, in press). The high levels revealed in both red wolf samples are somewhat incongruous in a dwindling population reduced to only a few individuals from which 14 apparently pure-bred individuals were selected for captive breeding, but would be wholly consistent for a population representing a hybrid swarm containing a mixture of genes from both coyotes and grey wolves species.

Hybrid, not Species?

The genetic evidence from both nuclear and mitochondrial DNA strongly supports the hypothesis that red wolves have hybridized with both grey wolves and coyotes in their recent past. This situation could have developed historically as a result of habitat changes that favoured hybridization of the two species such as is occurring today in eastern Canada. Alternatively, hybridization might have begun thousands of years ago (Dowling *et al.*, 1992); the genetic data cannot easily discriminate between these two scenarios. In addition, our results are consistent with the red wolf possibly having been a distinct subspecies of grey wolf, such as the Mexican grey wolf is today. The Mexican wolf is the most distinct of surviving North American grey wolves and has a few unique genetic markers (García-Moreno *et al.*, in press). Such markers may have existed historically in the red wolf but been lost due to hybridization with coyotes and small population size. However, our results are not consistent with the ancient origin and genetic isolation of the red wolf as envisioned by Nowak because the red wolf would be expected to have many unique genetic markers, more than coyotes and grey wolves have. We would be unlikely to miss so many genetic markers in our extensive recent and historical samples of the red wolf, even given hybridization and small population size.

The idea that the red wolf may have been a subspecies similar to the Mexican wolf is in fact quite appealing. Both the Mexican wolf and red wolf are smaller than other grey wolves (in accordance with Bergmann's rule) and some morphological studies have supported the idea that present-day red wolves are descendants of a now extinct unique southern subspecies of grey wolf (Lawrence & Bossert, 1967; 1975). If the red wolf was a southern subspecies of grey wolf, gene flow would have occurred with other grey wolf populations throughout the species' history in North America, but to a limited degree, allowing some morphological differentiation. The subspecies hypothesis would also explain the persistence of a red wolf morphology into the fossil record and the suggested "absence" of grey wolves in the historic range of red wolves. Otherwise, it is difficult to imagine why grey wolves, which have the largest distribution of any land mammal and are known from fossils in Virginia, Arkansas, Nebraska, Texas, and Georgia (Nowak, 1979) would have so carefully avoided entering the southeastern corner of the US where red wolves were hypothesized to exist in isolation.

Conserving the Red Wolf

The taxonomic status of the red wolf remains controversial. Although the genetic evidence is clear cut, morphological and behavioural evidence have been cited in support of its status as a unique species (Nowak, 1992; Phillips & Henry, 1992). Meanwhile the captive programme continues to flourish. If the hybrid hypothesis **is** correct, is the expense justifiable?

The protection of hybrid populations and issues of taxonomic distinction are not, in general, satisfactorily addressed by the US Endangered Species Act. Furthermore, the causes and consequences of hybridization are varied, and it would perhaps be best to evaluate each case separately. For example, many new plant species arise from a single cross between two species. Such 'hybrids' are of value in themselves and deserve protection as distinct species. Similarly, new hybrid forms of fish may form naturally as water drainages change and once distinct forms mix (DeMarais *et al.*, 1992). In contrast, the genetic uniqueness of a number of rare species is at risk from hybridization. Conservation of the highly endangered Ethiopian wolf is beset by many problems, not least of which is interbreeding with free-ranging domestic dogs (Gottelli *et al.*, 1994). In such situations the hybrid form is patently undesirable, and only merits protection if the pure-bred form becomes extinct or so reduced in numbers as to become unviable.

It can be hard to evaluate the conservation status of intermediate forms in hybrid zones whose geographical limits are determined by dynamic interaction between selection and dispersal. Nevertheless, there are certain generalities which should apply. Firstly, one should consider the causes of hybridization. Where hybrid zones develop as a result of disturbance or artificial introduction of non-native or domestic species, the hybrids should be accorded lower protection than distinct species. Hybridization may happen naturally, however, as two or more previously geographically isolated species shift or expand their range, perhaps due to climatic factors. The resulting hybrids may persist for some time and become an important part of the ecological landscape, and would thus merit preservation. Secondly, hybrids may develop unique genetic or phenotypic qualities over time, which may justify greater protection than hybrid forms which could be easily regenerated by future interbreeding of the parent species.

We can tentatively apply these criteria to the canids investigated. The hybrids resulting from the recent interbreeding of coyotes with grey wolves in the Minnesota region would not deserve protection as a distinct form. They arose as a result of habitat alterations and predator control measures which decimated the wolf population. Now, under protection of the ESA, grey wolves are once more flourishing in Minnesota, which currently supports over 2000 individuals. Previous analysis of grey wolves in this area suggests that hybridization with coyotes is no longer occurring, and grey wolves have been observed actively to exclude coyotes from their territories. Therefore not only did hybridization happen under unnatural conditions, it does not persist when the causal factors are reversed. Furthermore, the hybrids are of recent origin and do not appear to have developed any unique characteristics worthy of preservation.

The red wolf situation is more uncertain due to the time scale involved. Historical records and the genetic evidence would suggest that it is either an ancient, naturally formed hybrid which was in existence before human settlement of its range in the early 18th century, or a later hybrid which arose, at least in part, as a result of human settlement. It has nevertheless been in existence for quite some time and may have played an important role in the predator community of the area. Moreover, if we accept the possibility of the red wolf being a distinct subspecies of grey wolf (currently defined as populations that are generally allopatric and have a distinct evolutionary heritage (Ryder 1986; Avise & Ball 1990; O'Brien & Mayr 1991)), then although the red wolf may not now satisfy this definition because of hybridization, it may be the only living repository of characteristics once held by a valid subspecies of grey wolf. In order to justify curtailment of the captive breeding program, it should be demonstrated that the loss of the distinct red wolf phenotype (Nowak, 1979) and behaviour (Phillips & Henry, 1992) is reversible by simple interbreeding of extant coyotes and grey wolves. Ecological concerns need to be considered as well; red wolves, even if they are intergrades of grey wolf and coyote, may be extremely successful and have an important role in the predator community of disturbed habitats of the southcentral USA. The red wolf in its current form would therefore seem to merit some degree of protection.

"the red wolf in its current form would therefore seem to merit some degree of protection"

The debate on the origin and conservation of the red wolf needs to be an open one and both sides should support their case with new data published in peer-reviewed journals. This should be an academic debate, removed from concerns about the importance and persistence of the red wolf reintroduction programme. Moreover, the facts on which both sides agree should be incorporated into the rationale and design underlying the reintroduction programme. For example, it is agreed by both sides that hybridization between coyotes and red wolves was common as the red wolf approached extinction in the wild. The same conditions that led to hybridization then (red wolves in small numbers relative to the abundant coyote) exist in areas where the red wolf is now being introduced. Reintroduced red wolves have been observed with coyotes and hybrid litters may have been produced in the wild (Mike Phillips, pers. comm.). Therefore, the reintroduction programme needs to confront the problems of hybridization, perhaps by introducing several packs of red wolves into areas where coyotes are rare in the hope that they may exclude invading coyotes and perhaps maintain their genetic integrity over time.

Acknowledgements

I am extremely grateful to Laura Handoca without whose collaboration and enormous editorial effort it would not have been possible to compile this article in time.

Literature Cited

Avise, J. C. 1994. Molecular markers, natural history and evolution. Chapman and Hall, Inc.

Avise, J. C. & Ball, R. M. 1990. Principles of genealogical concordance in species concepts and biological taxonomy. In: Oxford Surveys in Evolutionary Biology, Eds. D. Futuyma & J. Antonovics, pp. 45-67. OUP, Oxford.

Barton, N. H. & Hewitt, G. M. 1989. Adaptation, speciation, and hybrid zones. Nature, 341: 497-503.

DeMarais B. D., Dowling, T. E., Douglas, M. E., Minckley, W. L. & Marsh, P. C. 1992. Origin of *Gila seminuda* (Teleostei: Cyprinidae) through introgressive hybridization: implications for evolution and conservation. Proceedings of the National Academy of Sciences of the United States of America, 89: 2747-51.

Dowling, T. E., Minckley, W. L., Douglas, M. E., Marsh, P. C. & Demarais, B. D. 1992. Response to Wayne, Nowak, and Phillips and Henry: use of molecular characters in conservation biology. Conservation Biology, 6: 600-603.

García-Moreno J., Roy, M. S., Geffen, E. & Wayne, R. K. In press. Relationships and genetic purity of the endangered mexican wolf: an analysis of 10 microsatellite loci. Conservation Biology.

Girman, D. J., Kat, P. W., Mills, M. G. L., Ginsberg, J. R., Borner, M., Wilson, V., Fanshawe, J. H., Fitzgibbon, C., Lau, L. M. & Wayne, R. K. 1993. Molecular Genetic and Morphological Analyses of the African Wild Dog (*Lycaon pictus*). Journal of Heredity, 84: 450-459.

Gottelli, D., Sillero-Zubiri, C., Applebaum, G. D., Roy, M. S. D., Girman, J., García-Moreno, J., Ostrander, E. A. & Wayne, R. K. 1994. Molecular genetics of the most endangered canid: the Ethiopian wolf, *Canis simensis*. Molecular Ecology, 3: 301-312.

Jenks, S., & Wayne, R. K. 1992. Problems and policy for a species threatened by hybridization: the red wolf as a case study. In: Wildlife 2001: populations, Eds. McCullough Barrety, pp. 237-251. Elsevier Applied Science, London.

Lariviere, S. & Crete, M. 1993. The size of eastern coyotes (*Canis latrans*) – a comment. Journal of Mammalogy, 74: 1072-1074.

Lawrence, B. & Bossert, W. H. 1967. Multiple character analysis of *Canis lupus*, *latrans*, and *familiaris* with a discussion of *Canis niger*. American Zoologist, 7: 223-232.

Lawrence, B. & Bossert, W. H. 1975. Relationships of North American *Canis* shown by multiple character analysis of selected populations. In: The wild canids, Ed. M. W. Fox, pp.73-86. Van Nostrand Reinhold, New York.

Lehman, N. & Wayne, R. K. 1991. Analysis of coyote mitochondrial DNA genotype frequencies: estimation of effective number of alleles. Genetics, 128: 405-416.

Lehman, N., Eisenhawer, A., Hansen, K., Mech, L. D., Peterson, R. O., Gogan, P. J. P. & Wayne, R. K. 1991. Introgression of coyote mitochondrial DNA into sympatric North American grey wolf populations. Evolution, 45: 104-119.

Mallet, J. 1995. A species definition for the modern synthesis. TREE, 10 : 294-299.

McKitrick, M. C. & Zink, R. M. 1988. Species concepts in ornithology. The Condor, 90: 1-14.

Nowak, R. M. 1979. North American Quaternary *Canis*. Monograph Number 6, Museum of Natural History, University of Kansas, Lawrence, Kansas.

Nowak, R. M. 1992. The red wolf is not a hybrid. Conservation Biology, 6: 593-595.

O'Brien, S. J. & Mayr, E. 1991. Species hybridization and protection of endangered animals. Science, 253: 251-252.

Phillips, M. K., & Henry, V. G. 1992. Comments on red wolf taxonomy. Conservation Biology, 6: 596-599.

Phillips, M. K. & Parker, W. T. 1988. Red wolf recovery: a progress report. Conservation Biology, 2: 139-141.

Roy, M. S., Geffen, E., Smith, D., Ostrander, E. A. & Wayne, R. K. 1994a. Patterns of differentiation and hybridization in North American wolflike canids, revealed by analysis of microsatellite loci. Molecular Biology and Evolution, 11: 553-570.

Roy, M. S., Girman, D. G., Taylor, A. C. & Wayne, R. K. 1994b. The use of museum specimens to reconstruct the genetic variability and relationships of extinct populations. Experientia, 50: 551-557.

Roy, M. S., Geffen, E., Smith, D. & Wayne, R. K. In review. The genetic distinction of the red wolf: a review of the molecular evidence with new microsatellite and mitochondrial DNA data on historic red wolves.

Wayne, R. K. 1992. On the use of molecular genetic characters to investigate species status. Conservation Biology, 6: 590-592

Wayne, R. K. & Jenks, S. M. 1991. Mitochondrial DNA analysis implying extensive hybridization of the endangered red wolf *Canis rufus*. Nature, 351: 565-568.

Wayne, R. K., Lehman, N., Allard, M. W. & Honeycutt, R. L. 1992. Mitochondrial DNA variability of the grey wolf – genetic consequences of population decline and habitat fragmentation. Conservation Biology, 6: 559-569.

Conserving the Red Wolf *Mike Phillips*

The rescue of the red wolf from the brink of extinction has been one of conservation's success stories. The reintroduced wild population is increasing annually.

Introduction

Red wolves once ranged throughout the southeastern United States before European settlement of that region, but by 1980 was considered extinct in the wild. The demise of the red wolf was due to many factors: man's persecution of wild canids and the destruction of optimal habitat forced the few remaining red wolves into marginal habitat in Louisiana and Texas where they interbred with coyotes and suffered heavy parasite infestation.

The plight of the red wolf was recognized in the early 1960s. The species was listed as endangered in 1967, and a recovery programme was initiated after passage of the Endangered Species Act of 1973. During the early 1970s the U.S. Fish and Wildlife Service (USFWS) realized that the species' recovery could only be achieved through captive breeding and reintroduction to the wild.

Mike Phillips was the coordinator of field projects for the red wolf recovery programme for several years, until he recently moved to Yellowstone to direct the programme to reintroduce the grey wolf there. His interests include management of canid populations and endangered species restoration.

Captive breeding

By 1976 a captive breeding programme had been established utilizing 17 red wolves captured in Texas and Louisiana. In 1977 the first pups were born, and by 1985 the captive population numbered 65 individuals held in six zoological facilities.

With the species reasonably secure in captivity, the USFWS initiated a reintroduction project in 1987. Since this represented the first ever attempt to restore a carnivore species which had been declared extinct throughout its former range, the programme generated tremendous public interest in the red wolf. Between September 1987 and April 1991 a further 18 zoological facilities committed themselves to maintaining red wolves, and the annual federal budget for captive breeding increased from about $30,000 to $191,000. By January 1991 there were 159 red wolves in captivity; currently there are at least 220.

Red Wolf Recovery/Species Survival Plan

In 1984 the red wolf was selected for inclusion in the American Association of Zoological Parks and Aquaria Species Survival Plan (Plan) programme. Inclusion in this programme provided the impetus and expertise needed to intensify management of the species in captivity.

The Plan delineates and schedules actions necessary to ensure genetic stability and reintroduction of the species to the wild. Specifically, the goal of the plan is to maintain 80-85% of the genetic diversity found in the original founder stock for at least 150 years. This goal is equivalent to preserving 90% of the heterozygosity present in the existing captive population. A population viability analysis indicated that to meet the above objective, the USFWS would have to establish a population of 550 red wolves. Furthermore, it was decided that these 550 would be distributed between a captive population of 330 and a free-ranging population of 220 distributed at three or more sites.

Reintroduction to Alligator River National Wildlife Refuge

In 1987 a reintroduction project was initiated in northeastern North Carolina in the Alligator River National Wildlife Refuge (ARNWR), which covers 60,727 ha, and adjacent Department of Defence land, which covers 18,218 ha (see Fig. 1). The reintroduction area consists of marshes, non-riverine swamp forests, pocosins (a common habitat on the coastal plain of southeastern USA, characterized by an understory of evergreen shrubs and an overstory of pond pines) and agricultural fields. The region's climate is characterized by hot summers, mild winters and high humidity. The area is bisected by numerous logging roads, many of which are only seasonally passable with a 4-wheel drive vehicle or ou foot. The area supports abundant prey, including white-tailed deer, raccoons and marsh rabbits, but there are no coyotes, feral dogs or livestock present. In addition the area is sparsely settled, and surrounded on three sides by large bodies of water that wolves are unlikely to cross successfully.

Public planning and experimental/nonessential designation

The decision to conduct the reintroduction was dependent upon public acceptance of the proposal. The USFWS briefed representatives of environmental organizations in Washington D.C., along with the North Carolina Congressional Delegation, the North Carolina Department of Agriculture, the Governor's office, local officials and local landowners. The U.S. Air Force and Navy were briefed because they conduct training missions on 18,218 ha adjacent to the refuge. Numerous personal contacts were made with local citizens, especially hunters and trappers, in preparation for public meetings held during February 1986. At the briefings and meetings considerable effort was made to explain the significance of the decision to consider reintroduced wolves wolves as members of an "experimental/nonessential" population.

The experimental/nonessential designation was promulgated under the 1982 amendments to the ESA and provided the USFWS with the opportunity to relax restrictions of the ESA to encourage cooperation from those likely to be affected by the reintroduction. The flexibility of the designation was important in soliciting support for the reintroduction.

The regulations developed for the reintroduction project prohibited taking of red wolves by the public to prevent the loss of livestock or property damage. In instances of depredations, citizens were required to contact USFWS or state conservation officers authorized to initiate control measures. Such control could include lethal means only if attempts to capture the animals concerned failed, or if there was clear danger to human life. No compensation programme to offset depredations was developed because livestock were virtually absent in the area.

Human activities in the refuge included public trapping and hunting, which could accidentally kill a red wolf despite reasonable care by sportsmen. The USFWS proposed that prosecution should not be pursued when the accident was unavoidable, unintentional, did not result from negligent conduct, and was immediately reported to authorized personnel. The regulation also stated that wolves could be taken in defence of human life, although such circumstances were considered extremely unlikely.

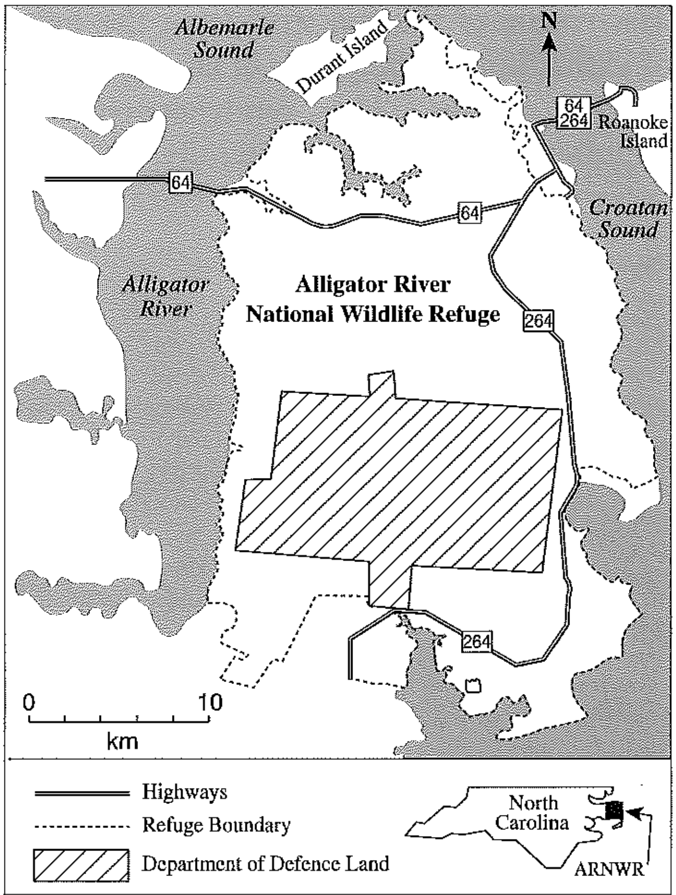


Figure 1. Location of Alligator River National Wildlife Refuge in North Carolina.

Transportation of wolves for release into the wild

Selection of wolves and acclimation

Wolves selected for release were taken from the USFWS's certified captive-breeding stock. Age, health, genetics, reproductive history, behaviour, and physical traits representative of the species were considered in the selection process.

Before release, each wolf was acclimated in 255 m² pens at the refuge. We employed acclimation in order to prepare the wolves for life in the wild and to attenuate their tendency to travel widely immediately following release. Acclimation periods for adults were purposefully lengthy and averaged 18.7 months ($n = 42$, $sd = 13.5$ months), with the exception of two adults that were acclimated for 2.2 months.

We were naturally worried about the effect that long-term captivity would have on the wolves' ability to survive. Accordingly, during acclimation we minimized human contact, hoping to reduce the wolves' tolerance of humans. We varied the feeding regime to expose the animals to feast or famine, weaned the wolves from dog food and fed them an all-meat diet, and provided the opportunity to hone predatory skills by giving them live prey.

During pre-release health checks we administered a standard series of canine vaccines, vitamin supplements and a parasiticide, determined weights, took blood samples and fitted the wolves with motion-sensitive radio-collars. The first nine adults were also implanted with abdominal transmitters as back-ups to radio-collars. Nine of the first ten adults were also implanted with radioactive tags that allowed us to assign collected scats to individual wolves (Crabtree *et al.*, 1989). All pups were fitted with abdominal transmitters at about 10 weeks of age.

White-tailed deer carcasses were placed at initial release sites with the intent of decreasing the chances of wolves immediately ranging widely in search of food. Supplementary feeding continued for a month or two after release to provide the wolves with the opportunity to learn to forage successfully in unfamiliar terrain. Supplementary food was sometimes provided for wolves being re-released.

Releases

Between 14th September 1987 and 31st December 1995 63 captive-born red wolves were involved in 76 releases: 32 adults (16.16) and ne female yearling in 45 releases, and 31 (16,15) pups in 31 releases. We released each wolf once, except for three adults that we released three times, and six adults that were released twice. We defined a release as an initial release or a re-release of a wolf in a different area or with a different social group, and a successful release as one that resulted in the released wolf breeding and producing pups in the wild.

We conducted releases every year from 1987 onwards. Most releases (71%) were carried out between August and October when pups were 4-6 months of age, and usually involved families or adult pairs. Unforeseen circumstances resulted in most wolves being re-released on numerous occasions at various times of the year.

Animals were released either as members of 14 adult pairs, 8 families, one sibliug gronp, one adult/yearling pair, and oue adult/pup pair. We defined adults as animals $\geq$ 24 months old, and pups $\leq$ 12 months of age.The adults released ranged in age from 2.25-7.33 years.

Outcomes of releases involving adults & one yearling

Forty-four of the 45 releases of adults aud the yearling were conducted early enough in the experiment to be potentially successful by December 1994. We excluded the release of 316F during September 1989 because she disappeared during December of that year; her radio-collar probably malfunctioned.

Of these 44 releases, only 12 (27%) were in fact successful. Wolves involved in the successful releases persisted in the wild for an average of 22.1 months (u = 12, sd = 17.6 months).

Outcomes of releases involving pups

Thirty-one captive-born pups were involved in 31 releases. We cannot comment on the outcome of four of these releases because the pups disappeared before experiencing a breeding season in the wild. Of the 27 remaining, 11% (n = 3) were successful. These three pups were still free-ranging and consorting with their mates as of 31st December 1994; they had persisted in the wild for an average of 61.6. months (sd = 4.4 months).

Reproduction in the wild

During the restoration programme a minimum of 22 litters containing 66 pups (30 males, 27 females, and 9 of nnknown sex) were conceived and born in the wild. Litters were produced in the wild every year except for 1989 when there were no pairs together during the breeding season. The average litter contained at least three pups although we documented litters that contained just one pup and litters that contained as many as five pups.

The 11 captive-born adults iuvolved in the successful releases contributed to nine litters that contained 25 pups, or 38% of the total number of pups that were conceived and born in the wild, whereas the three captive-born pups involved in successful releases contributed to seven litters that contained at least 24 pups (36% of the total). Eleven wild-born wolves themselves bred in the wild and contributed to 12 litters containing a minimum of 36 pups (54% of the total number born).

Survival of Wild-born Pups

Of the 66 pups, as of 31st December 1994, 54% (n = 36) were free-ranging, 23% (n = 15) had unknown fates, 15% (n = 10) had died, and 8% (n = 5) had been returned to captivity. The oldest wild-born free-ranging red wolf was 79.9 mouths (344F). Wild-born red wolves that died persisted for an average of 13.5 months (sd = 13.6 months).

On average the 51 pups that were conceived and born in the wild and whose fates were known to us persisted for 21.8 months (sd = 17.9 months), whereas the 27 captive-born pups we released whose fates were known to us persisted for only an average of 13.4 months (sd = 18.7 months). The 44 captive-born adults and the yearling whose fates were know to us persisted for only an average of 8.0 months (sd =12.9 months). Wild-born pups persisted for significantly longer periods than did either adults or pups we released (χ^2 = 12.58, $p < 0.001$).

Mortality

Of the 135 red wolves involved in the restoration effort between September 1987 and the end of December 1994, 51 (38%) iudividuals died whilst free-ranging. A number of factors caused the death of a few red wolves: ingestion of poison, a trapping accident aud a handling accident each led to the death of a wolf, three wolves died of unknown causes, and four were shot by individuals who were not sympathetic to the plight of the species.

Of the remaining 41 deaths, 36% (n = 15) were accidental and caused by vehicles and 64% (n = 26) were caused by a

variety of non-human factors including intraspecific aggression, drowning, mange, malnutrition and parasites, and natural causes.

Home ranges

The size of home ranges for reintroduced wolves that established themselves in the wild and wild-born wolves varied according to habitat. In forested areas consisting of pine/hardwood swamps in various stages of succession, the home range of one pack that included 11 different wolves was about 100 km². In agricultural areas consisting of planted fields interspersed among early to mid successional fallow fields and piue/hardwood stands, the home ranges of eight lone wolves and four packs involving 30 different wolves measured about 50 km². The relative abundance of prey in agricultural areas may account for the differences in home range size exhibited by red wolves.

Diet of Wolves in the Wild

Scat analysis indicated that white-tailed deer, raccoon and marsh rabbits were primary year-round food items and accounted for 88.7% of the biomass consumed by wolves. Although some of the deer were probably eaten as carrion, we documented wolf predation of apparently healthy deer.

Management

We knew from the outset that we would have to intensively manage the wolves in order to ensure the establishment of the population and adequate resolution of wolf/human conflicts. Furthermore we realized that while the restoration effort was not a research initiative it did offer us an unparalleled opportunity to acquire new knowledge about red wolves and endaugered species restoration. However, because the wolves are so wide-ranging and secretive, the only way to ensure our success was to embrace radio-tracking as our primary field method. Accordingly, capturing wolves for telemetric purposes became our primary field activity. Once wolves were captured we could attach or replace radio-collars and if necessary implement management actions that had been specifically crafted for that particular wolf.

We captured 45 of 63 released wolves (71%) 110 times in total, and 59 of the 71 wild-born wolves (83%) 125 times. We accomplished 195 of these captures (83%) using leghold traps. Additionally, we modified acclimation pens to act as traps for 27 captures (11%) of 12 captive-born wolves and

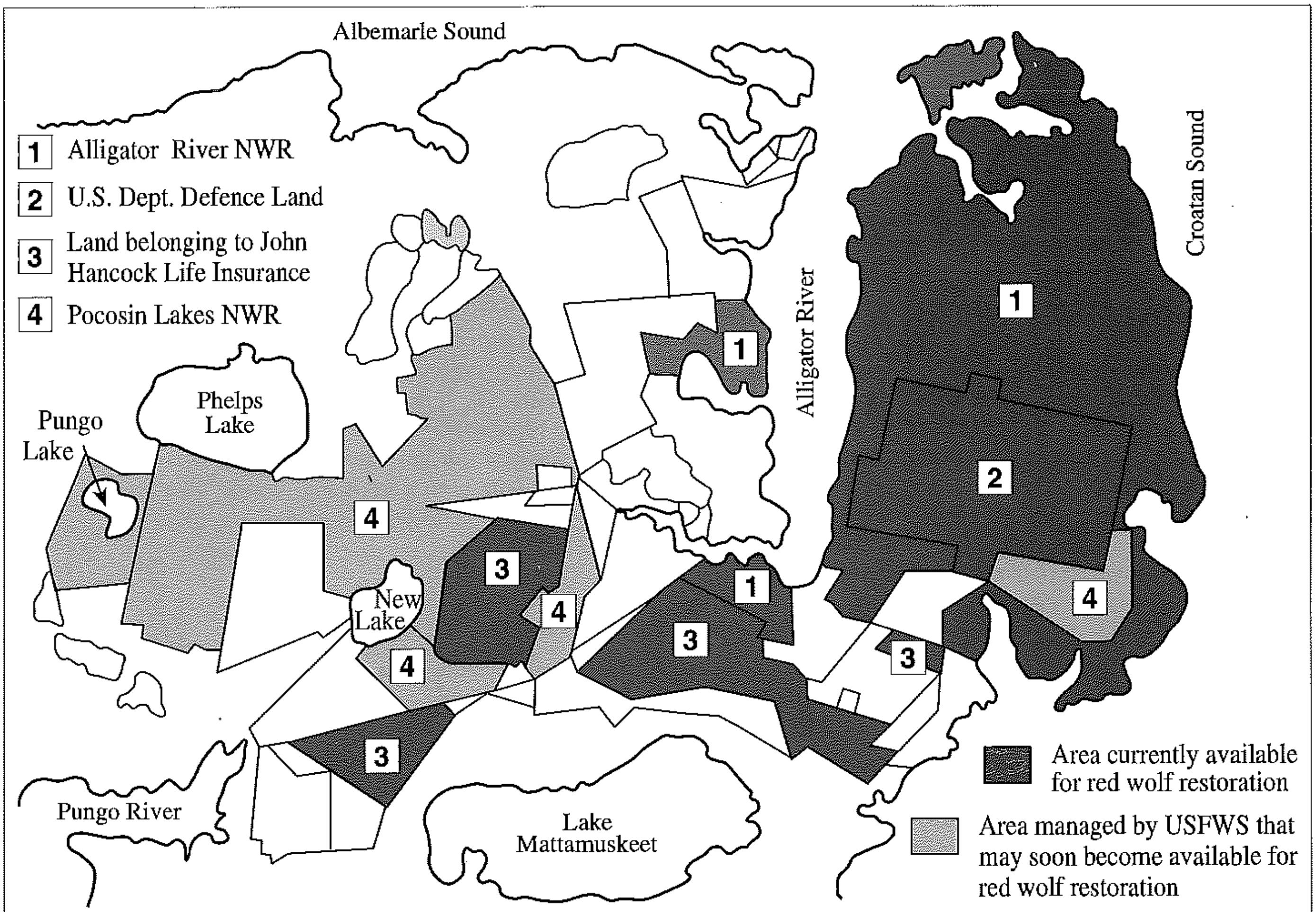


Figure 2. Map showing the areas in North Carolina involved in the red wolf recovery programme.

one wild born wolf. We accomplished the remaining 13 captures using a variety of techniques including dart guns, box traps and nets.

Aerial telemetry was our primary method of maintaining contact with radio-collared wolves. From September 1987 to the end of December 1994 we logged 1,345 hours in fixed-wing aircraft during 906 telemetry flights. During these flights we recorded over 10,000 wolf locations.

Capturing animals and monitoring them telemetrically allowed us to determine the outcome of 71 of the 76 releases (93%) of captive-born red wolves and the fates of 56 of the 71 wild-born wolves (79%). These figures vividly illustrate that red wolves can be restored to northeastern North Carolina in a controlled manner.

Conclusions

The red wolf restoration programme progressed considerably during the seven years from 1987 to 1994. As of 31st December 1994 a minimum of 42 red wolves were free-ranging, including 36 wild-born animals. Most of these animals (76%) inhabited private land. Since 1988 we have integrated about 60,000 acres of private land into the restoration area at a cost of $3,951 per year for 5 years. Private land increased the size of the restoration area by 25%. Red wolves now have access to 320,000 acres of forest, swamps, marshes and agricultural fields in northeastern North Carolina. Within the next few months we hope to add another 130,000 acres of private property. Parties involved include Weyerhaeuser, Georgia-Pacific and private citizens.

During February 1995 we expect about eight pairs to breed in the wild, resulting in the production of about 25-30 pups that mature to an age of self-sufficiency. Thus by December 1995 the red wolf population should number about 60-70 animals. We expect that over 100 wolves will come to inhabit northeastern North Carolina by the year 2000.

We feel that by every measure the reintroduction was successful and generated benefits that extended beyond the immediate preservation of red wolves, to positively affect local citizens and communities, larger conservation efforts and other imperilled species. During the reintroduction two important points surfaced:

1) Wide-ranging movements that required management intervention (e.g. if a wolf wandered outside the reintroduction area) or led to an animal's death soon after release were common. As a result intensive management of the wolves was required throughout the reintroduction. However, since every management issue that arose was resolved without iuflicting long-term damage to the wolves and with little inconvenience to residents of the area, we know that red wolves can be restored to northeastern North Carolina in a controlled manner. Success at managing the wolves was the single most important thing we did to promote and maintain public support or tolerance of the restoration effort.
2) Significant land-use restrictions were not necessary in order for wolves to survive. Indeed, the rather lenient hunting and trapping regulations for the refuge remained nnchanged or were further relaxed during the experiment.

Red wolves can flourish in a wide variety of habitats and there is sufficient habitat available to meet the population objectives outlined in the Recovery Plan. Much of that habitat, however, is privately owned: landowner support is a requisite for recovery of the red wolf. The recovery of the species is not dependent on the setting aside of undisturbed habitat but rather on overcoming the political and logistical obstacles to human coexistence with wild wolves.

Relevant Literature

McCarley, H. 1962. The taxonomic status of wild Canis (Canidae) in the southcentral United States. Southwestern Naturalist, 7: 227-235.

Nowak, R. M. 1972. The mysterious wolf of the south. Natural History, 81: 511-53, 744-77.

Nowak, R. M. 1992. The red wolf is not a hybrid. Conservation Biology, 6(4): 593-5595.

Paradiso, J. L. 1968. Canids recently collected in est Texas, with comments on the taxonomy of the red wolf. American Midland Naturalist, 80: 529-534.

Paradiso, J. L. 1972. Canis rufus. Mammalian Species Account No. 22

Parker, W. T. & Phillips, M. K. 1991. Applications of the experimental population designation to recovery of endangered red wolves. Wildlife Society Bulletin, 19: 73-79.

Phillips, M. K. 1990a. Media and public involvement in red wolf recovery. In: Proceedings of the Aizona Wolf Symposium, March 23-24 1990, Ed. B. Holaday, pp. 855-98. Tempe, Arizona.

Phillips, M. K. 1990b. Mea-sures of the value and success of a reintroduction project: red wolf reintroduction in Alligator River National Wildlife Refuge. Endangered Species Update, 8: 24-26.

Phillips, M. K. & Parker, W. T. 1988. Red wolf recovery: a progres report. Conservation Biology, 2: 139-141.

Phillips, M. K. & Henry, V. G. 1992. Comments on red wolf taxonomy. Conservation Biology, 6(4): 596-599.

Status, Abundance & Distribution of the Wolf in Lithuania

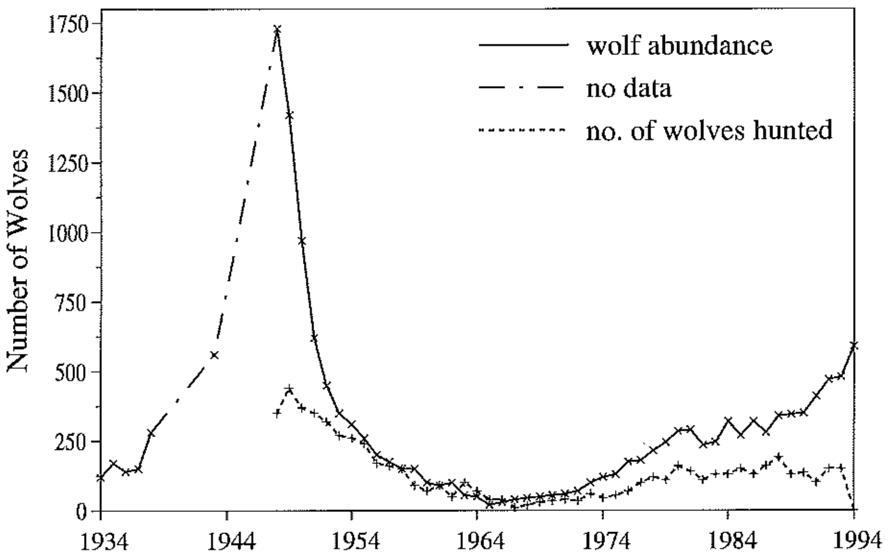


Figure 1. *Graph showing the abundance of wolves in Lithuania and the hunting pressure over the last 60 years.*

The canid family has not been well studied in Lithuania. Most of the scientific information available comes from the work of D. J. Prusaite in early in 1960s (Prusaite, 1960a,b, 1961a,b,). Her studies focused mainly on canid morphology, distribution, diet and reproduction. Since these studies only a few investigations on canid helminth fauna and the diet of the fox have been carried out (Navalinskas, 1968; Kazlauskas & Prusaite, 1976). During the last two decades a few short reviews concerning the abundance and distribution of canids in Lithuania have been published (Bluzma & Baranauskas, 1986; Bluzma, 1990). Three canid species now dwell in Lithuania. Two are natives: the wolf (*Canis lupus*) and the fox (*Vulpes vulpes*). The raccoon dog (*Nyctereutes procyonoides*) has been introdnced into the country.

The wolf is the largest of the three canid species dwelling in Lithuania. The largest recorded male weighed 81 kg (average weight 45 kg), the biggest female 51 kg (average weight 37 kg) (Prusaite, 1961).

The abundance of wolves in Lithuauia depends on hunting pressure and habitat quality, particularly abundance of food and shelter and conditions for reproduction. Lithuania is a densely inhabited agricultural country with an average rural density of 20.8 people per km², and the wolf was historically persecuted because of cattle predation. The number of wolves in Lithuania tended to increase when the country was at war, during which times hunting pressure was reduced. The population would then decrease in periods between the wars.

In 1934, after the first census of game mammals in Lithuania, 112 wolves were recorded (Fig. 1). The population remained at this level until the second World War. During this war the number of wolves increased rapidly, reaching 1,700 by 1948. After a big wolf hunting and trapping campaign, initiated by the Government, the number of wolves decreased dramatically, reaching a minimum of 34 individuals in 1965. In the 1970s the wolf's role in forest ecology was recognized and the hunting pressure was reduced, allowing the wolf population to recover until it reached 300 in the early 1980s. It was then maintained at a stable level until 1990 after which the number of wolves began to increase rapidly. According to census of 1994 there are now about 600

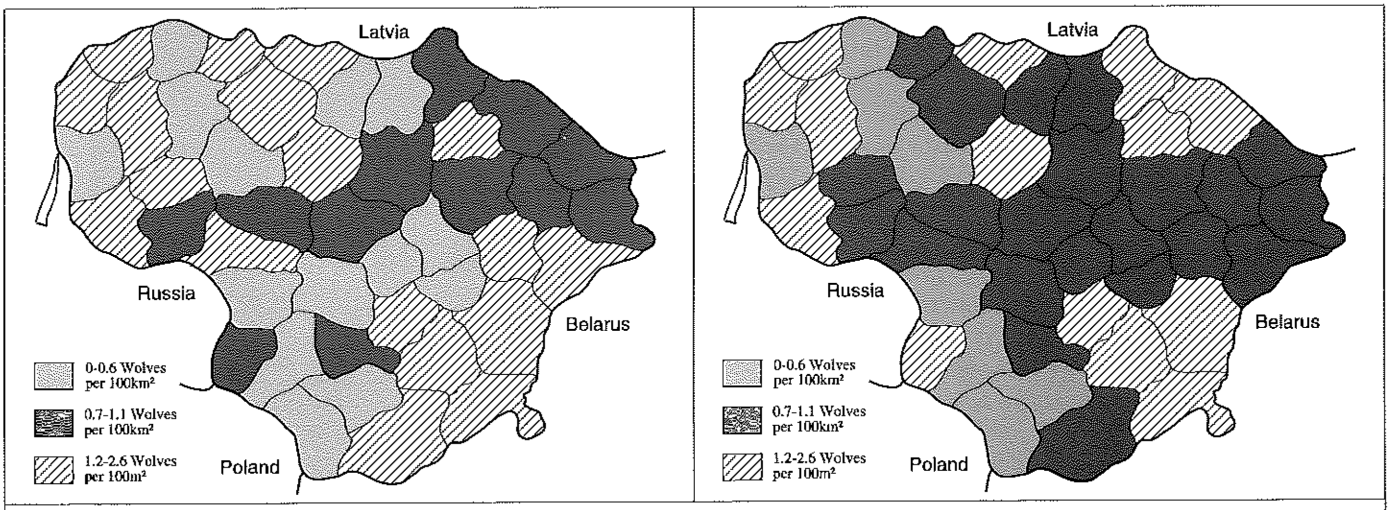
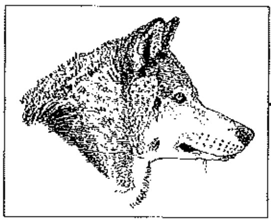


Figure 2. *Maps of Lithuania showing the densities of wolves in (a) rural habitats and (b) wetland and forest habitats.*



wolves in Lithuania. The distribution and average density of the wolf in Lithuania is shown in Fig. 2 and Fig. 3. In 1994 the presence of wolves was recorded in 43 of the 44 regions in Lithuania. Mean densities in Lithuania are one wolf per 100 km² in rural habitat (excluding roads, built-up areas and lakes etc) and 2.7 wolves per 100 km² in forest and wetland areas. The species is more abundant in those parts of the country where there are more forests and wetlands.

The wolf is not protected in Lithuania and can be hunted all year round. Most wolves are taken during the autumn and winter hunts for hoofed mammals. Special wolf hunts using flandry are less common. Hunters consider the wolf a prestidious trophy species, but peasants regard it as a pest because of its predation on livestock; in 1979, for example, wolves killed 581 sheep and 84 cows in Lithuania (Isokas, 1981).

In conclusion it seems that the mosaic landscape of Lithuania provides good conditions for wolves, and that the number of wolves living within the coutry should be controlled. We believe that the optimal size of the wolf population in Lithuania should be 150-200 wolves.

Literature Cited

Bluzma, P. 1990. Avaiable habitats and status of mammal populations in Lithuania. In: Mammals in the cultivated landscape of Lithuania, Vilnius.

Bluzma, P. & Baranauskas, K, S. 1986. Population dynamics, density and the utilization of populations of carnivorous forest-dwelling mammals in the Lithuanian SSR. IV Congress of the All-Union Theriological Society, Vol. 3, Moscow.

Isokas, G. 1981.Gaudzia ragas.

Kazlauskas, Yu., & Prusaite, Ya. 1976. Helminths of the Carnivora of Lithuania Acta Parasitologica Lithuanica, Vol. 14.

Navalinskas V. 1968.Lapes (*Vulpes vulpes* L.) mityba Labanoro girioje ir Vilniaus apylinkese. Diplominis dapbas. VU GF Zoologijos katedra, Vilnius.

Prusaite J. 1960A. Usurinio suns (*Nyctereutes procyonoides* Gray) plitimas ir mityba Lietuvoje. Liet. TSR MA darbai. 1.2(22). Ser. C.

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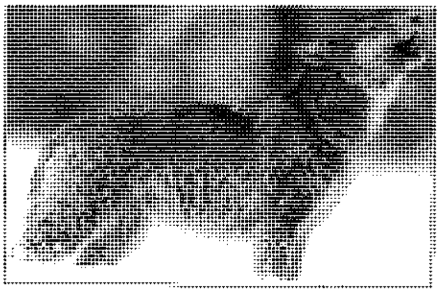
The Abundance of Wolves in Northern Siberia

Introduction

Once the most widely distributed mammal, the wolf (*Canis lupus*) now occupies only around half of its original range. The main threat facing the species is high hunting pressure, but there are still some remote places in the world with very low human population density where the wolf can enjoy a relatively undisturbed existance.

In northern parts of Siberia the density of wolves was reported to be between one and five animals per 1000 km², based on pelt statistics (Bibikov, 1990; Bibikov *et al.*, 1993), but more recently the density was reported to be less than one per 1000 km² (Bibikov, 1994). It is very difficult to obtain

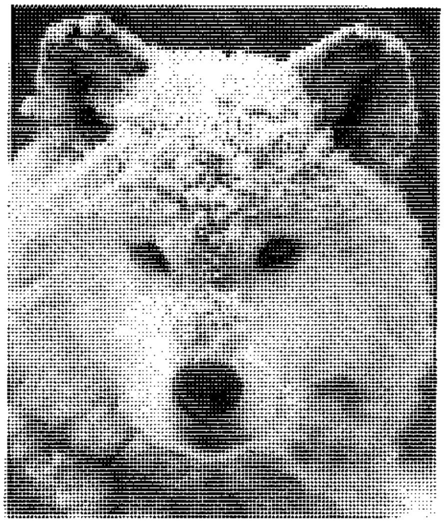


accurate information from such a vast area, and there are no good recent surveys from the region (N. Ovsyanikov, pers. comm.).

We were given the opportunity to investigate wolf abundance in northern Siberia during the summer of 1994. A joint Swedish-Russian expedition travelled along the coast of Siberia to study the life on the tundra (Goryachkin *et al.*, 1994), visiting 18 different sites from the Kola peninsula to Wrangel Island. The data presented here are based on inventories of wolves collected during this expedition.

Materials & methods

The members of the expedition, 35 Swedish and 35 Russian scientists, were based on the ice-going research vessel Akademik Fedorov. At each research site (see Fig. 1) we were flown ashore by Russian helicopters to



four different camp sites. We stayed at each site for 1–2.5 days (see Table 1). The expedition covered a wide variety of topics, including lemmings, birds, plants and fish. Some members of the expedition traversed large areas, whereas others remained relatively stationary. Only a few of us had an active interest in wolves.

The authors of this report made inventories of all mammalian and bird predators of lemmings, including arctic fox, snowy owl and skuas. Our research enabled us to search for wolf tracks along rivers, small streams and lake shores. We also spent a considerable amount of time conducting systematic observations of the tundra. Each of us covered about 25–50 km² at each site. We present here a summary of our observations on wolves and their tracks, but also include data from all other members of the expedition where we could confirm their observations.

Study area

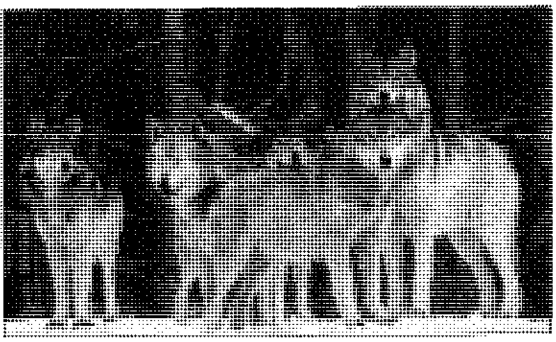
The expedition set out from Gothenburg on 3rd June, and passed Nordkap (71° N, 26°E) on 7th June. The first stop was the Kola peninsula. All study sites were well north of the tree line, from 67° to 77° N. The terrain varied from mountain types (sites 8, 15, 17) to tussock tundra areas (1, 2, 3) or wet delta types (4, 12, 14, 15), but the most common type was flat tundra (5, 6, 7, 9, 10, 13a, 13b, 16). This is of course only a general classification; many sites contained more than one habitat type.

Results

In the western part of Siberia, from the Kola peninsula (site 1) to Yamal (5, 6) and Jenisej river, we saw no sign of wolves. These areas support relatively dense populations of domestic reindeer and thus also reindeer keepers. Further to the east, from Taimyr, wolves or wolf tracks were found at each site. Brief descriptions of some of these observations are given below.

On NE Taimyr (site 10) in June we found skin and bones of a male reindeer that had died the previous autumn. The long bones had been crushed by carnivores and wolf hairs were discovered nearby. About 2 km away there were fresh tracks of two adult wolves which we were able to follow for 30 m. In August, while we were 20 km from the first site, a member of the expedition saw a wolf on the shore of a small lake chasing about 200 moulting white fronted geese. The wolf swam 50 m across the lake but failed to catch any geese. As it departed it was joined by another wolf.

At Olenekskiy (site 11) we discovered fresh tracks of an adult wolf at our camp site, and after several hours searching found an inhabited wolf den. There were two adult wolves nearby (a male and female) and at least two pups in the den judging from the vocalizations. The den was an old arctic fox den, probably inhabited by arctic foxes two years ago. The wolves had dug out five of the 20 entrances on the lush green hillside. Less than 1 km away we found a fresh reindeer carcass surrounded by wolf tracks. Independently, another member of the expedition observed a lone wolf 15 km away.



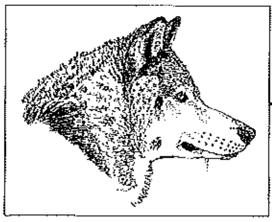
At Yana (site 12) a member of the expedition saw two wolves on a coastal mud flat. He observed the wolves for 30 minutes, during which time they made no attempt to hunt. The expedition leader, Anders Karlqvist, saw a wolf from the helicopter when passing another area at the same site.

On one of the New Siberian Islands, Faadevsky (site 13b), one of the authors and another member of the expedition independently saw single wolves at different places from the helicopter. On Kotelny (13b), another New Siberian Island, we saw tracks of two adults and two pups which had walked together for 200 m along a stream. About 2 km away we discovered an arctic fox den which had been dug ont by wolves, but the wolf tracks at the den suggested that this had happened a year ago. The size and wear of the den indicated that it was probably not used for breeding. Another member of the expedition also spotted a wolf nearby.

At Indigirka (14) a male wolf approached to within 50 m of us before

Site	Position	Date	Hours	Tracks	Observations	Reindeer (ind/1000 km²)	Human activity
1 Kola	67°N 41°E	10/06	27	0	0	domesticated / moderately	high
1 Kola		01/09	23	0	0		
2 Kanin	68°N 45°E	13/06	31	0	0	domesticated / high	moderate
2 Kanin		28/08	29	0	0		
3 Kolguyev	69°N 50°E	16/06	30	0	0	domesticated / moderately	high
3 Kolguyev		27/08	27	0	0		
4 Pechora	68°N 53°E	18/06	30	0	0	domesticated / high	moderate
4 Pechora		25/08	30	0	0		
5 Yamal	70°N 67°E	18/06	31	0	0	domesticated / high	high
5 Yamal		22/08	28	0	0		
6 N Yamal	73°N 71°E	23/06	23	0	0	domesticated / high	high
7 Arctic Inst Isl	75°N 82°E	23/06	6	0	0	absent	none
8 W Taimyr	76°N 94°E	26/06	47	0	0	wild / herds of 500–1000	low
8 W Taimyr		15/08	44	1 ad + 2 ad			
9 Chelyuskin	77°N 103°E	27/06	28	1 ad	0	wild / herds of 500–1000	low
9 Chelyuskin		13/08	22	1 ad + 1 ad			
10 NE Taimyr	76°N 111°E	30/06	55	2 ad + 1 ad	0	wild / herds of 100–300	very low
10 NE Taimyr		10/08	36	0	2 ad		
11 Olenekskiy	73°N 120°E	06/07	43	2 ad, 1 ad, den	2 ad + pups, 1 ad	wild / herds of 500–1500	low
12 Yana	72°N 135°E	04/08	20	2 ad	2 ad, 1 ad	wild / herds of 250–500	low
13b Faadevsky	75°N 144°E	16/07	11	1 ad	1 ad, 1 ad	wild / few	very low
13a Kotelny	75°N 138°E	11/07	21	2 ad + 2 pups, den	1 ad	wild / herds of 100–150	low
14 Indigirka	72°N 149°E	13/07	42	1 ad	0	wild / herds of 250–500	moderate
15 Kolyma	69°N 163°E	18/07	26	1 ad, 1 ad, den	1 ad	domesticated / few	high
16 Ayon Isl	69°N 168°E	20/07	20	0	0	domesticated / high	high
17 Wrangel Isl	71°N 180°E	24/07	48	0	0	wild / moderately	low

Table 1. Data concerning the study sites marked on the map opposite (Figure 1).



slowly moving away. On an island in the Kolyma delta some Japanese people had seen three wolves three weeks earlier. We saw tracks on the shore and a member of the expedition found a hole in the ground with some wolf droppings, suggesting a wolf den, but we had no time to check whether it was inhabited by wolves.

Discussion

Between the Kola peninsula and Jenisej we saw no wolf tracks. The area is mainly occupied by the Nentsi people with their domestic reindeer. We met some reindeer herders and they told us that they only found wolves a problem in the taiga during winter. Thus it is likely that very few wolves inhabit these tundra areas.

Between the Taimyr peninsula (8) and Kolyma river (15) we observed wolf sigus at every site. These areas support fairly dense populations of wild reindeer (Table 1), with domestic reindeer only kept in a few places. Furthermore, these reindeer are managed differently. Whereas the Nentsei people migrate with the reindeer over large areas, the reindeer farms in the east are more stationary, resulting in differences in wolf-hunting practices. Wolves are probably hunted far more intensively in the western parts of Siberia.

Wolves were reported to be absent from most of the islands in northern Siberia (Bibikov, 1990; 1994). Our observations show them to be present on the New Siberian Islands Kotelny and Faadevsky, but confirm their absence on Wrangel Island.

Bibikov (1994) reported the density of wolves in all parts of northern Siberia to be less than one per 1000 km². Our observations support his estimations for wolves in the western parts of north Siberia, but eastern areas support a higher density – at least the 1–5 wolves per 1000 km² as suggested earlier by Bibikov (1990).

Acknowledgements

We are very grateful to the members of the expedition who shared their observations of wolves with us: L. Edenius, A. Karlkvist, N. Kjellén, A. Kuprianov, E. Lindstrom, V. Savenko, M. Stenström, I. Sukhanov. We are also grateful to the Swedish Polar Research Institute for organizing the expedition.

Literature Cited

Bibikov, D. I. 1990. Der Wolf. A. Ziemsen Verlag, Wittenberg Lutherstadt.

Bibikov, D. I. 1994. Wolf problems in Russia. Lutreola, 3: 10-14.

Bibikov, D. I., Ovsyanikov, N. G. & Filimonov, A. N. 1983. The status and management of wolf populations in the USSR. Acta Zool. Fenn., 174: 269-272.

Goryachkin, S. V., Zlotin, R. I. & Tertitsky, G. M. 1994. Russian-Swedish expedition "Tundra Ecology -94". Diversity of natural ecosystems in the Russiau Arctic. Lund University.

Anders Angerbjörn & Erik Isakson

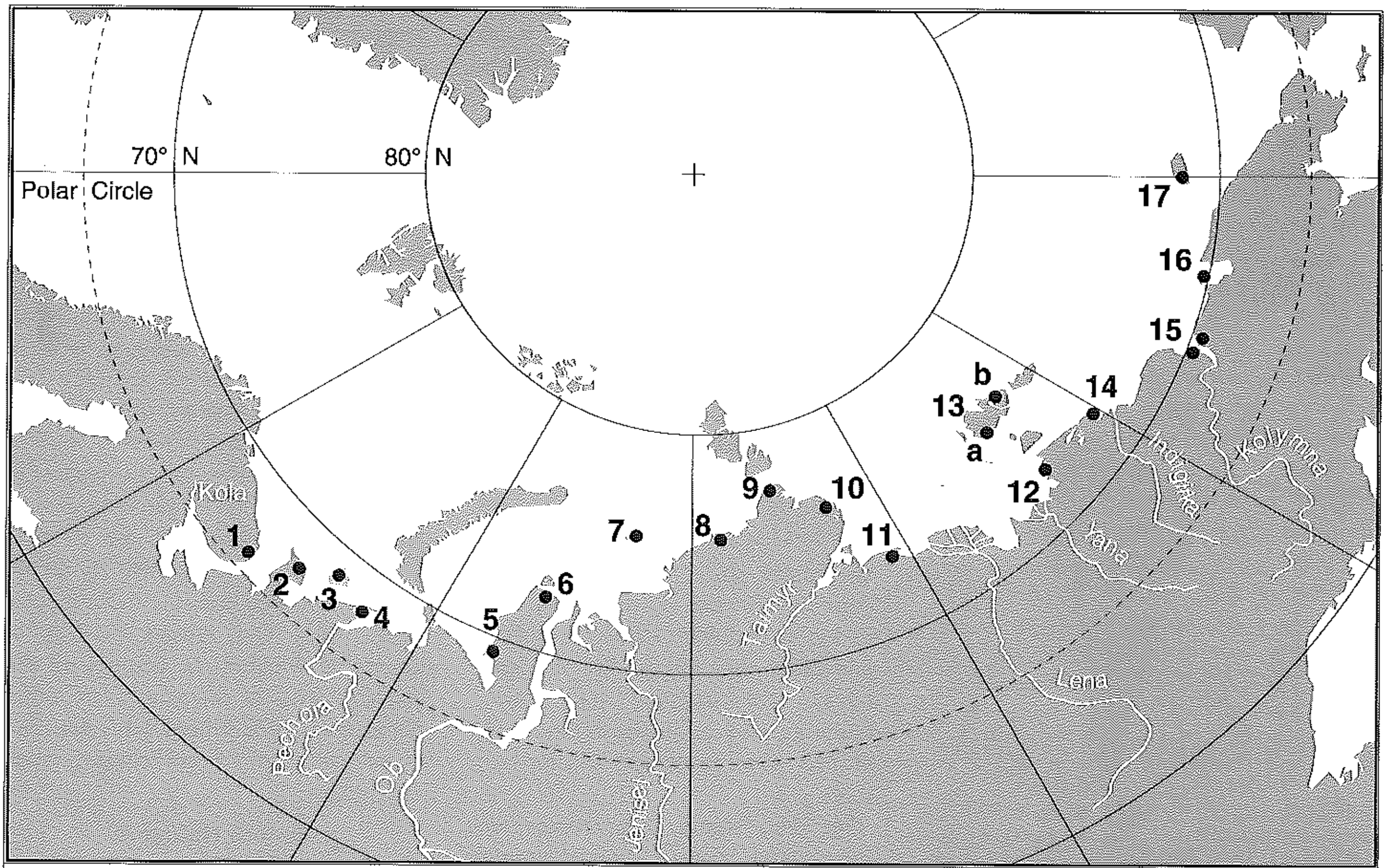
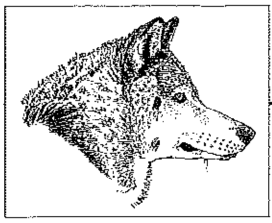


Figure 1. Map of the north polar region showing the positions of the study sites visited in North Siberia (see Table 1).



The Arabian Wolf (Canis lupus) in Israel

The wolf is distributed over most of the Palearctic region, and is found in a variety of habitats. Although the ecology of the wolf has been studied intensively over the past 20 years, all the populations studied were of northern origin (e.g. Northern Europe, Alaska, Minnesota). However, the same species that inhabits forests and tundras in the north reaches south deep into the Arabian deserts (the Arabian peninsula and the Syrian desert).

The Arabian wolf is much smaller than the northern subspecies, weighing about 20 kg. Its fur is thinner, and sometimes lighter in colour. Arabian wolves prey on gazzels, ibexes, hares, and small rodents and birds. Analyses of 700 scats collected in the southern Arava valley in Israel showed that wolves there feed mostly on livestock, human garbage and fruit, preying on cow calves, sheep and goats, and scavenging from domestic herbivore carcasses. This diet suggests that wolves frequeutly live around human settlements, and may have a severe impact on livestock uuless measures to prevent depredation are taken.

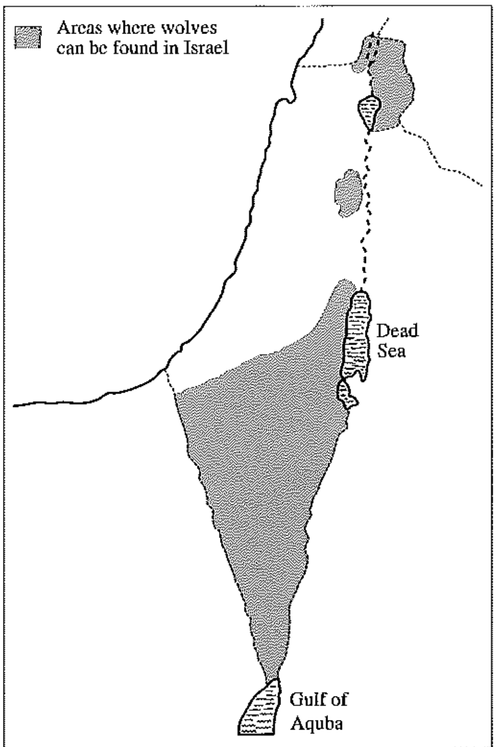


Figure 1. Map showing the distibution of the Arabian wolf in Israel.

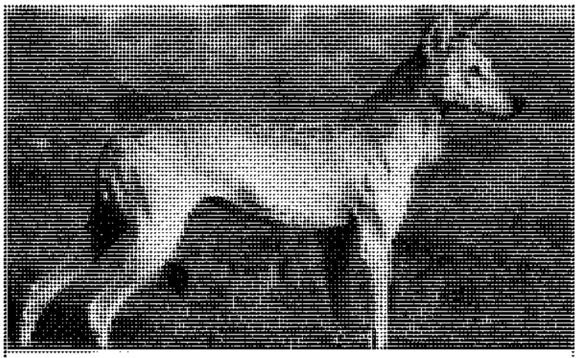


Figure 2. Photograph of female Arabian wolf, by Professor H. Mendelssohn.

In Israel, the estimated total population of the Arabian wolf is 100-200 individuals. We do not have reliable data on population size in neighbouring countries (e.g. Jordan, Saudi Arabia), but the wolves there are systematically killed by locals because of predation on livestock, a policy supported by the authorities. Israel is thus the only country in the Middle East where Arabian wolves are protected by law, and where it is forbidden to poison, shoot or trap them.

At the beginning of the 1990s predation on cow calves by wolves increased notably in the southern Arava valley. This has lead some settlers to react aggressively towards the local wolf population. Several wolves were trapped and relocated or shot. In response to this escalation in wolf persecution we initiated a study into the ecology of the Arabian wolf. Our aim was to use the data collected to find a simple solution that would eliminate predation on livestock and allow the future existence of wolves in the area. We have now collected data for approximately three years. About 20 individuals were fitted with radio collars, and tracked for at least several months. Some were tracked for 1–2 years, others moved 100-200 km north and we are unable at present to continue monitoring their movements. Two crossed over to Jordan and were killed by soldiers patrolling the border. We are currently still trapping and radio-collaring wolves in the region, and aim to continue this project for two more years.

Our data shows that wolves are most active around areas of human activity (army camps, garbage dumps, settlements). Most of their food and water comes from humans. Apart from preying on small livestock the wolves feed on garbage they find in dumps or iu settlements, and on water melon and other agriculturally grown fruits. Being swift and nocturnal, the wolves are able to cross settlement boundaries, either tunneling under fences of finding gaps. They have negligible effect on crops, but do significant damage to livestock.

Long discussions with settlers based on our preliminary data convinced all those having cattle farms in the area to construct electrically fenced enclosures and keep calves indoors overnight. This simple solution eliminated calf predation completely. With these economic concerns under control, people in the area are now in favour of coexistence, and enjoy the proximity of wolves.

Although this is fundamentally an applicative research project, we are also collecting data on sociality and reproduction of Arabian wolves. Blood samples are taken from every trapped individual for future genetic studies at the individual and population levels. Now that the future of the Arabian wolves in Israel seems relatively secure we aim to concentrate on more theoretical issues. Our present goal is to determine whether the ecology of the Arabian wolf is different from other populations at northern latitudes, and investigate the factors causing such differences.

Reuven Hafner &
Eli Geffen

The Hoary Fox in Brazil

Feeding Habits

The hoary fox, *Dusicyon vetulus*, is endemic to the Brazilian grasslands. It is not rare, but is one of the least well studied neotropical canids. This report presents data taken from an article I prepared recently concerning the diet of wild hoary foxes in an area of cerrado vegetation in Mato Grosso (near Chapada dos Guimarães National Park).

289 fox scats (collected in 1983, 1984 and 1985) were analysed, and 69 specific food items were identified and organized into eight groups (Fig. 1). Although the results revealed a varied diet, the items found most frequently were termites, especially *Syntermes spp*. The hoary fox showed a preference for feeding on the large, aggressive *Syntermes* soldiers throughout the year. Other insects (especially beetles and grasshoppers) and wild fruits make up much of the remainder of the foxes' diet; vertebrates make only a small contibution.

The hoary fox is well adapted to tackling small prey in the relatively dry savauna environment. It is small (2.5-3 kg) and agile, enabling it to move easily amongst the undergrowth of the cerrado, and has dental adaptations (small carnassials and crushing molars) suitable for consuming termites, insects etc. The hoary fox's preference for invertebrates and fruits is an important factor separating the food niches of this species from other sympatric canids in the Brazilian cerrado.

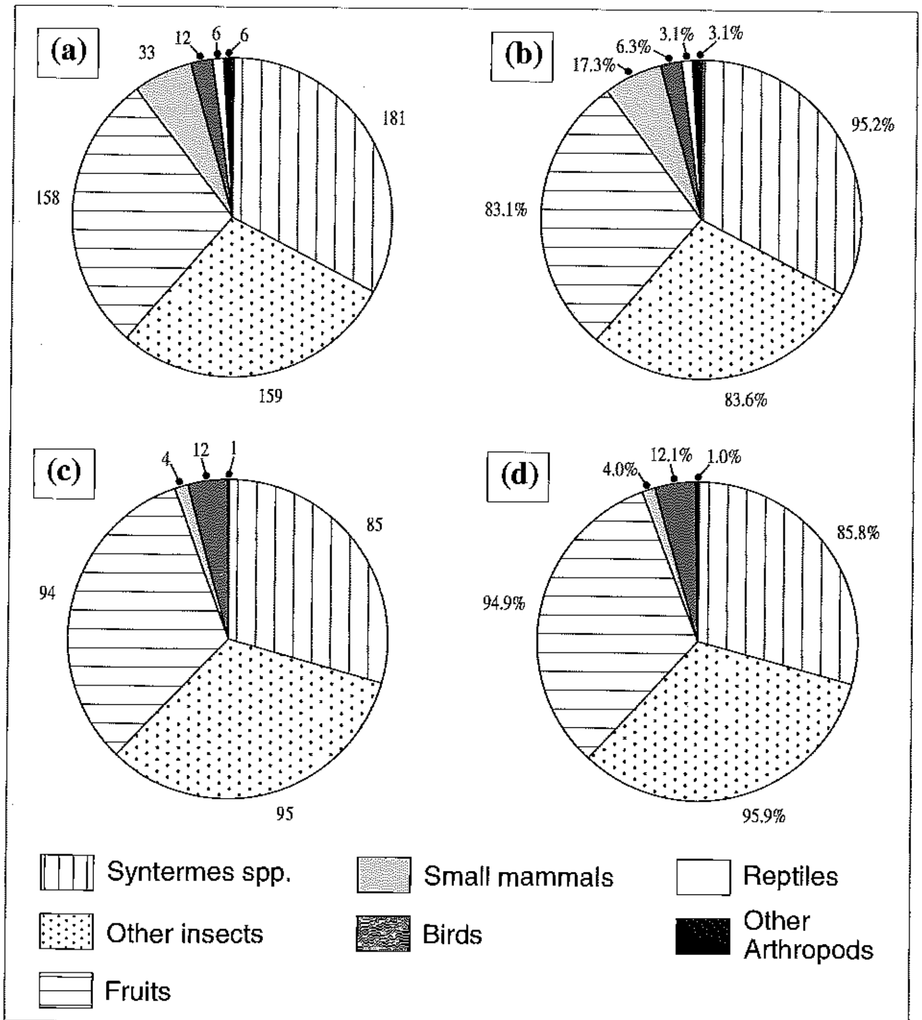


Figure 1. *Seasonal occurrence of selected food items in scats of the hoary fox in Mato Grosso, central Brazil: (a) and (b) dry season; (c) and (d) wet season.*

Distribution, habitat and status

The hoary fox is distributed throughout the Central Plateau and Northern Brazil, from the state of Ceará as far as São Paulo and Mato Grosso do Sul, extending into Mato Grosso, Goiás, Tocatins, Minas Gerais and Pernambuco. It can be found in several types of open habitat throughout the central savaunas (cerrados), transitional areas and esteppic savannas (caatingas) (Viera, 1946; Langguth, 1975; Carvalho, 1980). According to Von Ihering (1911), *D. vetulus* does not occur in Para state. The literature in Mato Grosso includes only historical records (Thomas, 1903).

During the last 10 years I have been able to collect new data on the occurrence of the species in Mato Grosso do Sul, especially from road kills (the priucipal cause of fox mortality) and direct sightings (Fig. 3). The greatest number of signs of hoary fox presence were found in the tablelands of Chapada dos Guimarães, where a narrow and endangered strip of scrub (fruticetum) provides optimal hoary fox (and maned wolf) habitat. This particular site (15° 25′S and 55° 47′W) is located outside, but near, Chapada dos Guimarães National Park. Other areas suitable for hoary foxes in southern Mato Grosso, characterized by mauy types of cerrado vegetation, are rarely undisturbed. The Central and Northern parts of the state are dominated by forested areas which are not suitable for the hoary fox. *D. vetulus* is thought to exist at low densities throughout the drier perimeter of the flooded savannas of the Paraguay River (Pantanal region), but is not expected in the highly flooded swamplands of the interior Pantanal.

In general, this species seems to be fairly secure in the open areas of Central Brazil. However, the widespread and increasing human occupation of prime fox habitat could result in a long-term threats to the hoary fox population in the region. Nevertheless, hoary foxes are frequently seen in cattle pastures, which support high densities of termite mounds (pers. obs.).

The species faces a different problem in Bahia State (Northeastern Brazil) where, according to C. Yamashita (pers. comm.), the hoary fox is hunted for its fur. The numbers of foxes killed and the impact of commercial (and illegal) hunting on the fox population is currently unknown.

Literature Cited

Carvalho, C. T. 1980. Mamiferos dos parques e reservas de São Paulo. Silvic. S. Paulo, 13/14: 49-72.

Langguth, A. 1975. Ecology and evolution in the South American canids. In: The Wild Canids, Ed. M. W. Fox, pp. 192-206.. Van Nostrand Reinhold, New York.

Thomas, O. 1903. On the mammals collected by Mr. A. Robert et Chapada, Matto Grosso (Percy Sladen Expedition to Central Brazil). P.Z.S. London, 2: 27.

Vierra, C. C. 1946. Carnivoros do Estada de . Arq. Zool., São Paulo, 5(3): 135-176.

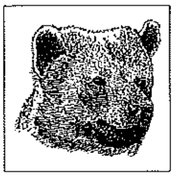
Von Ihering, H. 1911. Os mamíferos do Brasil meridional. Rev. Mus. Paulista, Vol. 8.

Julio César Dalponte

EDITOR'S NOTE

The hoary fox is one of the least well studied members of the canid family. We are anxious to gather more data on this species. We would be pleased to receive any information that comes to light, as well as positions of sightings to update the species' distribution map.

Proposal to Study Bush Dogs in Brazil



A project proposal on ecology & behaviour

The bush dog is one of the least well studied neotropical canids and in the wild is known only from unconfirmed records or incidental observations (Tate, 1931; Bates, 1944; Sanderson, 1949; Linares, 1967; Crespo, 1974; Deustchl, 1983; Strahl *et al*, 1992).

Although it can be found from Panama to Argentina, this species is naturally sparse and rarely seen in the wild, and field studies specifically concerned with bush dogs have not been conducted in Brazil or any other Latin American country. Consequently no specific measures have been taken in order to protect this species in its natural habitat. It is essential to obtain information about wild bush dogs in order to develop a management plan, particularly if the reintroduction of captive-born individuals is planned. Two main factors limiting the feasibility of conducting a field study on bush dogs are the rarity of the species and the problem of locating a suitable study site. In Brazil, bush dogs may occur in some protected areas, but unfortunately there are no guarantees that any of these reserves might be ideal sites to conduct a long-term field study. The problems facing researchers include the lack of reliable records to indicate the occurrence of a suitable bush dog population, absence of adequate facilities (accommmodation, paths, roads, laboratories etc.) and limited access routes into the reserves.

We have recently prepared a project proposal on wild bush dog ecology and behaviour. The project goal is to obtain data on a bush dog population at Serra das Araras Ecological Station (57° 01′S, 15° 53′W), in Mato Grosso State, and to determine the basic parameters affecting species conservation. We chose this particular reserve because a previous survey (Dalponte, 1988: Table 1) confirmed the existence

Date	Time & distance from research headquarters	Sighting method	Notes
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
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Table 1. Bush dogs sighted in Serra das Araras Ecological Station, Mato Grosso State, Brazil (from Dalponte, 1988).

of a suitable bush dog population, and it has adequate facilities for conducting a long term study. This proposal was planned in close collaboration with Maria Cecília Buschinelli, coordinator of the Bush Dog Management Plan at the Brazilian Zoo Society. After critical revision of a draft proposal by Dr. Todd Fuller (Massachusetts University at Amherst), a funding application will be submitted to Wildlife Conservation International.

Literature Cited

Bates, M. 1944. Notes on a captive Icticyon. Journal of Mammalogy, 25: 152-154.

Crespo, J. A. 1974. Incorporacion de un genero de canidos a la fauna de Argentina-Fam. Canidae: *Speothos venaticus* (LUND, 1843). Communicaciones del Museo Argentino de Ciencias Naturales "Bernadino Rivadavia", 6: 37-39.

Dalponte, J. C. 1988. Estudos preliminares sobre o cachorro do mato-vinagre, *Speothos venaticus*, na Estação Ecológica Serra das Araras, Estado do Mato Grosso, Brasil. Unpublished Report: Program for Studies in Tropical Conservation, University of Florida, 12pp.

Defler, T. R. 1986. A bush dog (*Speothos venaticus*) pack in the Eastern Lhanos of Colombia. Journal of Mammalogy, 67(2): 421-422.

Deustch, L. A. 1983. An encounter between a bush dog (*Speothos venaticus*) and paca (*Agouti paca*). Journal of Mammalogy, 64(3): 532-533.

Linares, O. J. 1967. El pero de monte, *Speothos venaticus* (LUND), en el norte de Venezuela (CANIDAE). Sociedad de Ciencias Naturales "La Salle", Memoria, 27: 83-86.

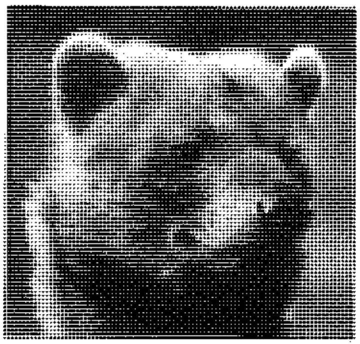
Lund, P. W. 1950. Memórias sobre a paleontologia brasileira. INL, Rio de Janeiro, C.P. Couto (ed). 589 pp.

Sanderson, I. T. 1949. A brief review of the mammals of Snriname (Dutch Gniana), based upon a collection made in 1938. Proceedings of the Zoological Society of London, 119: 755-789.

Strahl, S. D., Silva, J. L. & Goldstein, I. R. 1992. The bush dog (*Speothos venaticus*) in Venezuela. Mammalia, 56(1): 9-13.

Tate, G. H. H. 1931. Random observations on habits of South American mammals. Journal of Mammalogy, 12: 248-256.

Julio César Dalponte



Faecal Hormones: a Helping Hand in the Study of Maned Wolves

The maned wolf, largest of the South American canids, has been facing rapidly increasing pressures from human development across most of its Brazilian range. However, the massive destruction of grassland habitat in some areas seems to be somewhat compensated by deforestation in other locations, which turns incompatible patches of forest into scrub forest that can be used by maned wolves (Dietz, 1985)

Despite increasing attention from Brazilian authorities and institutions during the past few years, very little is known of this species in the wild. Their nocturnal habits and large territories, together with their earthy coloured coat make them extremely difficult to observe in their natural habitat (Dietz, 1984). Most of the data currently available are based on captive stndies.

Despite the efforts of captive breeding programmes such as the North American SSP, Maned Wolf EEP and the recently (1992) created Brazilian Committee for the Maned Wolf, reproduction in captivity remains problematical. Some of the management problems described by Brady and Ditton (1979) contiuue to affect maned wolf reproduction in many zoos, including disturbance which causes unsatisfactory parental behaviour.

For the past five years I have been workiug with captive maned wolves, attempting to pinpoint the problems with captive breeding aud sniggest solutions for better management and reproductive success. In a two-year (1990/91) study for the Jersey Wildlife Preservation Trust, I visited many Brazilian zoos housing maned wolves. Through behavioural observations, interviews with zoo personel, and examination of animal records, I found that stress – resulting from proximity to other wolves, lack of hiding places, and insufficient number of dens – was the main factor affecting reproduction in the maned wolf pairs (Velloso, 1991). Recommendations were made to increase the pairs' isolation from the public and from other maned wolves during gestation and pup rearing and to hand-rear pups when necessary. As a result, neonatal survival improved in several institutions, although diseases and other factors still require attention.

Nevertheless, there is still much to be learned about wild maned wolves, and it is with that in mind that I have been working for the past two years with Dr. Sam Wasser at the National Zoological Park's Conservation and Research Center (Smithsonian Institution) to improve the faecal steroid analysis technique his lab has developed and adapt it for maned wolves, as part of my Masters thesis through the University of Maryland. From the long-term field work conducted with maned wolves by Dr. James Dietz (Dietz, 1984), it is clear that a non-invasive method of data collection would be of great advantage in the further study of this secretive species in the wild. Hormone levels have traditionally been measured in blood, a technique that is not practical wheu working with captive or wild animals. The recently developed faecal steroid technique allows us to measure levels of several hormones which are also metabolized and excreted in urine and faeces, and from which fertility and pregnancy can be determined without disturbing the animals. Faecal sample collection is also very practical considering that maned wolves tend to defaecate at specific sites (Dietz, 1984).

Current hormonal study

We have been applying the faecal hormoue analysis technique successfully for the past two years to determine the reproductive status of several captive female maned wolves. We also obtained promisiug results in distinguishing between real and pseudo-pregnancy, as well as differentiating between the sexes (Wasser *et al*, in prep). Furthermore, we found that in the maned wolf, 97% of the hormones are excreted in the faeces versus in the urine (Velloso & Wasser, in prep); a distinct advantage for sample collection both in captivity and in the wild. The success already attained using this technique, together with the potential still being tested, makes it a very valuable tool for the field study not only of this species, but other mammals and perhaps birds as well.

For this study, faecal samples were collected for three years during the annual breeding season (October to February in the Northern Hemisphere). With the assistance of the Maned Wolf SSP, eight North American zoos collaborated with this study by conducting behavioural observations and collecting faecal samples from a total of 19 animals. Sample collection during the first two breeding seasons focused on females in an attempt to monitor their cycles to improve the poor captive breeding results. Five zoos housing a total of nine reproductively active females participated in the first year of this study. Twelve females were sampled dnring the second year in addition to ten others housed in Brazilian zoos. During the third year of this study, samples were collected from four females and four males housed in two American zoos.

Faecal samples were collected at least twice a week from the onset of the breeding season until 80 days following oestrus or one week post-partum. Sample collection was increased to three times per week for two weeks when oestrus behaviour was observed. All samples were frozen upon collection and shipped to the Conservation and Research Center on dry ice. Food colouring was occasionally fed to the animals for easier identification of the sample, and had no effect on the aualysis. The extraction and analysis methods used are described elsewhere (Wasser *et al.*, 1991 and Wasser *et al.*, in prep. for the latest modifications).

The samples were assayed for oestrogens, progestogens and are still being analyzed for testosterone. By combining behavioural and hormonal data, we have confirmed that the female maned wolf cycle conforms to the typical mammal cycle, breeding at or immediately after a high oestrogen peak, followed by rising levels of progestogens and maintenance of low oestrogens if pregnancy occurs (Wasser *et al*, in prep). Young, acyclic females present much lower levels of both oestrogens and progestogens than older, cyling females.

In summary, from the results thus far, cyclical patterns can be identified for individual females although there is considerable variation between females in the absolute amount of measured hormones. It is possible to determine fertility and pregnancy, but I am still working on all samples and trying different assays, looking for a method that will provide more detailed information, and allow me to improve detection of differences between pregnant and pseudo-pregnant females.

Acknowledgements

I gratefully acknowledge the financial support from WWF Brasil, Brascan Brasil, Smithsonian Institution and the University of Maryland. This study has also been carried out with the valuable support from the Conservation and Research Center (Smithsonian Institution), which made laboratory facilities and personnel assistance available. Special thanks go to Melissa Rodden, James Dietz, Sam Wasser and Nicole Presley.

Literature cited

Brady, C. A. & Ditton, M. K. 1979. Management and breeding of maned wolves at the National Zoological Park, Washington. International Zoo Yearbook, 19:171-176.

Dietz, J. M. 1984. Ecology and social organization of the maned wolf (*Chrysocyon brachyurus*). Smithsonian Contributions to Zoology, No. 392. 51pp.

Dietz, J. M. 1985. Conservation of the maned Wolf. IUCN Special Publication.

Velloso, A. L. 1991. Captive breeding and behaviour of the maned wolf (*Chrysocyon brachyurus*) in Brazilian zoos. Unpublished report to the Jersey Wildlife Preservation Trust and the University of Kent at Canterbury,UK.51pp.

Wasser, S. K. et al. 1991. Rapid extraction of faecal steroids for measuring reproductive cyclicity and early pregnancy in free-ranging yellow baboons (*Papio cynocephalus*). J.Reprod.Fert. 92, 415-423.

Agnes Velloso

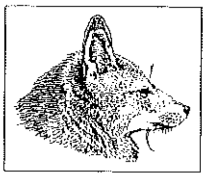
Zoo News:- Canids in Captivity in Argentina

The following data has been compiled by Dr. Margarita Mas, Jardin Zoologico de Buenos Aires, Produced iu June 1994 based on the 4 zoos that had replied by that time.

Species	Buenos Aires		Mendoza		Cordoba		La Plata		Total
	Male	Female	Male	Female	Male	Female	Male	Female	
Dusicyon culpaeus	0	1	0	0	2	0	0	1	4
Dusicyon gymnocercus	0	0	0	0	19[1]	0	1	3	23
Dusicyon griseus	4	1	3	6	0	0	0	0	14
Cerdocyon thous	0	0	0	0	1	1	1	1	4
Chrysocyon brachyurus	2	0	0	0	0	0	0	0	2
Alopex lagopus	0	0	1	2	0	0	0	0	3
Canis lupus	0	0	1	3	3	2[3]	1	1	12
Lycaon pictus	1	1[2]	0	0	0	0	0	0	2
Vulpes vulpes	0	2	2	4	0	0	0	0	8

[1] sex unspecified; [2] 2 juveniles: sex unspecified; [3] bred early 1994. Litter died.

The Distribution of the Golden Jackal in Kazakhstan



The authors present here the results of research carried out between 1978-1993 in the territories of the Mangistau, South Kazakhstan, Kyzyl-Orda, Zhambyl, Almaty and Taldykorgan Regions.

The northern limit of the golden jackal's (*Canis aureus* L.) range falls within Kazakhstan, where it is found mainly in the valley of the Syrdar'ya River and on the shores of the Aral Sea. It would appear that the reeds and riparian forests along the Syrdar'ya river-bed served as a corridor along which the jackal dispersed from the south (Uzbekistan), penetrating northwards as far as the Aral Sea (Bekenov, 1981, Bekenov & Musabekov, 1987). Prior to the 1950s, sightings of jackals were rare along the middle course of the Syrdar'ya River, to the south of its confluence with the Arys' River (Sludskiy, 1953). However, expansion of the area being cultivated for crops in the Syrdar'ya Basin contributed to the creation of more favourable conditions for the jackal, which has led to an increase in population size and allowed its natural range to expand quite considerably.

During the last 25–30 years considerable environmental damage has been caused by experimenting with the water meadows of the Syrdar'ya Basin. In association with the construction of the Chardara and Bugun reservoirs (South Kazakhstan Region) large areas, formerly barren and waste, were irrigated and sown with cotton, rice and maize. It was in precisely this period of time that the jackal was observed spreading rapidly into the cultivated parts of the valleys of the Syrdar'ya, Zhanadar'ya, Kuandar'ya, Arys', Badam, Bugun and Keles Rivers. After the construction of the Kyzylkum and Zhetykol' Canals (South Kazakhstan Region) the jackal began to settle in the outlying districts of the Kyzylkum Sands, facilitated by the availability of good shelter and an abundance of food (garbage, carrion, rodents).

In the 1970s the exploitation of the Telekol' canal (Kyzyl-Orda Region) altered the natural conditions of the area quite considerably: thick reed beds grew along the shores of the canals and the waste water storage lakes. Young jackals dispersed from the banks of the Syrdar'ya River into the Sarysu floodplains (Zharkum pastures) and into the Telekol' Lakes system (Bekenov, 1981).

The jackal's distribution has now expanded northwards along the Sarysu River to the city of Dzhezkazgan, thus extending its range to the northeast by about 700-750 km. Jackals can also be found in the periodically flooded water-meadows of the Irghiz and

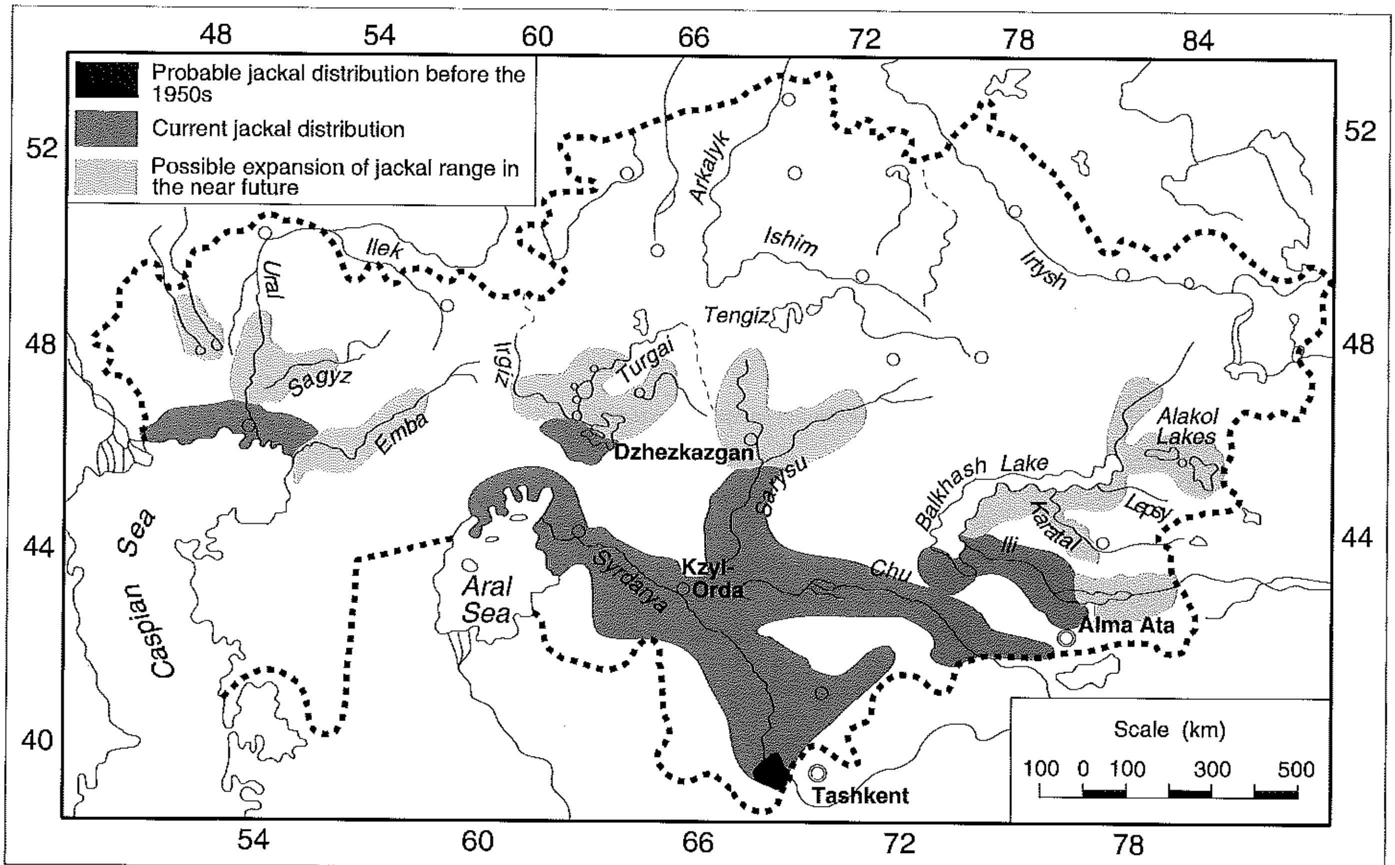


Figure 1. Map showing the changes in the distribution of the golden jackal in Kazakhstan.

Ulyka-yak Rivers and on the adjacent lakes. In 1984 two jackals were killed in the outskirts of the town of Nura (in the lower course of the Turgai River, Aktyubinsk Region), and on September 6th 1985 another was encountered 20 km to the north of the town (Bekenov & Musabekov, 1987). This represents the northernmost point in the species' range in Kazakhstan.

By the end of the 1970s jackals had spread through the Telekol' Lakes to the basin of the Chu River where they colonized the neighbourhood of the towns of Malyye Kamaly, Karakol' and Karabuget. They have been encountered repeatedly in the riparian forests near the town of Furmanovka. From 1978 jackals began to appear in the environs of Biylikol', Ashchikol' and Akkol' Lakes and in the lower course of the Talas River, in the Zhambyl Region.

In 1975-1977 the jackal spread through the Chu basin into the lower part of the Ili River valley (the species' range has thus expanded 750-800 km south-eastwards from the Syrdar'ya River), where it found good protective conditions and plenty of food. Their numbers in this region increase annually.

Data are also available concerning the killing of jackals in the Volga-Ural mesopotamia (Postuikov *et al.*, 1983). In addition, the jackal has filtered along the coast of the Caspian Sea to the territory of the Atyrau and Mangystau Regions and appeared in the Ural Delta and neighbouring lakes. From the lower course of the Amudar'ya River jackals sometimes roam into the Ustiurt Plateau.

Thus, during the last 30-35 years the range of this canid has spread throughout the flood plane of the Syrdar'ya River and the adjacent districts on the shores of the Aral Sea, and continues to increase as more jackals disperse northwards and south-eastwards. In the coming years the species is likely to occupy the whole of the Karatal and Lepsy River basins and to invade the Alakol' Lake system, and should become more widespread in the basins of the Ural, Irghiz and Yurgai Rivers and of the Tenghiz Lake. The jackal's ecological plasticity (its synanthropic and omnivorous character, elevated fecundity, etc.) in Kazakhstan favours the expansion of its range and an increase in population size. The Republic currently supports between 30-35 thousand individuals, and permits are available allowing up to 15-20 thonsand jackals to be killed annually.

Literature cited

Bekenov, A. 1981. The jackal. In: the mammals of Kazakhstan. Alma-Ata. Vol. 3, part 1: 57-72 (in Russian).

Bekenov, A. & Musabekov, K. S. 1987. The expansion of the jackal range in Kazakhstan. In: Izvestiya Akademii Nauk Kazakhskoy SSR. Seriya Biologicheskaya. Issue 1 (139): 30-33 (in Russian).

Sludskiy, A. A. 1953. The jackal. In: the mammals of Kazakhstan. Alma-Ata: 398-400 (in Russian).

Postnikov, G. B., Dubinin, S. P. & Chikrizov, F. D. 1983. The jackal (*Canis aureus*) in the Volga-Ural mesopotamia. Zoologicheskiy Zhurnal, 62(3): 462-464 (in Russian).

A. Bekenov & K. S. Musabekov

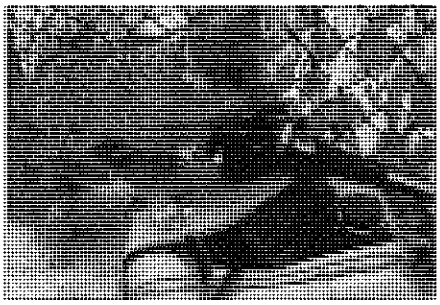
Book Review

"Foxes, wolves and wild dogs of the world"

By David Alderton

London: Blandford Press (1994). 192 pp.

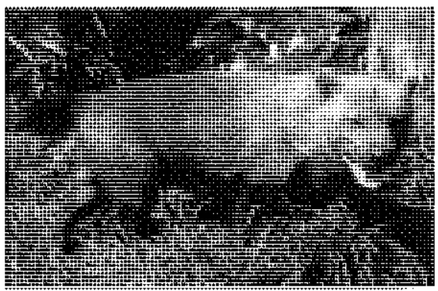
This is an attractive hardback book containing lots of information and plenty of colour photographs. There are nine chapters, the first four covering general topics. Chapter one provides an entertaining account of man's relationships with the dog family, including persecution of 'man-eating' wolves, the fur trade, conservation, control and disease transmission. The second chapter, entitled "form and function", gives an overview of canid morphology, and outlines some of the adaptations of particular species. It also covers some aspects of behaviour and social structure. Chapter three describes canid reproduction, whilst chapter four provides an introduction to the evolution and distribution of the various species. Topics covered include the fossil record, the process of domestication and some of the recent genetic studies of taxonomy. Chapter five gives a brief introduction to the taxonomic divisions in the family, and the remaining four chapters deal with each species individually, grouping them according to geographical distribution.



The book contains many colour photographs, but the standard of the illustrations varies considerably. Some are extremely good, but many were obviously taken in captivity, and a few species are not shown at all.

Overall the book is nicely laid out, well written and informative, although some of the information is now a little out of date. It is an enjoyable introduction to this fascinating family, and includes a comprehensive reading list for those wishing to explore the topic further.

Laura Handoca



Swift Fox Recovery Team Meeting

An interesting and productive meeting of the swift Fox Recovery Team (held in Medicine Hat, Alberta, Canada on 19–20th April 1995) resulted in the decision to increase the number of swift fox (*Vulpes velox* / *V. v. hebes*) to be released in the programme's second major reintroduction site, Grassland's National Park and its environs.

This decision took into account the research of Dr. Dale Hjertaas (Saskatchewan Parks and Renewable Resources; see Table 1) which indicated that there was no statistical difference between the relative survival success of reintroduced wild-caught swift fox (imported from Wyoming) and captive-bred reintroduced swift fox.

The preliminary results of the call and response survey (method developed by the Cochrane Ecological Institute), undertaken by the Saskatchewan government (Wayne Harris), illustrated clearly that the pilot project method was serviceable as a means of population estimation but required more research and work to make it a totally reliable tool. This is presently being undertaken by Philip Stevens, of the Cochrane Ecological Institute (CEI).

The (CEI), in collaboration with Resources (SPRR) in Grasslands National Park and Southern Saskatchewan, is currently working to establish swift fox occurrence and verify swift fox sightings and densities. Release sites in Saskatchewan for the 1995 captive bred and wild caught swift fox will be determined on the information collected by SPRR and CEI.

A major change in the management protocol for wild-caught imported swift fox has recently been instituted by the Federal and Provincial government authorities involved in the Canadian reintroduction: the 30 day quarantine period for wild caught, imported U.S. swift fox has been abolished. Throughout the programme, imported swift fox have undergone 30 days to three months quarantine prior to release. As a result of the change in protocol this will no longer occur.

It is unlikely that wild-caught, imported, translocated, unquarantined swift fox will be released in Grassland's National Park, as the park holds Canada's only colonies of the re-introduced black-tailed prairie dog (*Cynomys ludovincencis*), a species extremely susceptible to sylvatic plague (*Yersina pestis*). The method by which sylvatic plague spreads from prairie dog to prairie dog is not fully understood, but if it is introduced into a prairie dog town it will result in the eradication of that town's prairie dog population. *Yersina pestis* is, as yet, unknown in Canada although prevalent in the U.S. It is found in the areas of Wyoming from which the wild-caught swift fox intended for the Canadian reintroduction programme are taken. Relatively little work has been done on the parasites and diseases of swift fox (Twelve-Month Administrative Finding on Petition to List the swift Fox, U.S. Fish & Wildlife Service, April 14, 1995). However, a study undertaken in Wyoming (Survey of Carnivores for Disease in the Shirley Basin, Wyoming in 1992, Williams *et al.*) showed that of the swift foxes examined, 100% tested seriopositive for sylvatic plague.

Swift fox from the captive breeding programme will be added to the Alberta "core" release site if captive-bred cub numbers are higher than 50, in which case the number of animals destined for release will be split between Alberta and Saskatchewan.

Axel Moehrenschlager and Jasper Michie's research in the Alberta "core" release area constitutes the first substantial radio-tracking study of swift foxes in Canada and is producing copious valuable information for the future management of the programme.

Clio Smeeton

(photo by Laura Handoca)

	3 month	6 month	9 month	12 month
(A) MINIMUM KNOWN SURVIVAL (alive divided by total cohort)				
Spring Captive	14%	14%	14%	0
Autumn Captive	57%	47%	30%	13%
Wild	61%	50%	38%	19%
(B) MINIMUM KNOWN SURVIVAL (alive divided by alive plus dead) EXCLUDING UNKNOWNS				
Spring Captive	17%	17%	14%	0
Autumn Captive	57%	43%	33%	18%
Wild	69%	60%	40%	25%
(C) SURVIVAL AS ESTIMATED BY DAILY MORTALITY RATE				
Spring Captive	13%	—	—	1.5%
Autumn Captive	55%	—	—	17%
Wild	73%	—	—	11%

Table 1. Comparison of survival between captive-raised spring release, captive-raised autumn release and wild transplanted swift foxes in the Wood Mountain Area.

Canids in the southeastern Arabian Penninsula

At the request of the Arabian Leopard Trust, the authors undertook a vertebrate survey of the Hajar Mountains and the southern reaches of the Rus al Jibal that fall within the United Arab Emirates, from March to the middle of May 1995. Although the primary goal was to establish the current couservation status of the leopard (*Panthera pardus nimr*) in these mountains, the opportunity was taken to compile information on a wide variety of other mammals occurring here, as well as birds, reptiles, amphibians and fish.

Two canid species have previously been recorded from the mountain ranges and vicinity of the United Arab Emirates (UAE); the current survey discovered a third:

Arabian wolf	*Canis lupus arabs*
Arabian red fox	*Vulpes vulpes arabica*
Blanford's fox	*Vulpes cana cana* **(new record)**

The only other canid species occurring within the UAE is Rüppell's fox (*Vulpes rueppellii sabaea*) but this species is entirely restricted to sand areas. There are unsubstantiated records of the presence of the Asiatic, or common jackal (*Canis aureus*) but we obtained no information that would indicate that it occurs at the present time in the areas we surveyed.

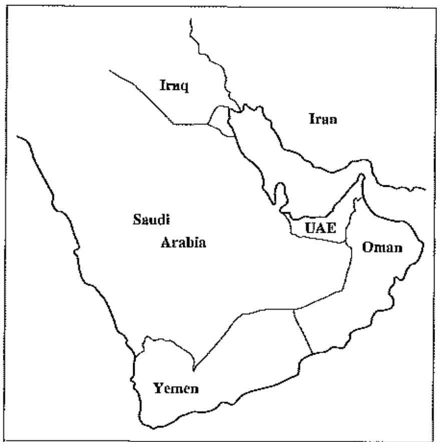


Figure 1. Location of the United Arab Emirates on the Arabian Peninsula.

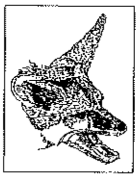
Type	Exact locality (GPS)	Altitude	Habitat
Live-capture	[illegible] N [illegible] E	[illegible] m	Steep mountain slopes; wadis
Hair sample, clear tracks	[illegible] N [illegible] E	270 m	Rugged hills; narrow rocky valley
Droppings, tracks	[illegible] N [illegible] E	400 m	Low ridges above rocky wadi; ringed by higher ridges

Table 1. Locality details for Blanford's fox recorded in the UAE (see Figure 2).

Animal	Date	Head & Body	Tail	Hft	Ear	Scrotum
Male 1	17/03, 24/03	440 mm	327	91	67	18
Male 2	19/03, 26/03, 27/03	455 mm	345	100	91	20
Female 1	20/03	390 mm	317	88	57	–

Table 2. Details of the three Blanford's foxes trapped, marked and released at Wadi Ziqt, Emirate of Fujairah (UAE).

Blanford's Fox, *Vulpes cana*



The first records of the occurrence of the Blanford's fox from Arabia were noted in 1981, with animals being sighted and captured in Israel (Palestine) and Sinai (Egypt). It is doubtful that these were recent immigrants; a more likely explanation is that established populations were overlooked in an arid and relatively hostile environment (Ilani, 1983; Mendelssohn *et al.*, 1987; Geffen *et al.*, 1993). Two specimens of this species were caught at Jabal Samhan in the Dhofar of the Sultanate of Oman (Harrison & Bates, 1989), and a road casualty was recorded 40 km south-east of Biljurshi in Saudi Arabia. There is a photographic record from the nearby Jabal Shada (Harrison & Bates, 1991).

If one excludes the records from Israel (Palestine) and the Sinai (Egypt) then only four specimens of this small desert fox have been recorded from three localities in the actiual Arabian Peninsular (see Geffen & Macdonald in Canid News 2, p. 24). The current survey live-trapped and photographed three individual Blanford's foxes at one location in the Hajar Mountains (UAE), located a hair sample and clear tracks of an animal that escaped from a live-trap at a second location and collected droppings at two other sites that bore a close resemblance to those previously collected from trapped animals (see Fig. 1). Through an Arab-speaking colleague we were able to determine that this fox is known to tribesmen living in the Rus al Jibal mountains within the UAE, adjacent to and extending into the northernmost territory of the Sultan of Oman. They clearly distinguished between the Arabian red fox and this species, giving accurate descriptions, particularly mentioning its small size, black-tipped tail and the fact that it moved easily on the cliffs and in the boulder strewn upper reaches of the wadis. As with all mammalian carnivores occurring in the area, they are actively hunted by man.

Harrison and Bates (1991) stated that it was probable that Blanford's fox inhabits other montane areas in Arabia, but has yet to be recorded. The current records for south-eastern Arabia bear out this belief. It is our opinion that this small fox will be found to occur more or less continuously in the mountains bounding on the Indian Ocean and Red Sea seaboards of Arabia when more extensive trapping is undertaken. In addition, given the nature of the terrain in the zoologically poorly-explored Red Sea hills of Africa and the recent geological union of this continent and Arabia, there is a distinct possibility that Blanford's fox could be the continent's twelth canid species!

Several points of interest were noted during the examination of these animals. In particular male 1, unlike typical Blandford's fox with a black-tipped tail, had a distinctive white tip to the tail but in all other respects was typical of the species. Male 1 and male 2 are illustrated in the photographs. The only female caught was lactating (6 mammae) and the area of the belly was largely naked of hair.

Both male foxes gave regular harsh screaming yaps when we approached the cages but the female did not call at any stage. Male 2 on each of the three releases gave a few short yip-calls after halting at the foot of a steep wadi cliff some 50 m from the trap, and at 100 m away in the opposite direction. On all three occasions male 2 followed exactly the same route after release, across the wadi bottom and up the facing cliff. Despite extensive searches no trace was found of the animal's resting site. Male 1 on both releases made for the same cliff as male 2 but after pausing briefly at its base, crept into a narrow cleft in the rock where it remained for several minutes before emerging to continue over the ridge. The only female trapped on release ran to the wadi bottom and moved up the bed in the opposite direction from that taken by the males on the total of five releases.

Only five positively identified Blanford's fox droppings were available for analysis; three were removed from the traps, two from a ridge close to the trapping locality. Feathers from quail used as bait were present in two droppings but the only other food remains in all five samples were the skins and pips of the fruit of the sidr tree (*Ziziphus spina-christi*). Several of these trees were located in close proximity to the trap-site and most were laden with fruit. The foxes almost certainly harvest these fruits from the ground. Densities of potential prey species, such as rodents, reptiles and birds within the study area were extremely low and this could account for foxes relying on a temporarily abundant food resource. Numbers of invertebrates were also surprisingly meagre at the time of the study, but numbers of grasshoppers, tenebrionid beetles and lepidopterans increased dramatically shortly after the onset of the rains when we left the area. Two droppings collected at the third locality given in the table contained numerous seeds from the fruit *Ficus salicifolia*. [See box of recent literature concerning Blanford's fox]

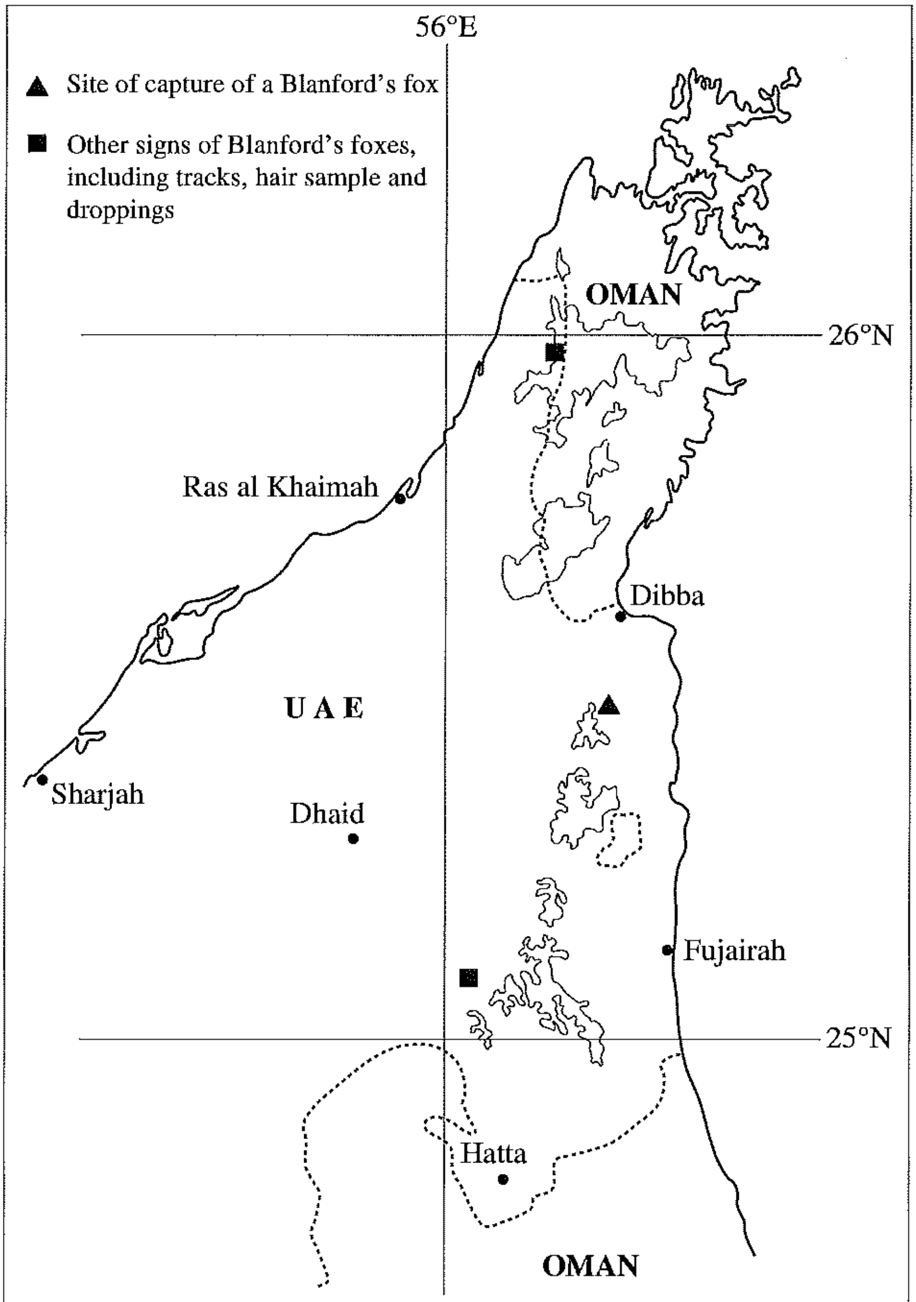


Figure 2. *Location of Blanford's fox in the UAE.*

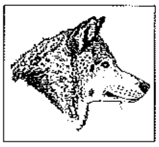
Recent Blanford's fox publications

[illegible]

Figure 3. Male 2 Blanford's fox, showing normal black tail tip.

Figure 4. Male 1 Blanford's fox, showing aberrant white tail tip.

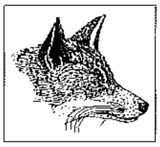
Arabian wolf, *Canis lupus arabs*



Harrison and Bates (1991) record the only confirmed Arabian wolf from the mountainous area of the UAE, from Dibba, lying adjacent to the northern Omani territory (25°43´N; 56°15´E). During the course of the current survey we found no indications of the presence of the Arabian wolf in the mountaius of north-eastern UAE, although from interviews it became obvious that it had occurred here in the recent past. Despite the extensive nature of our survey it is possible that animals do still survive in the rugged mountain fastness, although it is rather unlikely that viable numbers of wolves remain. It is probable, however, that small numbers of wolves do survive in the northernmost Omani territories (Rus al Jibal), within the extensive system of deep wadis and gorges. This is also the area in which the last surviving population of Arabian leopard is centred iu the UAE/Oman border region. If adequate protection is given to these predators and their natural prey species it is highly likely that they would repopulate the Hajar mountains to the south. The setting aside of montane sanctuaries would, however, be inadequate on its own since it is unlikely that either the wolf, or leopard for that matter, could be maintained in viable numbers within sanctuaries covering less than a few hundred square kilometres.

A number of recent reported sightings of "wolves" appear to have been either of feral dogs, or wolf/dog hybrids, and in at least one case, an Arabian red fox. Hybridisation between domestic dogs and wolves could pose a serious threat to any attempts to conserve this, Arabia's largest canid.

Arabian red fox, *Vulpes vulpes arabica*



This is by far the most abundaut and widespread of the canids occurring in the UAE, even in the montane areas. During the course of this survey we found them at all the locations we checked, from Sharm in the western Al Hjir al Gharbi foothills in the Sultanate of Oman, northwards through the Hajir Mountains (Shumayliyah) of the UAE and in the western reaches of the Rus al Jibal of northernmost Oman (sometimes referred to as the Musanda). There was little evidence of their presence in the higher mountains, or those wadis that penetrated deep into the mountain chains, but in the foothills and particularly in the vicinity of small rural settlements they occurred at the highest densities. In the latter case they appeared to be relying on waste discarded by peasant farming communities. Farmers complained that the species frequently raided their poultry and took very young goat kids, and as a result were extensively trapped and shot.

Acknowledgements:
The funding for the survey was provided by the Arabian Leopard Trust, Dubai (UAE) under the patronage of H.H. Dr Sheikh Sultan bin Mohammed al Qasimi, and their various sponsors. The African Carnivore Research programme wishes to thank Maryke Jongbloed , Moas Sawaf, Tim Turner and Christian Gross for their support; Central Military Command, Dubai for providing helicopter transportation into remote mountain areas.

Literature Cited

Harrision, D. L. & Bates, P. J. J. 1989. Observations on two mammal species new to the Sultanate of Oman, *Vulpes cana* Blanford, 1877 (Carnivora : Canidae) and *Nycteris thebaica* Geoffroy, 1818 (Chiroptera : Nycteridae). Bonner zool. Betir.. 40(2) : 73-77

Harrison, D. L. & Bates, P. J. J. 1991. The mammals of Arabia. Harrison Zoological Museum Publication, Kent, England.

Ilani, G. 1983. Blanford's fox *Vulpes cana* Blanford, 1877, a new species in Israel. Israel J. Zool. 32 : 150

Mendelssohn, H., Yom-Tov, G. & Meninger, D. 1987. On the occurrenece of Blanford's fox *Vulpes cana* Blanford, 1877, in Israel and Sinai. Mammalia 51(3) : 459-462

Chris & Tilde Stuart

Ethiopian Wolf Thesis

There are a few copies remaining of Claudio Sillero-Zubiri's doctoral thesis entitled "Behavioural Ecology of the Ethiopian Wolf (*Canis simensis*)". If you would like a copy, please send a cheque for £18 (payable to Claudio) to Dr. Sillero Zubiri, c/o WildCRU, Department of Zoology, Oxford University, South Parks Road, Oxford, OX1 3PS, UK.

A Survey of African Wild Dogs in Southeastern Sénégal

The endeavour to conserve the endangered African wild dog (*Lycaon pictus*) has focused on eastern and southern populations, a bias acknowledged in recent wild dog conservation plans that list population surveys and research in western Africa amongst their priorities. The largest remaining wild dog population in West Africa, and the best prospect for long-term conservation, is probably the one found in southeastern Sénégal, in and around the Niokolo-Koba National Park (NKNP). Wild dog sightings have been reported regularly there suggesting that the species may occur at reasonable densities. A field survey of NKNP was carried out in November – December 1995 in order to determine the presence and status of the wild dog population in that area. The study consisted of a 10 day ground-search of NKNP and adjacent areas, and a series of interviews with park staff and hunt guides to review evidence of wild dog presence. Wild dogs were not observed during the visit. However, 21 interviews and analysis of 70 wild dog sightings reported revealed that wild dogs were present in NKNP and its surroundings and that they have been present there regularly in the last 20 years. Wild dog packs have been sighted at all times of year and have bred periodically there. Furthermore, a majority of the respondents believed that the wild dog population was on the increase. The main prey species reportedly hunted by wild dogs were bushbuck and Buffon's kob. Whilst wild dogs are feared by local people, they are not perceived as a serious risk to livestock. On the basis of the findings of this survey it would be valuable to carry out a full-time field study of wild dogs in NKNP, in order to estimate their abundance, conservatiou status and the extent of the demographic links existing with other populations in the region.

The survey was sponsored by Licaonė Fund. By means of a wild dog monitoring system we set up in NKNP we have information of many wild dog sightings, including breeding packs,

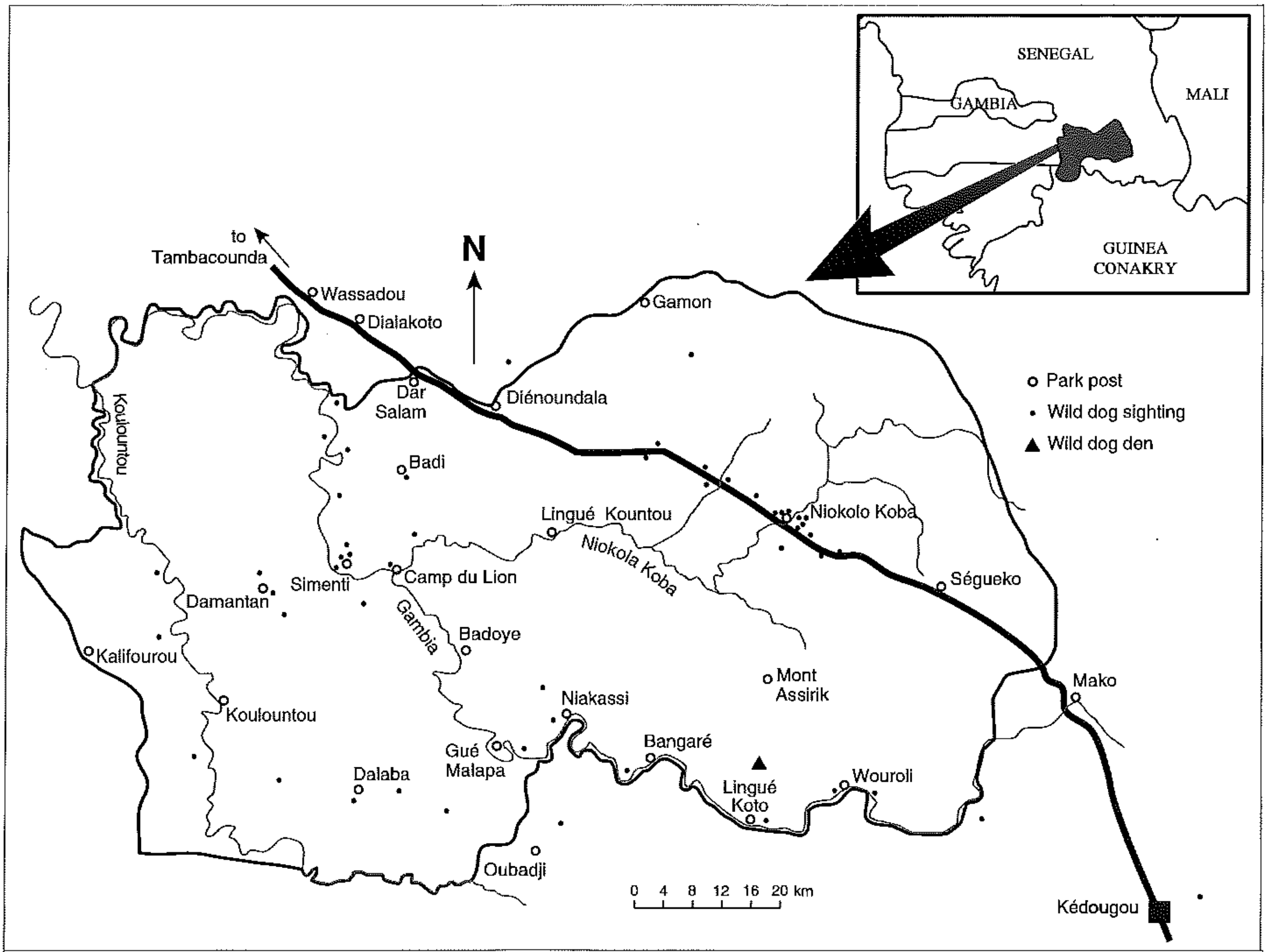
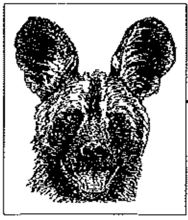


Figure 1. Map of Niokolo Koba National Park, Senegal, showing locations of wild dog sightings from 1972-1994, as reported by interviewees.



during the last six months. A field study on the demography and ecology of the Niokolo-Koba wild dog population will hopefully start in November 1995 with the support of Licaone Fund and the Born Free Foundation under the aegis of the Canid Specialist Group.

Claudio Sillero-Zubiri

This report forms the Summary of the publication: Sillero-Zubiri, C. (1995). A survey of African wild dogs in southeastern Senegal. IUCN/SSC Canid Specialist Group, Oxford. 20 pp.

African wild dogs in the Selous Game Reserve

Covering 43,000 km² of woodland habitat suitable for African wild dogs, the Selous Game Reserve is the single most important reservoir for African wild dogs (*Lycaon pictus*) on the continent. The goal of our study of wild dogs in Selous is to determine why wild dogs are rare throughout Africa, even in protected areas with suitable ecological conditions. On the regional and continental scale, an important first step is to document the wild dog's distribution, with estimates of the sizes of major populations. This report provides an estimate of the total population size for wild dogs in the Selous Game Reserve.

Since June 1991, we have concentrated our direct research on a study area of 2,600 km² in the Northern Sector of the Selous. As of November 1993, this area holds 151 wild dogs (103 adults and 48 pups). This yields a population density of 1 dog per 17 km², and 1 adult per 25 km². When compared with published densities of wild dogs in other protected areas (Fuller *et al.*, 1991), this number is quite high. Table 1 summarizes the composition of the six radio-collared packs, one uncollared pack, and two unisexual groups in the focal study area.

Although the healthy population in the Northern Sector is welcome news for wild dog conservation, direct extrapolation to the rest of the reserve would be likely to yield a serious overestimate of the total population. The vegetation of the Northern Sector is more variable than is typical of the Selous as a whole (Rogers, 1979), and the density of major prey species is higher than in other areas (Borner, 1981; Campbell, 1989; 1991).

Rather than extrapolating from data collected on the intensive study area, we have estimated densities from sightings of wild dogs for three areas south of the Rufiji River. This analysis used sightings from managers, scouts and hunters collected from 1990-1993. Information on pack size, composition and location are used to identify independent packs. Density estimates based on sightings have been confirmed as accurate for wild dogs in Botswana (J. W. McNutt, pers. comm.) and in northern Selous. In 1991-92 we used sightings to estimate that our intensive study site held 8 packs and 136-142 wild dogs. Using radiocollaring and a photo-identification file, we have subsequently found that the area holds 7 packs and 151 wild dogs. Thus, the population estimate based on sightings underestimated the population by 6-9%. Used cautiously, sighting programmes can yield good estimates of population density.

For most of the reserve, sightings were insufficient to allow meaningful analysis, and we have restricted our density estimates to three areas. Areas used are Blocks K4 and K5 in the west (1583 km²), Block LU2 in the south (1935 km², and portions of Blocks LL1, LL2, LL3 and RU1 in the east (3890 km²). Collectively, these areas cover 7408 km². Combining estimates from these areas with direct data from our study area (2600 km² in blocks Z1, MK1, KY1, B1 and Y1) gives density estimates based on 10,008 km², or 23% of the reserve. Density estimates are given by area in Table 1.

Sector	Estimate of Area	No. of Adults	Density	Comments
West	1583 km²	39	1 ad/41 km²	2 packs, no ID'd
East	3890 km²	63	1 ad/62 km²	6 packs, 1 collared
South	1935 km²	32-39	1 ad/55 km²	3-4 packs, some ID'd
North	2600 km²	103	1 ad/25 km²	7 packs, all ID'd

Table 1. Density estimates for wild dogs in the Northern, Southern, Eastern and Western sectors of Selous.

Figure 1. Map of Selous, showing the area (10,000 km²) for which wild dog density was estimated.

A) ANIMALS IN COLLARED PACKS			
Pack	Adults	Pups	Total
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
Collared Packs	84	48	132
B) OTHER WILD DOGS			
Uncollared	9		9
[illegible]	3		3
[illegible]	7		7
Total Pop. Size	103	48	151

Table 2. African wild dogs in a 2,600 km² area in Northern Selous.

The mean density for areas other than the north (using a weighted mean based on areas) is one adult per 56 km², almost identical to the average for other woodland areas (Fuller *et al.*, 1991). Extrapolating a density of one adult per 56 km² over 38,000 km² and a density of one adult per 25 km² to 5,000 km² in the northeast yields a total population size of 879 adults within Selous.

In Selons, the wild dog population peaks annually in September/October. At this time, adults comprise 68% of the total population. At the annual peak, the total population (including pups) probably numbers about 1,300 wild dogs. Mikumi National Park is contiguous with the Northern Sector of Selous, and the wild dogs of the two areas almost certainly form a single population. Using photographs and sightings, we have estimated the wild dog population for Mikumi National Park to be between 93-135 adults (Creel & Creel, 1993). Overall, we estimate the Selous-Mikumi wild dog population at 972 adults.

It is also noteworthy that wild dogs commonly use the open hunting areas adjacent to the Selous, and are sighted as much as 50 km from the reserve boundary. The density of prey species falls off considerably outside the reserve, so that the wild dog density is likely to be lower than within the reserve. However, it should be noted that our estimate of 972 adults for Selous-Mikumi does not include the dogs found within Game Controlled Areas and unprotected areas.

Given that recent estimates of the number of adult wild dogs in viable populations fall between 2,000 and 3,000, the large, healthy population in Selous Game Reserve will be an important reservoir for wild dogs on the continental scale.

Acknowledgements
This research was funded by the Frankfurt Zoological Society – Help for Threatened Animals Project 1112/90, The Smithsonian Institution Scholarly Studies Program, and NSF–NATO.

Literature Cited

Borner, M. 1981. Selous Census 1981. Ministry of Natural Resources and Tourism, Wildlife Division, Tanzania.

Creel, S. & Creel, N. M. 1993. Conservation of African wild dogs; a photographic census in Mikumi National Park. Unpublished report, Frankfurt Zoological Society, Project 1112/90.

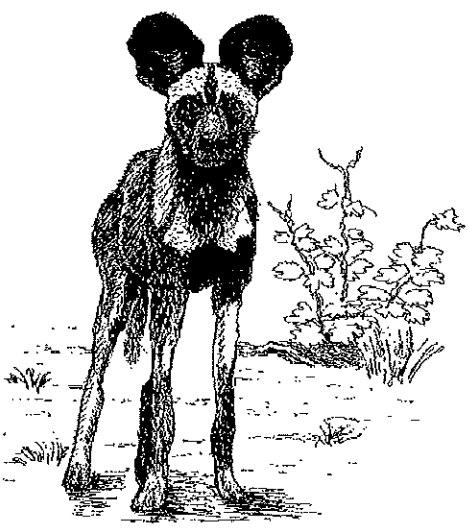
Campbell, K. L. I. 1989. Tanzania Wildlife Division Selous Census, 1989. Unpublished report, Tanzania Wildlife Conservation Monitoring.

Campbell, K. L. I. 1991. Tanzania Wildlife Division Selous Census, 1991. Unpublished report, Tanzania Wildlife Conservation Monitoring.

Fuller, T. K., Kat, P. W., Bulger, J. B., Maddock, A. H., Ginsberg, J. R., Burrows, R. McNutt, J. W. & Mills, M. G. L. 1992. Population dynamics of African wild dogs. In: Wildlife 2001: Populations, eds, D. R. McCullongh & R. H. Barret. Elsevier Applied Science Publishers, London, pp. 1125-1139.

Rogers, W. A. 1979. The ecology of large herbivores in the miombo woodlands of south eat Tanzania. Ph.D. Dissertation, University of Nairobe, Nairobe, Kenya.

Dr. S. Creel & N. M. Creel



Wild Dog Sighting in Laikipia, Kenya

Oscar Mascagni, one of the founder members of the "Licaone Fund" recently met the manager of a large ranch in the Kenyan district of Laikipia, Mr Claus Mortensen who became so interested in the aims and activities of our organization that he sent some of his men to patrol a large area of North Kenya looking for wild dogs. In June 1994 the search was successful: a pack of 7-8 animals was sighted. They were observed between the northern border of Samburu Game Reserve and the village of Wamba, near Matthews, range. They were probably all or part of a pack that had been reported to be ranging on the east side of Matthew's range.

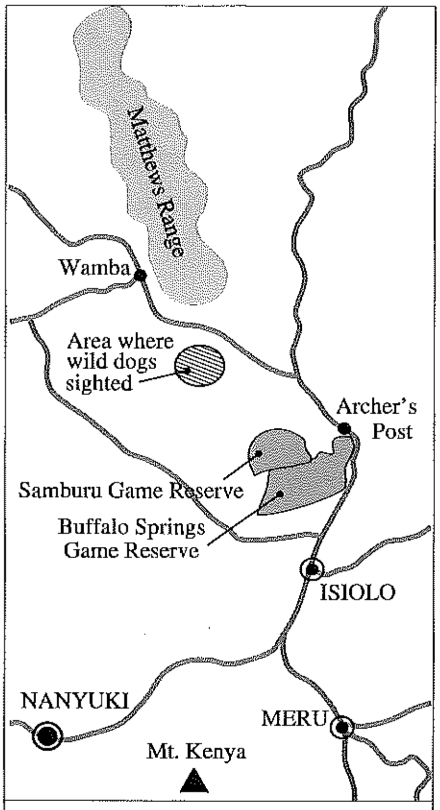


Figure 1. Map showing the location of the wild dog sighting relative to nearby roads, towns and other landmarks.

These wild dogs live in a semi-arid area with a low population and for this reason there is some hope for their survival. The "Licaone Fund" will try to have this pack observed at regular intervals.

Reproduced from *il Licaone* by kind permission of Andrea Maggi of the Licaone Fund. If you would like further information please contact the Licaone Fnnd at the address below. Both the Licaone Fund and Dr. Claudio Sillero-Zubiri at the WildCRU in Oxford wonld be pleased to receive information on other African wild dog sightings.

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Coyotes: Victims of their own Success *Marc Bekoff*

The coyote is highly adaptable, exhibiting many behavioural variations under different ecological circumstances. It continues to thrive despite considerable human persecution.

Introduction

Coyotes, *Canis latrans* Say, 1823, are medium-sized, sexually dimorphic, nearctic carnivores, originally inhabiting open country and grasslands. They continue both to amaze and to antagonize people because of their incredible success in resisting increased attempts by some humans to control and manage them, both by the random killing of individuals (including brutal planned community hunting) and by the use of frequently very inhumane methods that are rarely effective (Knowlton, Windberg, and Wahlgren, 1985; Scanlon, 1991; Fitzgerald, 1993).

Marc Bekoff is in the Department of Environmental, Population, and Organismic Biology, University of Colorado. In the past he has studied the social behaviour and behavioural ecology of various canids, especially coyotes. He is also very much interested cognitive ethology and animal welfare.

Coyotes can adapt to diverse habitats and show considerable variations in social behaviour and social organization which are closely related to food resonrces (for discussion, see the following representative references from which this brief summary is taken: Bekoff, 1977a, 1978, 1982; Camenzind, 1978; Bowen, 1981, 1982; Messier & Barrette, 1982; Bekoff, Gittleman, & Daniels, 1984; Pyrah, 1984; Bekoff & Wells, 1986; Gese, Rongstad, & Mytton, 1988a,b; Mills & Knowlton, 1991; Thurber & Peterson, 1991; Harrison, 1992; Holzman *et al.*, 1992; Larivière & Crête, 1993; Peterson & Thurber, 1993; Bright, 1993).

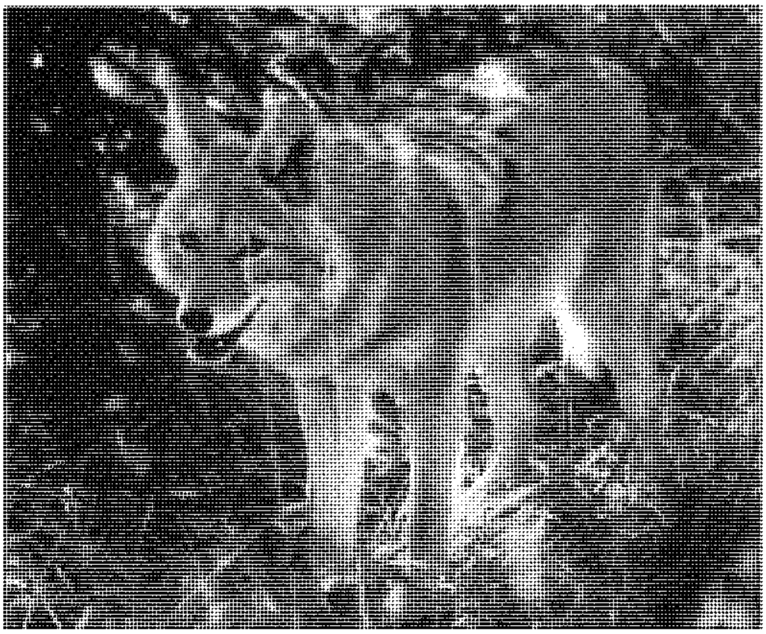
The decline of competitors such as grey wolves (*C. lupus*) and possibly cougars (*Felis concolor*; Boyd & O'Gara, 1985) was probably an important factor contributing to the range expansion and increasing success of coyotes. Overgrazing by livestock resulting in a more hospitable habitat for the small rodents on which coyotes prey might also have been influential. While coyotes are revered by many native American Indians (Bright, 1993), they also engender bitter hatred from some people who unjustly blame them for numerous ills. It is this hatred which forces us to confront many ethical issues that center on the control and management of wild predators. This topic will be covered in detail in an article in Canid News issue 4.

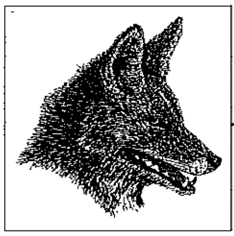
Distribution, Morphology & General Characteristics

Highly mobile (they can reach speeds of 48 km/hr) and opportunistic, coyotes currently thrive in virtually all types of habitat ranging from arid warm deserts, to wet grasslands and plains, to forests, to colder climates at high elevations (up to about 3000 m), to large urban cities such as Los Angeles, California. They are now found between about 10° north (northern Alaska) and 70° south (Costa Rica) and throughout mainland United States and Canada.

Males are typically heavier (8-20 kg), taller, and longer than females (7-18 kg), although there is significant geographic and subspecific variation among the 19 recognized subspecies. Head-body length ranges from about 1.0-1.6 m, and the tail is about 0.4 m long. Hair is generally longer and coarser in northern subspecies. Coyotes at higher altitudes tend to be grey and black, whereas those in the desert are more fulvous. The belly and throat are paler than the rest of the body, and melanistic coyotes are rare.

Coyotes are usually smaller (lighter and shorter at the shoulder) than grey wolves, but overlap in size with domestic dogs, *C. familiaris*, and red wolves, *C. rufus*. The nose pad and hind foot pad are smaller than in *lupus*, but *latrans* has longer ears. Coyotes usually have a shorter stride than *lupus* and *rufus*. *Latrans* can be differentiated from *lupus* and *familiaris* by dental characters, but these are often unreliable. *Latrans* also can be differentiated from *lupus* by cranial measurements and brain morphology (smaller braincase, zygomatic breadth, and bite ratio, no dimple in the middle of the coronal gyrus, different gross cerebellar morphology) and from *rufus* (narrower skull and less pronounced sagittal crest, different gross cerebellar morphology). They can also be distinguished from *lupus* and *familiaris* using serological and behavioural measures; coyotes are typically more aggressive as infants than either of these canids. Fur is of approximately the same insulative value as that of *lupus*.





Behaviour & Behavioural Ecology: a Lesson in Adaptability

Coyotes are frequently portrayed as cunning tricksters, gluttons, outlaws, spoilers, and survivors in American mythology and in Native American tales. These characterizations are based mainly on this maligned predator's uncanny ability to survive and reproduce successfully in diverse locations and in extremely harsh conditions, even during unrelenting and abusive onslaughts by humans. It is important to emphasize the incredible adaptability and particularly the behavioural variability of coyotes; references to the way in which "the" coyote lives can be misleading.

Studies of coyotes allow different behavioural patterns to be analyzed as phenotypic adaptations to local conditions (Bekoff & Wells, 1986). In some places coyotes live like typical grey wolves – in resident packs that are essentially closely-knit extended families consisting of overlapping generations of parents, young-of-the-year, and helpers of varying genetic relatedness. In other habitats they live either as resident mated pairs or as transient single individuals showing little or no site attachment. The mated pair seems to be the basic social unit.

The relative frequency with which different social groups are observed can vary from location to location and seems to depend mainly on the nature of food resources (Camenzind, 1978; Bowen, 1981; Bekoff & Wells, 1986; Gese, Rongstad, & Mytton, 1988a; see also Gese, Rongstad, & Mytton, 1988b). Pack members share in territorial defence and some serve as helpers for rearing young and for defending territories outside the breeding season. At least in northern climates, packs typically form when there is sufficient food in late autumn and winter to allow young-of-the-year to form strong social bonds with older pack members; this results in some young-of-the-year remaining with their parents and older siblings.

Diet and Hunting Behaviour

Coyotes enjoy a catholic diet including plant and animal matter (including reptiles; Hernández, Delibes & Hiraldo, 1944) and inanimate objects. Although coyotes are opportunistic predators, they can also be very selective hunters in certain situations (e.g. Hernández & Delibes, 1944). Diet varies greatly both seasonally and geographically, as do the methods by which prey are acquired. Coyotes are active predators relying primarily on vision whilst hunting, and they have been observed to fish and climb trees in pursuit

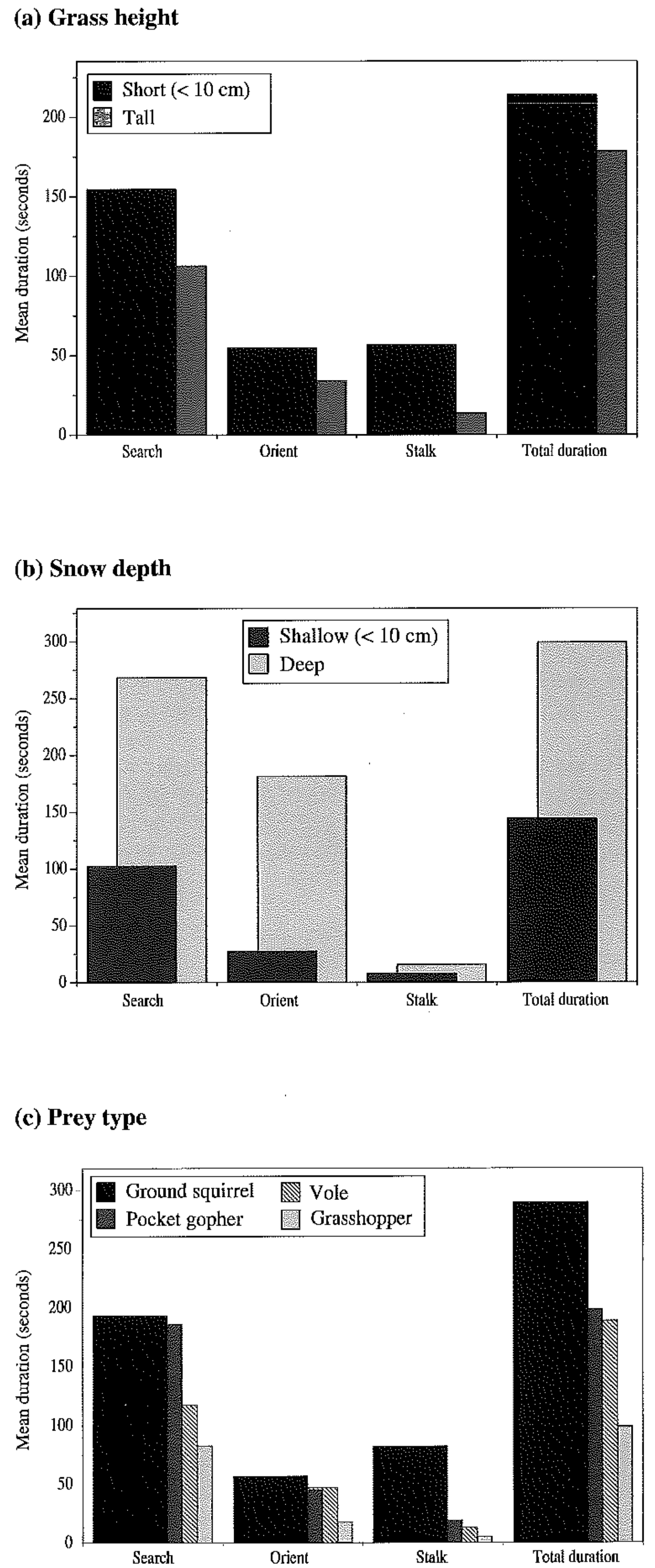


Figure 1. *Mean durations of types of predatory behaviour in relation to habitat variables and prey type. See Table 1 for data.*

of food. They are also successful scavengers. The success of hunting attempts varies with age, prey type, grass height, and snow depth.

A study by Bekoff & Wells (1986) showed that adults and juveniles were about equally successful when they hunted small rodents (about 20-25% of the time). Adults and juveniles also enjoyed their highest success rate when they hunted gophers and were least successful when they hunted voles. Coyotes were also more successful when they hunted small rodents in short grass and shallow snow. Wind conditions did not influence hunting success. This trend is consistent with the notion that vision is more important to coyotes than olfaction (or audition) when they are hunting small rodents. Grass height (c.f. snow depth, wind conditions, and prey type) accounted for the greatest amount of variation in the duration of searching and orienting.

> *"Coyotes are active predators relying primarily on vision whilst hunting, and they have been observed to fish and climb trees in pursuit of food"*

Higher rates of hunting success on small rodents seem to be associated with greater variability of predatory sequences, suggesting that coyotes vary their behaviour according to the immediate situation in which they find themselves. Furthermore, average stalking duration during successful hunts is longer than average stalking duration during unsuccessful hunts.

For the most part, large ungulates who are actively sought by coyotes do not constitute a major portion of their diet except when alternative food is scarce or when young, old, sick, or otherwise defenceless individuals are encountered.

Breeding and Dispersal

Coyotes are almost always monogamous and pair bonds between a male and female can last more than four years. In packs usually only one pair mates per season. Both males and females are able to breed during their first year of life, usually when they are about 9-10 months old. Females show one oestrous cycle per annum, and males also appear to go through an annual cycle of spermatogenesis. Oestrus lasts about 2-5 days and ovulation occurs about 2-3 days before the end of female receptivity. Coyotes typically breed once a year, in early-to mid-winter, depending on location. Courtship can last for as long as 2-3 months before mating takes place, and during copulation the male and female become tied to one another. The gestation period averages 63 days (58-65) and mean litter size is about six pups with an even sex ratio at birth; litter size can vary with population and prey density. Pups are born blind and helpless, usually in an excavated den. They emerge from the den at about 2-3 weeks of age, and are weaned at about 5-7 weeks of age. Mortality is typically highest during the first year, and greatest life expectancy seems to be between about 2-8 years of age. Mortality depends greatly on the level of exploitation to which populations are exposed. Coyotes can live as long as 18 years in captivity, but in the wild few live longer than 6-10 years. Coyotes can produce fertile hybrids when they mate with grey wolves, red wolves, domestic dogs, or golden jackals.

Dispersal of young-of-the-year from their natal area usually occurs between 4-10 months of age; although some individuals disperse after they are one year old. Only rarely will an entire litter remain intact for longer than a year. There does not appear to be any sex differences in the proportion of individuals which disperse or in the time period or distance individuals travel before they settle down (if they do settle down). Dispersal by young animals is highly risky; dispersing individuals generally suffer much higher mortality than do their sedentary peers who remain in their natal group in the area in which they were born (Bekoff & Wells, 1986; Harrison, 1992).

Causes of dispersal are unknown, although there appears to be an association between food availability and dispersal. When there is more than enough food for the mated pair, competition among individuals is reduced, social bonds are more likely to form among at least some group members, and the likelihood for dispersal is reduced (Bekoff, 1977b; see also Harris & White, 1992; White & Harris, 1994). It remains unclear whether or not aggression among young or between

	GRASS HEIGHT			SNOW DEPTH			PREY TYPE				
Act	Short (<20 cm)	Tall	p	Shallow (<11 cm)	Deep	p	Ground squirrel	Pocket gopher	Vole	Grasshopper	p
Search	136.6 (148.7)	116.3 (97.5)	0.004	100.5 (85.8)	56.9 (107.0)	0.182	191.2 (178.5)	89.8 (134.8)	117.4 (118.9)	82.5 (82.3)	0.001
Orient	56.5 (65.4)	32.0 (33.5)	0.024	37.4 (28.6)	18.4 (26.9)	0.008	58.7 (55.9)	46.6 (38.1)	47.0 (58.4)	12.7 (17.8)	NS
Stalk	56.4 (81.7)	11.6 (23.8)	0.006	7.8 (4.7)	15.7 (8.5)	0.05	82.1 (102.0)	120 (136.1)	12.9 (12.2)	5.1 (6.7)	0.003
Total duration	213.8 (195.5)	178.4 (125.4)	NS	144.2 (101.2)	295.1 (289.0)	0.02	250.7 (230.7)	158.1 (175.0)	188.8 (145.1)	99.7 (76.0)	0.001

Table 1. Mean duration (in seconds) of three predatory acts and total sequence length in different habitats and for encounters with four different prey types (from Bekoff & Wells, 1986). See Figure 1 for graphical representation.

adults and young plays a role in dispersal, but available data do not support this notion (Bekoff, 1977b). Some dispersing individuals continue to live as transients, whereas some join up with another individual(s) with whom they associate for varying periods of time. It is not known whether coyotes who disperse are more likely to breed than are more sedentary individuals.

Social Organization and Territory Size

Food supply appears to be a major factor influencing social organization and the use of space in some, but, not all studies (for review see Bekoff and Wells, 1986; see also Gese, Rongstad, & Mytton, 1988a). When packs form, defence of food and territory is shared by pack members. Bekoff & Wells (1986) found that it took an average of more than two individuals (more than just a mated pair) to deter intruders successfully. Packs are also frequently found around dead ungulates such as deer, elk, and moose, and while coyotes will kill these animals, there are few actual observations of this event; often packs merely congregate around carcasses of animals which died of other causes.

It is difficult to generalize about the size of coyote home ranges; there are no consistent sex differences. Home ranges can be as large as 50-70 km², but differ regionally and seasonally (with respect to temperature, food supply, the reproductive status of the female, the presence of pups), and also vary according to the age and type of individual who is being studied (transient or more sedentary pack member). Other influential factors include mortality rate (which might be related to food supply), the presence of other coyotes and potential competitors, intensity of exploitation, and the amount of population control to which individuals are subjected (for discussion see Bekoff, 1977a, 1982; Bowen, 1982; Laundré & Keller, 1984; Bekoff & Wells, 1986; Gese, Rongstad, & Mytton, 1988b; Mills & Knowlton, 1991; Holzman, Conroy, & Pickering, 1992).

Communication

Coyotes communicate using a rich repertoire of olfactory, tactile, vocal, and visual signals; many of their social signals are common to other canids (Fox, 1971; Lehner, 1978). Coyotes (usually males) scent-mark using urine in and around territory boundaries and areas of high intrusion by non-pack members. Males also mark during courtship and mating, while travelling, and during aggressive encounters. Marking by females is generally associated with the acquisition and possession of food, with the denning season, and with the location of the den. It should be emphasized that whilst marking by coyotes may serve some territorial function (e.g. urine marks may advertise territorial boundaries), the data-base is not very strong. For example, marks do not seem to serve as barriers through which trespassers will not travel.

"Coyotes communicate using a rich repertoire of olfactory, tactile, vocal, and visual signals; many of their social signals are common to other canids"

Although coyotes do not often groom one another they will frequently rest close to one another, and tactile contact may be important for reinforcing social bonds. Coyotes use vocalizations extensively, and may howl following a reunion, to announce their location, to announce territorial occupancy, or possibly because they 'enjoy' doing so (Lehner, 1978). They display a wide variety of facial expressions, and by combining these expressions with different vocalizations and

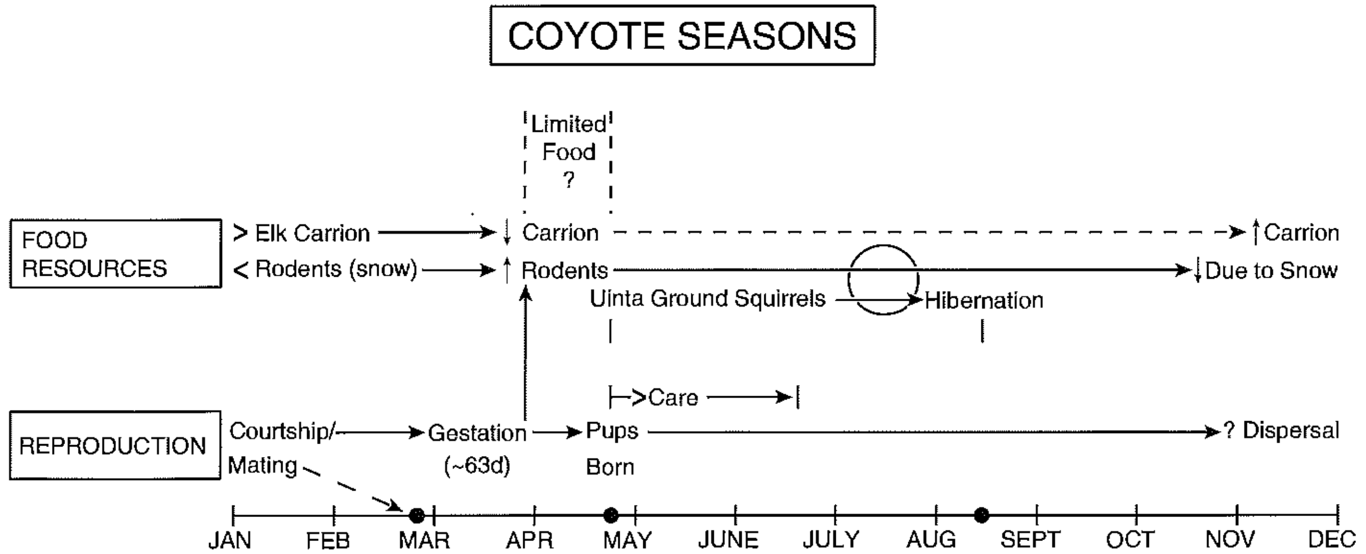


Figure 2. *Annual changes in food resources and patterns of reproductive behaviour shown by coyotes living around Blacktail Butte in Wyoming (from Bekoff & Wells, 1986).*

various gaits, postures, ear positions, and tail positions, they are able to send many subtle messages to other individuals (Fox, 1971).

Respecting Animals during Scientific Investigation

While many people study coyotes and other carnivores because they respect and admire them, there are those who regard these predators as pests which should be eradicated. Thus coyotes and other carnivores often find themselves in serious confrontations with humans who claim that they do extensive damage to livestock and game. As a result of these accusations, coyote populations are subject to control and management programmes involving trapping, shooting and poisoning campaigns. Such tactics raise serious ethical questions about control and handling of animals, some of which apply not only to predator removal, but to scientific research. These issues will be discussed in an article to appear in issue 4 of Canid News.

"While many people study coyotes and other carnivores because they respect and admire them, there are those who regard these predators as pests which should be eradicated"

Literature Cited

Bekoff, M. 1977a. *Canis latrans.* Mammualian Species, 79: 1-9.

Bekoff, M. 1977b. Mammalian dispersal and the ontogeny of individual behavioural phenotypes. Am. Nat., 111: 715-732.

Bekoff, M. 1978. (ed). Coyotes: biology, behavior, and management. Academic Press, New York.

Bekoff, M. 1982. Coyote, *Canis latrans.* In: Wild Mammals of North America: Biology, Management, and Economics, pp. 447-459. Eds. J.A. Chapman & G.A. Feldhammer. The Johns Hopkins University Press, Baltimore, Maryland.

Bekoff, M., Daniels, T. J. & Gittleman, J. L. 1984. Life history patterns and the comparative social ecology of carnivores. Ann. Rev. Ecol. System., 15: 191-232.

Bekoff, M. & Wells, M. C. 1986. Social ecology and behaviour of coyotes. Adv. study Behav., 16: 251-338.

Bowen, W. D. 1981. Variation in coyote social organization. Can. J. Zool., 59: 639-652.

Bowen, W. D. 1982. Home range and spatial organization of coyotes in Jasper National Park. Can. J. Wildl. Manage., 46: 201-216.

Boyd, D & O'Gara, B. 1985. Cougar predation on coyotes. The Murrelet, 66: 17.

Bright, W. 1993. A Coyote Reader, University of California Press, Berkeley.

Camenzind, F. 1978. Behavioural ecology of coyotes on the National Elk Refuge, Jackson, Wyoming. In:

Fitzgerald, J. P. 1993. Furbearer management analysis. Report submitted to the Department of Natural Resources, Colorado Division of Wildlife, Denver, Colorado.

Fox, M. W. 1971. The Behaviour of Wolves, Dogs, and Related Canids. Harper, New York.

Gese, E. M., Rongstad, O. J. & Mytton, W. R. 1988a. Relationship between coyote group size and diet in southeastern Colorado. J. Wildl. Manage., 52: 647-653.

Gese, E. M., Rongstad, O. J., & Mytton, W. R. 1988b. Home range and habitat use of coyotes in southeastern Colorado. J. Wildl. Manage., 52: 640-646.

Harris, S. & White, P. C. L. 1992. Is reduced affiliative rather than increased agonistic behaviour associated with dispersal in red foxes.? Anim. Behav., 44: 1085-1089.

Harrison, D. J. 1992. Dispersal characteristics of juvenile coyotes in Maine. J. Wildl. Manage., 56:128-138.

Hernández, L. & Delibes, M. 1994. Seasonal food habits of coyotes, *Canis latrans*, in the Bolsón de Mapimí, Southern Chihuahuan Desert, Mexico. Z. Saugetierkunde, 59: 82-86.

Hernández, L., Delibes, M. & Hiraldo, F. 1994. Role of reptiles and arthropods in the diet of coyotes in extreme desert areas of northern Mexico. J. Arid Env., 26: 165-170.

Holzman, S., Conry, M. J. & Pickering, J. 1992. Home range, movements, and habitat use of coyotes in southcentral Georgia. J. Wildl. Manage., 56: 139-146.

Knowlton, F. F., Windberg, L. A. & Wahlgren, C. E. 1985. Coyote vulnerability to several management techniques. Proc. 7th Great Plains Animal Damage Control Workshop. pp. 165-176.

Larivière, S. & Crête, M. 1993. The size of eastern coyotes (*Canis latrans*): A comment. J. Mammal., 74: 1072-1074.

Laundré, J. W. & Keller, B. L. 1984. Home range of coyotes: A critical review. J. Wildl. Manage., 48: 127-139.

Lehner, P. N. 1978. Coyote communication. In: Coyotes: Biology, behaviour, and management, pp. 127-162. Ed. M. Bekoff. Academic Press, New York.

Messier, F. & Barrette, C. 1982. The social system of the coyote (*Canis latrans*) in a forested habitat. Can. J. Zool., 60: 1743-1753.

Mills, L. S., & Knowlton, F. F. 1991. Coyote space use in relation to prey abundance. Can. J. Zool., 69: 1516-1521.

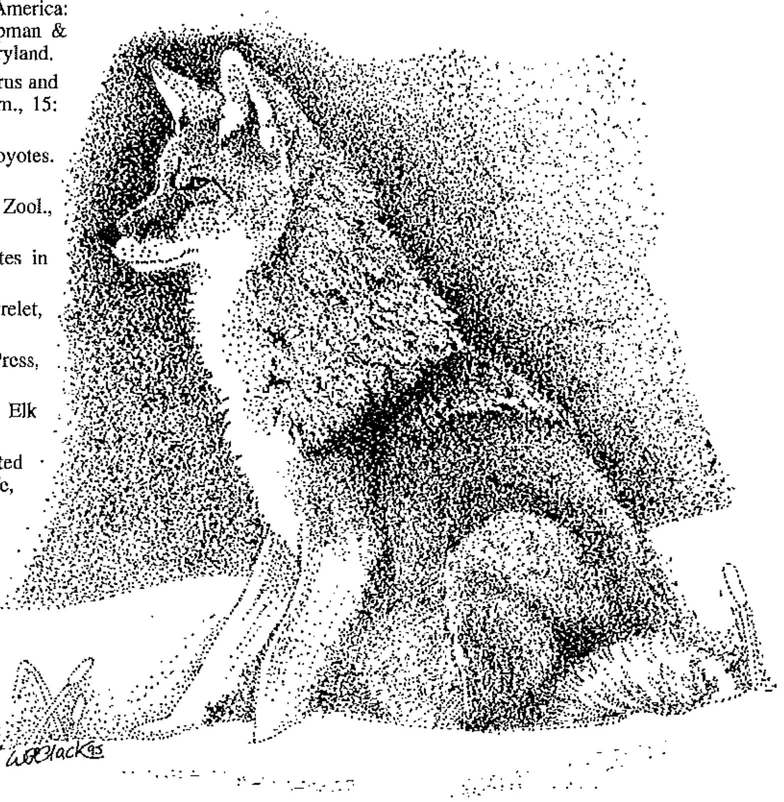
Peterson, R. O. & Thurber, J. M. 1993. The size of eastern coyotes (*Canis latrans*): A rebuttal. J. Mammal., 74: 1075-1076.

Pyrah, D. 1984. Social distribution and population estimates of coyotes in north-central Minnesota. J. Wildl. Manage., 48: 679-690.

Scanlon, B. 1991. A tale of diseased goats, snafus. Rocky Mountain News, 16 June: 45.

Thurber, J. M. & Peterson, R. O. 1991. Changes in body size associated with range expansion in the coyote (*Canis latrans*). J. Mammal., 72: 750-755.

White, P. L. C. & Harris, S. 1994. Encounters between red foxes (*Vulpes vulpes*): implications for territory maintenance, social cohesion, and dispersal. J. Anim. Ecol., 63: 315-327.



Swift Foxes on the North American Plains Lu Carbyn

The swift fox was extirpated in Canada, largely as a result of human activities. A major reintroduction programme seeks to restore them to their former range.

The Swift Fox: a Disappearing Species

When the first European explorers penetrated westward on the North American continent they encountered a faunal complex quite different from what it is today. Bison herds (*Bison bison*) dominated the landscape. Wolves (*Canis lupus*) and grizzly bears (*Ursus horibilis*) shared the plains with the numerons Indian tribes. Other predators benefited from the mix of fannal elements on this landscape. The smallest of the canids, the swift fox, was considered common by those naturalists and explorers who kept notes of what they saw (FannaWest 1991).

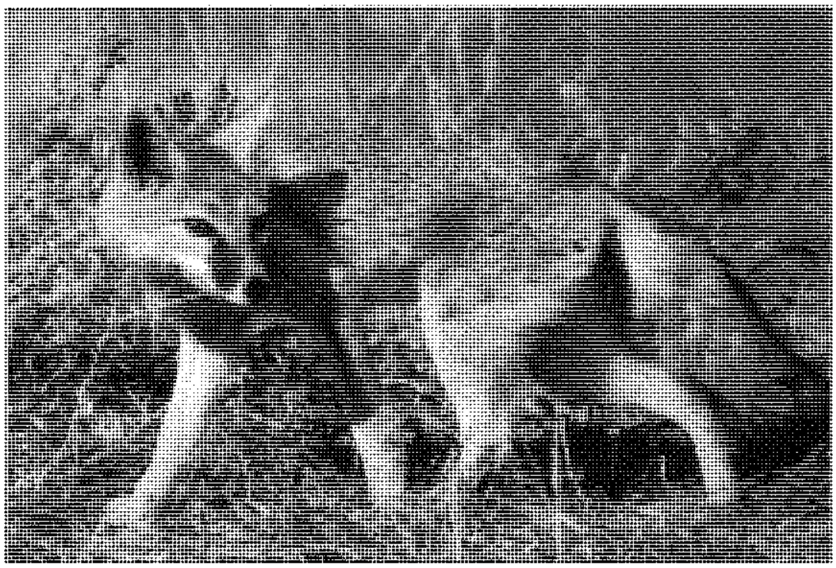
Sometime in the late 1800s and 1900s this delightful, cat-sized carnivore declined in range and numbers in the northern prairie areas and major rednctions were recorded for more sontherly prairie regions. In Canada the last officially recorded swift fox in a museum collection was obtained in 1928. Obvionsly, stragglers probably persisted here and there bnt the Canadian population vanished within a period of only a few decades. Swift foxes in the states of Montana and North Dakota were also reduced to the point of virtual extinction. Sonth Dakota was an interesting special case. The last record of swift foxes in that state was reported by Visher (1914-citation from FaunaWest 1914) and the species remained nnrecorded until 1966 (McDaniel 1976-citation from FaunaWest). Within the next 15 years numbers in South Dakota increased somewhat (Hillman and Sharps 1978) and populations were noted in two different counties. Foxes were not reported in Wyoming for many years until they seemed to reappear in the late 1950s (Long 1965). Swift foxes were not apparent In Nebraska between 1901-1953. In the 1960s and 1970s the little fox appeared to make modest comeback, bnt nnmbers were again reduced in the 1990s (FaunaWest 1991).

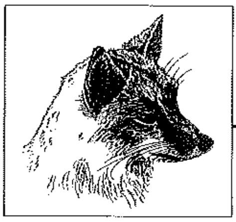
Lu Carbyn is a senior biologist working with the Canadian Wildlife Service and is a member of the Swift Fox Recovery Team. He has years of experience working with canids, including wolves and coyotes.

The demise of the species in Canada went largely unnoticed at first. Old-timers still talked about those "leather eating kit foxes", bnt beyond that no one payed much attention until a greater awareness of the environment penetrated the consciousness of North American society in the latter part of the 1960s and 1970s. By chance, an eccentric, globe trotting couple were looking for new adventures and decided to set up a game farm. Among an eclectic collection of wildlife species they inclnded swift foxes as part of their menagerie. This was a stroke of good fortune, as the captive founder foxes eventually became the core of a major re-introduction project. A University professor with graduate students forged links with the private initiative and began a process that continues today, namely a long term reintroduction programme. Government agencies, slower to respond to specific needs, became involved as well. In 1978 an official committee (COSEWIC: Committee on the Status of Endangered Wildlife in Canada), comprised of many agencies and charged with the responsibilities of reviewing the status of rare, threatened or endangered species, officially declared the swift fox as "extirpated" (meaning once a native species, existing in Canada, bnt currently extinct although still existing elsewhere on the continent).

The decline of the swift fox and its demise in Canada are nnlikely to have been caused by just one factor. Possible explanations include: (1) habitat loss through conversion of native prairies to agricnlture; (2) species' vulnerability to human activities such as trapping, predator control, shooting, collisions with vehicles; (3) use of rodenticides to control prey populations; (4) introdnction of diseases from domestic farm dogs; (5) weather and winter severity; (6) interspecific competition from a mix of competing carnivores, including other canids such as wolves, coyotes (*Canis latrans*) and red foxes (*Vulpes vulpes*).

Swift foxes often tend to be docile, unafraid, curions and inquisitive which renders them vulnerable to a nnmber of mortality agents. They are small, and therefore exposed to a host of potential avian and mammalian predators. Attributing the demise solely to direct human interference (persecntion of predators and habitat destruction) is probably unjustified. Enropean inflnences on predator control were much more severe and appeared earlier in the sonth than in the northern portions of the species' range. The same could be said in general for habitat destruction, yet swift foxes survived in remnant pockets in the south whilst northern populations vanished. However, indirect results of human pressures are

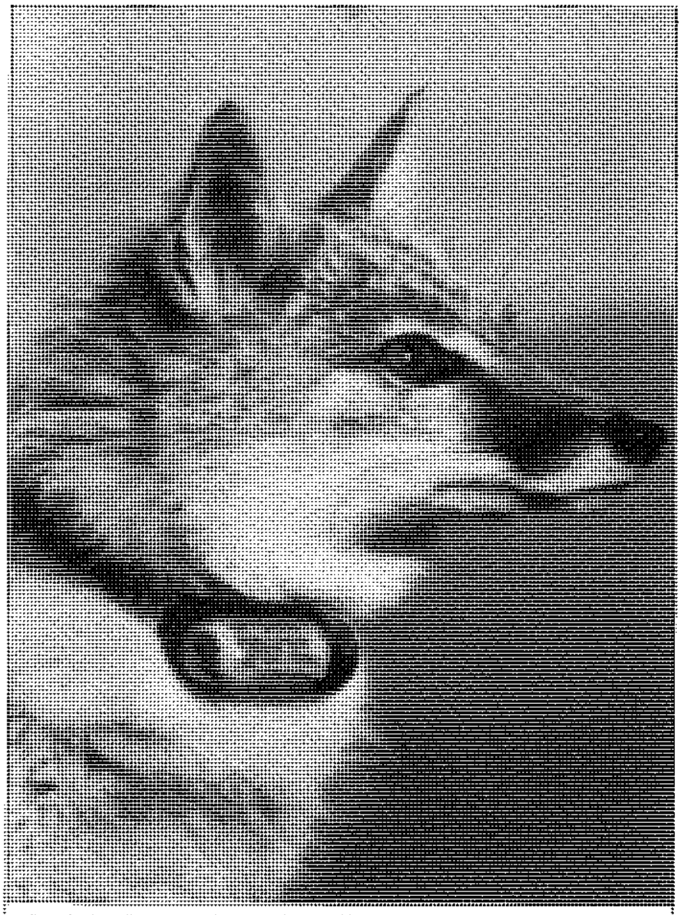




likely to have had an unfavourable impact on the species. Coyotes can more effectively access a range of resources from mice to deer and in the scheme of evolutionary processes benefited from European settlers, while swift foxes were being squeezed out of the ecosystem.

Evolutionary Trends

In an evolutionary context we have experienced major shifts within the canid guild on the North American Great Plains (Sargeant 1982). The red fox expanded its range from 1801-1900 but remained scarce between 1901-1930. Numbers then increased rapidly between 1931-1980. Human persecution of grey wolves on the Great Plains was followed by increased coyote populations. Coyotes in turn have impacted red foxes (Sargeant and Allen 1989 and others). Competition may be food related or exploitive (where one species kills another). The outcome of coexistence and competition may be influenced in subtle ways by topography, snow cover, seasonality, food abundance, population characteristics, niche overlap and the overriding influence of humans, which can impact in a multitude of direct and indirect ways. By changing the environment for swift foxes (i.e. eliminating wolves, creating an environmental mosaic enhancing the survival of competitors such as coyotes/red foxes) man's hand may well have dealt the "little fox on the prairie" a double blow, firstly through direct elimination (shooting, trapping, poisoning) and secondly by giving competitors a "leg up". The question therefore, that faced both academia and government administrators in the mid 1970s was "does the swift fox niche still exist in an altered prairie landscape?" The social climate was such that an expenditure on experimental release programmes was warranted.



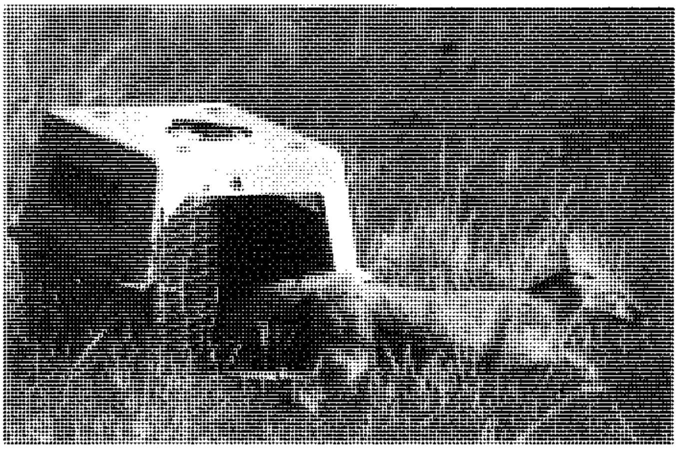
Swift fox fitted with a radio-collar, one of fifteen kindly donated to the project by Lotek Engineering.

The Canadian Experience

Miles and Beryl Smeeton imported the first two pairs of swift fox from the United States in 1972 and obtained another pair from a game park (provenance unknown). The Smeeton estate, first called the Wildlife Reserve of Western Canada and now the Cochrane Wildlife Reserve (a change brought about by their daughter, Clio Smeeton) became the important centre at which captive foxes were raised. This facility also served the purpose of raising the public profile of the project as it provided a ready supply of animals for media attention. Steven Herrero (University of Calgary), Richard Russel (Canadian Wildlife Service) and a number of graduate students developed ideas concerning reintroduction of the species to the wild. The first foxes were released in Alberta in 1983 using a "soft release programme": paired foxes were held in release pens (3.7 m x 7.3 m) constructed in prairie habitats and fenced for protection from disturbance by free-ranging cattle. The foxes were placed in the pens in October and held during the mating season. If they had produced young, the adults and the offspring were released from these pens during the summer. This release method was expensive, time consuming and there was no evidence that it was more effective than hard releases. Soft release pens in fact attracted coyotes and potentially rendered swift foxes more vulnerable to coyote predation. From 1987 hard releases were used, in which swift foxes were transported from the captive facilities and released directly into the wild without prior conditioning in release pens (see adjacent photo).

From 1989 to 1994 the programme was directed through a

Recovery Team, with representation of federal and provincial agencies, University Institutes and Zoological gardens. An experimental programme from 1989 to 1992 (Brechtel *et al.*, 1993) tested the efficacy of different techniques and was designed to determine if the niche for swift foxes does still exist in the Canadian prairies. About 30% of the foxes released were monitored for survival, using techniques to evaluate relative survival rates of wild-captured versus captive-raised foxes, survival of spring-released versus autumn-released foxes, and assess releases into areas with moister habitats.



NicheDisappearance?

Throughout the initial period it was questionable whether conditions for the re-establishment of a fox population were still present on the prairies. More conclusive proof came in 1990 when trapping was carried out from 3rd November to 7th December. Forty one foxes were caught of which 14 were marked (of known origin) and 27 unmarked (born in the wild). Most revealing was that three of the marked swift foxes had survived 3.5 years, two had survived 2.5 years and one had survived 1.5 years. Survival of released animals and young born in the field was proof that the niche for foxes was still present. Further confirmation of success emerged during another trapping effort in March, 1994. Mamo reported the capture of 13 foxes of which longest survivor, a fox named "Bert" (captured in the wild in Colorado in September 1988) had survived for six years after the release (Mamo, 1994).The current estimate is that there are about 150 foxes in the Canadian prairies.

"survival of released animals and young born in the field was proof that the niche for foxes was still present"

Survival and successful denning is not proof that the population is self-sustaining over time. The goal for the programme, as defined in the *Recovery Plan*, is to "establish a viable, self-sustaining population of swift foxes, well distributed across suitable habitats on the Canadian prairies, which would result in the removal of the species from the endangered category by the year 2000."

The Coyote Factor

The medium sized coyote (intermediate between wolves and red foxes) has extended its range following settlement of North America by Europeans. In nearly all areas where swift fox ecology has been studied it was established that coyotes kill and often do not consume swift foxes. Table 1 lists the source of mortality of foxes studied in the Canadian release programme, showing the importance of competition with coyotes.

Similar figures have been obtained for Colorado, California (kit foxes) and Kansas. In the latter case, of 30 collared foxes 19 were found dead of which 17 were killed by coyotes and two killed on highways (L. Fox, pers. com.). If man's presence has encouraged coyote abundance, then the plight of swift foxes may have been indirectly affected by large scale landscape changes that influenced predator guild combinations. This may mean that swift foxes in future will survive in areas of lowest coyote densities, thus evolving to exploit different niches in the prairie mosaic. In the

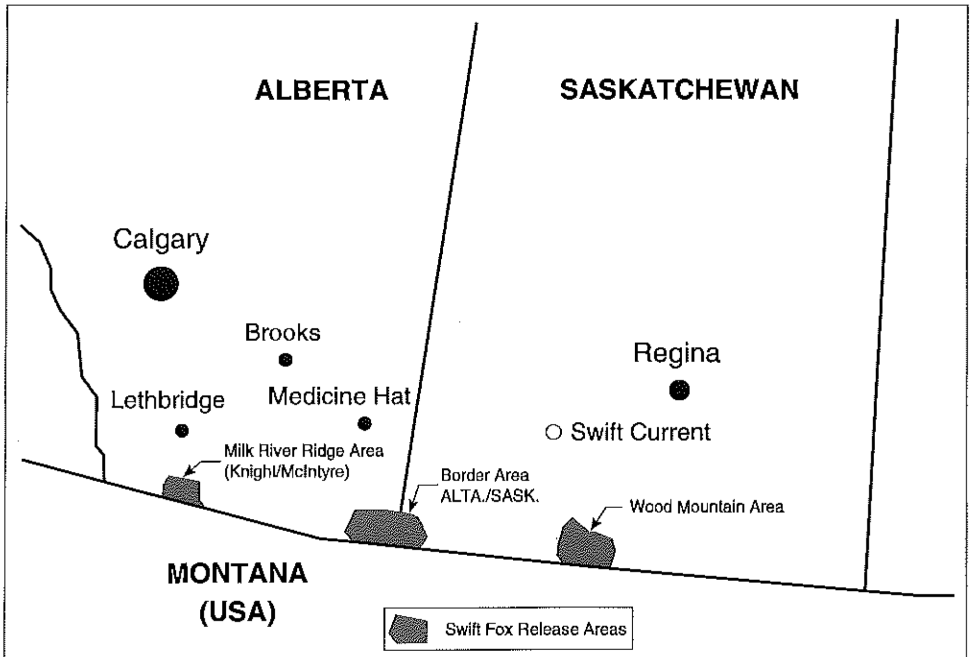
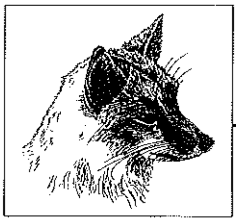


***Figure 1.** The three release areas for swift foxes in the Milk River Ridge Area, Lost River Ranch and Border Area, and the Wood Mountain Area.*



first swift fox vocalization surveys conducted in Canada, Wayne Harris of Saskatchewan found the greatest number of responses in farm/grassland interphase zones and not in core grassland areas. The suggestion is that in severe winters stockyards could provide conditions more conducive to survival than open grassland areas.

A Petition of Consequence

To date the Canadian project has depended heavily on access to American swift foxes, particularly from the state of Wyoming. A petition to declare swift foxes in the United States an endangered species was made in February 1992. The petition was upheld and a 90 day finding on the petition announced on May 23, 1994. The fact that swift foxes occur in highly disjunct populations in a much reduced portion of their range within the United States is cause for alarm. In many areas foxes are currently trapped and otherwise killed by man. Granting the species endangered species protection brings into play a new scenario. Killing of foxes will be illegal. This is likely to result in much lower human caused mortality, but it may also mean the loss of a supply of live-caught foxes for the Canadian Conservation programme. Prior to the announcement of the petition, the state of Wyoming had granted permission for the Canadian authorities to capture 150 foxes for the next five years. Twenty five foxes probably represents only a small fraction of the foxes currently killed by humans annually throughout its American range, and the capture of up to 25 foxes per annum from the wild American population could be considered an investment for the future of the species. However, American endangered species legislation carries with it a powerful impact; future access to foxes for the Canadian programme has not yet been determined. Clearly, a Canadian Recovery programme may need to be expanded into a North American Recovery plan. A hallmark of such an effort would be co-operation, where agencies from different federal, state and provincial jurisdictions can interact with other public and private interests in the conservation of the species. It may be that a major supply of foxes for future re-introductions, throughout the range, uay depend exclusively on captive raised foxes. Such decisions can only be made if the true status of the species has beeu determined. This calls for the development of new survey techniques. In the Canadian projects we have experimented with scent post surveys, winter track counts, night lighting and breeding call surveys.

	STUDY AREA			
Cause of Death	Wood Mountain	Border	Milk River	Total
Coyote	5	7	11	23
Probable coyote	6	4	0	10
Eagle	1	1	0	[illegible]
Probable eagle	2	0	0	2
Badger	0	2	0	2
Probable badger	0	2	0	2
Roadkill	1	3	0	4
Unknown canid	0	0	1	1
Unknown	12	10	1	[illegible]
Other	2	0	1	3
Total	29	29	14	[illegible]

Table 1. Causes of death of swift foxes found in the field, during the hard releases carried out from 1987-1991.

On the horns of a dilemma

Studies thus far indicate that wild-captured foxes are more effective in a reintroduction programme than captive-born ones (Brechtel *et al.*, 1993). Such wild-conditioned animals have greater experience in both avoiding enemies and capturing prey. In one comparison (1987-1990) the actual breeding population in the spring of 1991 indicated a roughly 1:1 ratio of residency as defined by den establishment, despite a 5:1 release ratio of captive-released to translocated foxes. The ratio of productive captive-raised foxes was 6/108 or 6%, versus productive translocated foxes of 6/19 or 32%. These statistics led Mamo to question the continued need for captive raised foxes on the programme (Mamo, 1994). On the other side of the debate is the effectiveness of supplying captive raised foxes to release sites not only in Canada, but possibly also to other areas in the United States from which foxes have disappeared, without manipulating already low established populations in the limited and reduced ranges where they now exist. The dilemma is "should we subject more captive raised foxes to trauma or death than would be the case had we used wild caught foxes instead (C. Mamo, *op cit*)" or should we disrupt already small populations in the wild instead? In the past the Canadian programme used both sources of foxes (Brechtel *et al.*, 1993).

If wild established populations are our main concern then only captive foxes shonld be considered. In the modern world the concerns are also for individual animals; the loss of a larger number of captive raised foxes thus becomes a moral issue.

Need for Research

The Canadian Recovery effort is currently guided by a Recovery Plan, which calls for continued management and research. One outgrowth of the research programme concerns two student projects involving a coyote/fox home range study and a swift fox habitat/cattle grazing ecosystem study. Other initiatives to enhance snrvival of foxes during post release phases are being considered. One such initiative was mentioned by Smeeton in issue 2 of Canid News. The technique involved the use of protective shelters for captive released foxes. Funding for these projects has to come from both governmental and non-governmental sources. One problem to be overcome is that funding of student projects should not compete with captive breeding programmes. Priorities set by a Recovery Team thus need to take precedence over narrowly defined agendas of specific projects or other self-serving endeavours of specific agencies associated with a high profile conservation programme.

"In nearly all areas where swift fox ecology has been studied it was established that coyotes kill and often do not consume swift foxes"

The Future

Clearly in the future a continental approach to swift fox conservation is needed. Several initiatives are already in place. In March 1993 the Canadian Wildlife Service initiated the first international workshop on the subject in Medicine Hat, Alberta. Plans are currently underway to organize a second such workshop for March 1996, at the same location.

Another recent initiative is a graduate student exchange programme in field research technology and methodology between Canada and Mexico. Two graduate students from Oxford University (Rurik List and Axel Moehrenschlager, under the direction of Dr. David Macdonald) will be working together. Other initiatives involving private institutions and public agencies are under way. In this age of globalization it is increasingly important to reach across borders and encourage cooperation between countries and among agencies. The Canadian experience can be useful in other parts of North America.

Literature Cited

Brechtel, S., Carbyn, L. N., Hjertaas, D. & Mamo, C. 1993. Canadian swift fox reintroduction feasibility study: 1989-1992. Report and Recommendations of the National Recovery Team. 117 pp.

Costanza, R. 1992. Toward an Operational Definition of Ecosystem Health. In: Ecosystem Health: New Goals for Environmental Management, pp. 239-256. Eds. R. Costanza, B.G. Norton & B.D. Haskell. Island Press, Washington D.C. 269 pp.

Darwin, C. 1859. Origin of the species, republished in 1972 (6th edition). Carlton House, New York.

FaunaWest. 1991. An ecological and taxonomic review of the swift fox (*Vulpes velox*) with a special reference to Montana. Summary prepared for Montana Department of Fish, Wildlife and Parks. 49 pp.

Hillman, C. N. & Sharps, J. C. 1978. Return of the swift fox to the Northern Great Plains. Proc. of the South Dakota Acad. of Sci., 57: 154-162.

Johnson, D. H. & Sargeant, A. B. 1977. Impact of red fox predation on the sex ratio of prairie mallards. Wildl. Res. Rep. No. 6. U.S. Fish and Wildlife Serv. Rep. Dept. of the Interior, Washington, D.C.

Long, C. A. 1965. The mammals of Wyoming. Univ. of Kansas Publ. Mus. Nat. Hist., 14: 493-758.

Mamo, C. 1994. Swift News. A Newsletter of the Swift Fox Conservation Society. Vol.8 No.1: 2-3.

Sargeant & Allen, S.H. 1989. Observed interactions between coyotes and red foxes. J. Mamm. 70: 631-633.

African Wild Dog Survey in Zambia: Kenneth Buk

Data from questionnaires and reports of sightings suggest that wild dog populations in Zambia are fragmented and vulnerable to increasing human pressure.

Introduction

The aim of the Zambia Wild Dog Project is to formulate recommendations for the conservation of Zambian wild dogs (*Lycaon pictus*) and their habitats (Buk, 1994a). The first project initiative is a survey of the species' conservation status. Below is a short update on the preliminary findings summarising Buk (1994b).

Methods

In September 1993 and March 1994 a total of 640 mail questionnaires with prepaid postage were distributed to field officers working for the National Parks and Wildlife Service (NPWS) both in and outside protected areas. Sighting sheets and information pamphlets on wild dog ecology and conservation were also distributed to this group. Some wild dog habitats were inspected during September 1993 – August 1994. On these occasions NPWS field officers, tour operators, villagers and others were interviewed and given sighting sheets and information pamphlets. In addition, literature and files were studied.

Kenneth Bnk, a Danish graduate student, is committed not only to finding out more about African wild dogs, but also to quantifying their impact on local people in Zambia. He initiated the Zambia Wild Dog Project in August 1993.

Results

Brief history of distribution and legal statns

The wide distribution of wild dogs in the recent past is reflected in local tales, in traditional use of wild dog 'products' and in memories of sightings among many middle-aged Zambians with a rural past. However, colonial wild dog vermin control units operated from the 1930s to the 1950s, killing 4,955 wild dogs in Zambia between 1945–1959 (Banage, 1979). A bounty system also existed. Despite this persecution, there was still a newspaper report in 1967 concerning a wild dog pack attacking cattle in one of the major agricultural areas and its subsequent eradication by the authorities. In the 1970s Zambians could still obtain a licence to shoot wild dogs free of charge. Ansell's 1978 "The Mammals of Zambia" reported a wide distribution for the wild dog, although concentrated around protected areas. NPWS hunters report controlling (i.e. shooting) wild dog packs outside protected areas during the 1980s. Since 1991 the species has been on the NPWS list of Protected Animals for which a special licence to shoot may only be issued by the Minister of Tourism. The price for a wild dog licence is listed at about US$100 for Zambians, but few, if any, licences are issued.

Distribution and conflicts

The data analysed consist of 76 questionnaires and 156 sightings between January 1993 – August 1994. Seven (8%) of the returned questionnaires were judged unreliable and were excluded from analysis. About 15 closely repeated sightings were regarded as duplicates and were also excluded.

There are first-hand reports of wild dog sightings from 13 game management areas and 10 national parks, which cover >130,000 square kilometres (Fig. 1). There are only two sightings from outside these protected areas, both close to national parks in Western Zambia. Zambian wild dog habitats have been categorised according to sighting frequency among NPWS field officers derived from questionnaires and interviews (Figure 1). Reported pack sizes range from 1–27 with a mean size of 8.3 ± sd 5.1.

Game management areas (G.M.A.) are, in practice, multiple use areas, which differ from unprotected areas only in having more rigorons regulations on hunting and better antipoaching measures. There are no legal restrictions on settling or land use, so all G.M.A.s have local residents. Some chiefs discourage settling in uninhabited parts to safeguard safari hunting as a source of income shared between NPWS, the tourist board and the chief's community through the ADMADE project. In national parks (N.P.) residents and any extractive utilization are generally prohibited. Some of the N.P.s do have residents, however, and all the protected areas are subject to some level of illegal extractive utilization.

Nineteen NPWS field officers report that they have sighted wild dogs within the past 12 months in areas where

African wild dogs hunting amongst game herds in the early morning mist settlements are allowed (i.e. in G.M.A.s or outside protected areas) and where livestock is not limited by tsetse. Eleven (58%) of these nineteen officers report that they also know of losses of domestic animals within the same 12 months. Reported losses range from 1–7 incidents per year, and suggest that kills are most frequently calves, goats and pigs, but also include adult cows. Reported wild prey includes medium sized antelopes: 4 impalas (*Aepyceros melampus*), 3 pukus (*Kobus kob*, 2 reedbucks (*Redunca arundinum*), 2 warthogs (*Phacochoerus aethiopicus*), 1 common duiker (*Silvicapra grimmia*), 1 sable calf (*Hippotragus niger*); but also larger prey: 3 wildebeest (*Connochaetes taurinus*) and 1 hartebeest (*Alcelaphus buselaphus*). Villagers report a recent attack by a rabid wild dog on a woman. Rabid wild dogs are often a concern among residents in wild dog habitats.

"colonial wild dog vermin control units operated from the 1930s to the 1950s, killing 4,955 wild dogs in Zambia between 1945–1959"

Nine respondents reported 32 different dead wild dogs (Fig. 2). Reporters of wild dog population decline or extinction believed the main reasons to be intentional killing of wild dogs (7), decline in prey (7), diseases (4), snaring (1), flooding of dens (1), moving elsewhere (1).

When NPWS receives complaints of wild dogs killing livestock, they send out one NPWS hunter if available. Although the primary policy is 'shoot to scare', dogs have been killed on a number of occasions due to pressure from residents. NPWS does not have the means to translocate problem animals or packs, which can in any case be very difficult (English *et al.*,1993).

The populations and their status

Sumbu protected area complex (game management areas: 7,274 sq.km, national parks: 2,900 sq.km.) is reported to support wild dogs in several areas, but there are only first hand reports of sightings from Sumbu N.P. (2,020 sq.km.).

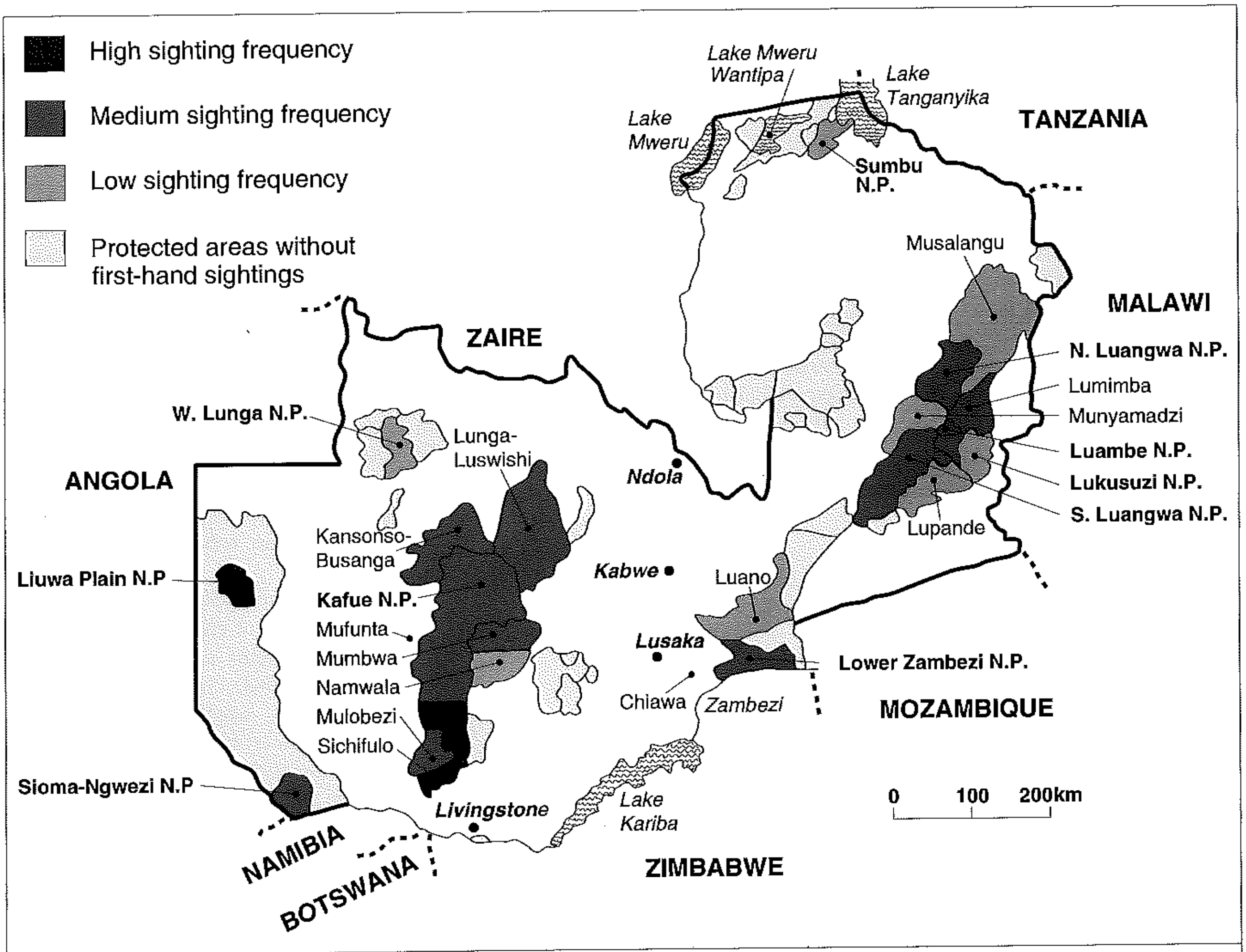


Figure 1. The distribution and sighting frequency of wild dogs in Zambia's national parks (N.P.) and game management areas. Geographical data for mapping Mufunta and Chiawa game management areas, which have a low sighting frequency, was not available.

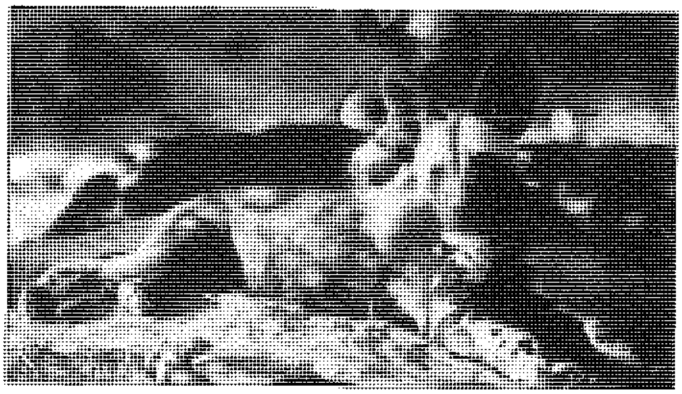
Only two out of six responding NPWS field officers have sighted wild dogs in 1993-August 1994. With a mean of 3.3 dogs, the four sighted packs are smaller than those of other sightings (p = 0.018, Mann-Whitney). There are reports of recent losses of livestock to wild dogs, persecution of wild dogs and poaching of prey.

Bangweulu protected area complex (G.M.A.: 28,960 sq.km., N.P.: 1,890 sq.km) contained wild dogs in the 1980s, but no sightings were reported to this study. Several respondents, including a WWF biologist, think that wild dogs as well as lions (*Panthera leo*) and hyenas (*Crocuta crocuta*) have become extinct because of persecution and poaching of prey.

Luangwa protected area complex (G.M.A.: 31,520 sq.km., N.P.: 16,660 sq.km) probably holds the second largest wild dog population in Zambia. Mean reported pack size is 8.8 (n = 24). Tsetse has limited cattle numbers and thus persecution of wild dogs, but tsetse are declining and goats increasing. In South Luangwa N.P. the wild dog population is beginning to recover from a precipitous decline after anthrax was documented in wild dogs in 1987 (Turnbull *et al.*, 1991). The population has been oscillating for decades, according to a resident tour operator.

The Lower Zambezi protected area complex (G.M.A.: >16,460 sq.km., N.P.: 4,140 sq.km.) has a low reported pack size (p = 0.008, Mann-Whitney) with a mean of 5.5 (n = 16). There are reports of livestock losses, and elephant poaching is evident.

The Kafue protected area complex (G.M.A.:>45,000 sq.km., N.P.: 23,260 sq.km) probably holds the largest Zambian wild dog population. Kafue N.P. (22,400 sq.km.) is the stronghold, while from the Central Eastern appendix to the complex there are no reports of recent sightings. Mean reported pack size is 8.3 (n = 83). Livestock losses are reported, as are wild dog losses due to poisoning (10), snares (2), rabies (2), traffic (1). The area suffers considerable poaching.



From West Lunga N.P. (1,684 sq.km) two respondents report sighting wild dogs, but the species is rare and declining. Heavy poaching occurs, and all predators are persecuted.

Liuwa N.P. (3,660 sq.km) boasts frequent sightings of larger than average packs (p = 0.002, Mann-Whitney) with a mean of 11.8 (n = 21). Much poaching and strong antagonism towards NPWS are reported. Livestock losses occur, and all predators are vigorously persecuted.

Sioma-Ngwezi N.P. (5,276 sq.km) has some sightings, with a mean reported pack size of 6.6 (n = 8). We received reports of heavy poaching.

Discussion

Zambia has one of the largest areas occupied by wild dogs, and additional data may even extend the area currently supporting the species. However, the preliminary data do not warrant estimates of population densities. Studies in protected woodlands in and around Selous Game Reserve (G.R.) (Southern Tanzania), Hwange N.P. (Northwestern Zimbabwe), Moremi G.R. (Northwestern Botswana) and Kruger N.P. (Northeastern South Africa) have found densities of 1 wild dog per 56-66 sq. km (Creel & Creel, 1994; Fuller *et al.*, 1991, Ginsberg, 1993; Maddock & Mills, 1994) These studies focused on optimal areas; many Zambian habitats probably have lower densities.

Surveys based on reported sightings tend to underestimate the size of each pack; a pack may have split or individuals may be obscured by vegetation (Reich, 1984). Sighting surveys may also under-represent small packs (Ginsberg, 1993). These tendencies may place two opposing biases on the reported mean pack from this sighting survey, and the resulting bias has not be quantified. Intensive field studies found mean pack size was 8.2 in and around Hwange N.P., 8.4 in Moremi G.R. (Ginsberg, 1993) and 13.7 ± sd 7.1 in and around Kruger N.P. (Maddock & Mills, 1994).

Zambia's wild dog population appears to have been fragmented into seven or eight popu-

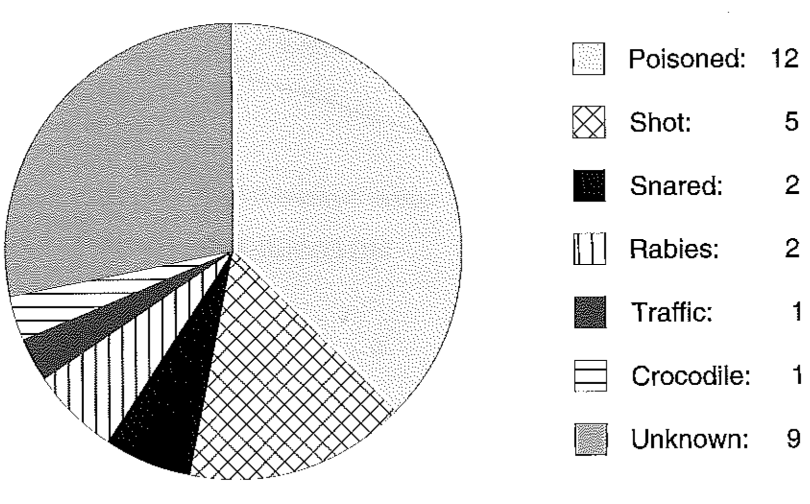
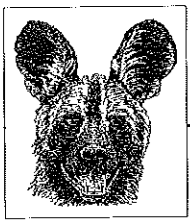


***Figure 2.** Cause of death for 32 African wild dogs as reported by National Parks and Wildlife Service field officers.*



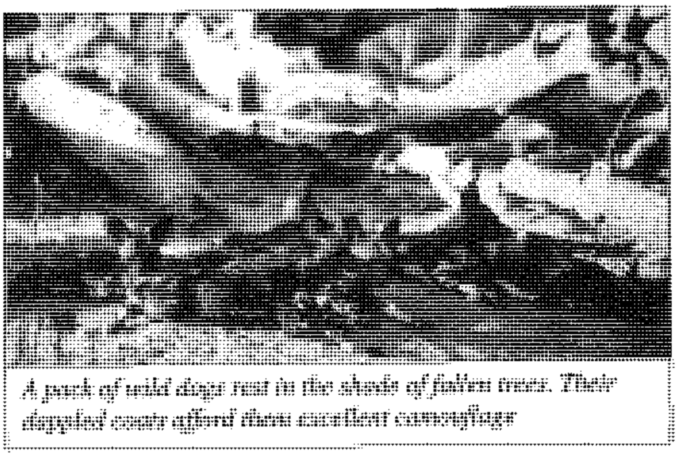
lations. The Bangweulu population may be extinct and the Sumbu and W. Lunga populations are on the brink of extinction. The Liuwa and Sioma populations appear to be more or less restricted to the National Parks. Although the size of minimal viable populations are widely discussed (e.g. Mace *et al.*, in prep.; Olney *et al.*, 1994; Soulé, 1987) it is inevitable that small, isolated populations, such as wild dogs in Liuwa and Sioma, are extinction-prone. The Lower Zambezi population could achieve long-term survival if interchange of individuals with the populations in Luangwa and Zimbabwe can occur. The Kafue and Luangwa populations should enjoy long-term survival if the present habitat can be maintained. Thus, much depends on the future of the G.M.A.s as natural habitats and dispersal corridors.

The human population density of Zambia is about 10/ sq.km., which will probably double in 20 years. Peasants living at subsistence level cannot afford to share livestock and crops with large, wild mammals. Therefore, if at least parts of the G.M.A.s are to remain natural habitats with large mammals, these parts must be kept free of human settlement, but should continue be subject to sustainable wildlife utilization. Conflicts on the perimeters of conservation areas must be addressed seriously and realistically to encourage a positive attitude from the outside and thus ensure the integrity of the inside of the areas. Perhaps wild dog conflicts could be alleviated through locally acceptable methods of particularly protective husbandry, especially for small livestock. Successful implementation of this and other wild dog conservation measures requires more data from field research, which in turn requires more funding.

"Zambia's wild dog population appears to have been fragmented into seven or eight populations"

Acknowledgements

I thank the Beckett Fund, the Chicago Zoological Society, Protecting African Wildlife, the Flora and Fauna Preservation Society, the Kjebi Fund, IUCN and the Platinum Foundation for contributing to ZWDP. I am grateful for constructive support from Dr.J.Ginsberg, Dr.D.Macdonald, Mr.H.Mwima, M.Zeko, Dr.B.Muus, Dr.H.Baagoe, NPWS and my family.



A pack of wild dogs rest in the shade of fallen trees. Their dappled coats afford them excellent camouflage

Literature Cited

Ansell, W. F. H. 1978. The Mammals of Zambia. National Parks and Wildlife Service, Chilanga, Zambia.

Banage, W. B. 1979. Wildlife conservation and its problems in Zambia. In: A review of some environmental problems in Zambia. Johnson, D.S. & Roeder W. eds. Proc. of the Nat. Sem. on Env. & Develop.

Buk, K. G. 1994a. Zambia Wild Dog Project. Canid News, 2:26-27.

Buk, K. G. 1994b. Preliminary report: Conservation status of wild dog in Zambia. Uni. of Copenhagen, Denmark.

Creel, S & Creel, N. M. 1994. Ray of hope for African wild dogs. Miombo,11:1-2.

English, R. A., Stalmans, M, Mills, M. G. L. & van Wyk, A. 1993. Helicopter-assisted boma capture of African wild dogs *Lycaon pictus*. Koedoe,36(1):103

Ginsberg, J. 1993. Mapping wild dogs. Canid News,1:2-6.

Fuller, T. K., Kat, P. W., Bulger, J. B., Maddock, A. H., Ginsberg, J. R., Burrows, R., McNutt, J. W. & Mills, M. G. L. 1992. Population Dynamics of African wild dogs. In: Wildlife 2001: Populations, pp. 1125-39. Eds. McCullongh, D.R. & Barrett, H. . Elsevier Applied Science, London & New York.

Mace, G., Ginsberg, J., Mills, G. M. L. et al. (in prep.) A population viability assessment of the African wild dog. In: An Action Plan for the Conservation of the African Wild Dog, *Lycaon pictus*. Eds. Ginsberg, J. & Macdonald, D.. IUCN, Gland , Switzerland.

Maddock, A. H. & Mills, M. G. L. 1994. Popnlation characteristics of African wild dog, Lycaon pictus, in the Eastern Transvaal Lowveld, South Africa, as revealed through photographic records. Biol.Cons., 67:57-62.

Olney, P. J. S., Mace, G. M., Feistner, A. T. C. (eds.) 1994. Creative Conservation: Interactive management of wild and captive animals. Chapmann & Hall, London.

Reich, 1984. The behavior and ecology of the African wild dog, *Lycaon pictus* in the Kruger National Park. Ph.D. thesis, Yale University, New Haven, Connecticut.

Soulé, M. E.(ed.). 1987. Viable Populations for Conservation. Cambridge Uni. Press.

Turnbull, P. C. B., Bell, R. H. V., Saigawa, K., Munyenyembe, F. E. C., Mulenga, C. K. & Makala, L. H. C. 1991. Anthrax in wildlife in Luangwa Valley, Zambia. Zambia Vet. Rec., 128: 399-403.

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Recent Publications

1990

BEDNARZ, M., BRZOZOWSKI, M., FRINDT, A. & KALETA, T. 1990. The effect of the teats activity and number on the **arctic foxes** reproduction results. *Zwierzeta Laboratoryjne*, 27(2): 175-180.

BRZOZOWSKI, M., BEDNARZ, M., FRINDT, A. & KALETA, T. 1990. An attempt to assess the quantity of somatic cells in milk of female **arctic fox** (***Alopex lagopus*** L.). *Zwierzeta Laboratoryjne*, 27(2): 181-186.

CLUTTON-BROCK, J. & NOE-NYGAARD, N. 1990. New osteological and carbon-isotope evidence on **Mesolithic dogs**: companions to hunters and fishers at Star Carr (Yorkshire, England, UK), Seamer Carr (Yorkshire, England, UK) and Kongemose (Sjaelland, Denmark). *Journal of Archaeological Science*, 17(6): 643-654.

FRINDT, A., BRZOZOWSKI, M., BEDNARZ, M. & KALETA, T. 1990. The evaluation of an **arctic foxes** (***Alopex lagopus*** L.) females teat morphology. *Zwierzeta Laboratoryjne*, 27(2): 169-174.

JOHNSON, W. E. & BALPH, D. F. 1990. Resource acquisition in the presence of novelty by **coyotes** of different rank. *Journal of Wildlife Management*, 54(4): 582-586.

KREEGER, T. J., SEAL, U. S., CALLAHAN, M. & BECKEL, M. 1990. Physiological and behavioral responses of **gray wolves** (***Canis lupus***) to immobilization with tiletamine and zolazepam. *Journal of Wildlife Diseases*, 26(1): 90-94.

LITVIN, K. E. & OVSYANIKOV, N. G. 1990. Relationship between the reproduction and numbers of snowy owls and **arctic foxes** and the numbers of true lemmings on the Vrangel Island (Arctic Ocean). *Zoologicheskii Zhurnal*, 69(4): 52-64.

LOURENS, S. & NEL, J. A. J. 1990. Winter activity of **bat-eared foxes *Otocyon megalotis*** on the Cape West coast (South Africa). South African Journal of Zoology 25(2): 124-132

MUNOZ, A. & MURUA, R. 1990. Control of small mammals in a pine plantation (Central Chile) by modification of the habitat of predators (*Tyto alba, strigiformes* and ***Pseudalopex sp.***, Canidae). *Acta Oecologica*, 11(2): 251-262.

PHILLIPS, D. P., DANILCHUK, W., RYON, J. & FENTRESS, J. C. 1990. Stereotypy of action sequence in food caching by **wolves** (***Canis lupus***) and **coyotes** (***Canis latrans***). *American Zoologist*, 30(4): 107a.

RYON, J., BROWN, R. E., FENTRESS, J. C. 1990. Food provisioning in captive **coyotes** (***Canis latrans***). *American Zoologist*, 30(4): 108a.

STOEHR, K., GEBAUER, R., HEROLD, W., HAEHN, J., PIEFEL, W. & KINTSCHER, M. 1990. Fluorescence microscopy to identify oxytetracycline in bones of **fox**. *Monatshefte Fuer Veterinaermedizin*, 45(3): 88-92.

WARD, O. G. & WURSTER-HILL. D. H. 1990. **Nyctereutes procyonoides**. *Mammalian Species*, 0(358): 1-5

1991

BURBANK, J. C. 1991. Vanishing lobo: the Mexican wolf and the Southwest. Johnson, 208 pp.

CATLING, P. C., CORBETT, L. K. & WESTCOTT, M. 1991. Age determination in the **dingo** and crossbreeds. *Wildlife Research*, 18(1): 75-84.

FLEMING, P. J. S. & PARKER, R. W. 1991. Temporal decline of 1080 within meat baits used for control of wild **dogs** in New South Wales. *Wildlife Research*, 18(6): 729-740.

GOSCICKA, D., GIELECKI, J., BRUDNICK, W. & JABLONSKI, R. 1991. Analysis of the volume of cerebral circle and basal artery in **blue fox**. *Polskie Archiwum Weterynaryjne*, 31(1-2): 83-90.

IKEDA, H. 1991. Comparative socioecology of **canids**. *Japanese Journal of Ecology (kyoto)*, 41(3): 263-277.

IVANOV, E. V., POTAPOV, V. A., FILIPENKO, E. A. & ROMASHCHENKO, A. G. 1991. Heterogeneity of the **Canidae** Bsp-repeats family: discovery of the EcoRI subfamily. *Genetika*, 27(6): 973-982.

IVANOV, S. V., POTAPOV, V. A., FILIPENKO, E. A. & ROMASHCHENKO, A. G. 1991. Species-specific differences in restriction patterns of **canid** Bsp-repeats. *Genetika*, 27(6): 964-972.

KOLESNIKOVA, L. A. 1991. Some quantitative characteristics of blastocytes of **silver foxes** under domestication. *Sibirskii Biologicheskii Zhurnal*, 0(6): 21-24.

1992

BAILEY, E. P. 1992. **Red foxes, *Vulpes vulpes***, as biological control agents for introduced **arctic foxes, *Alopex lagopus***, on Alaskan Islands. *Canadian Field-naturalist*, 106(2): 200-205.

BOYD, D. K. & NEALE, G. K. 1992. An adult cougar, *Felis concolor*, killed by **gray wolves, *Canis lupus***, in Glacier National Park, Montana. *Canadian Field-naturalist*, 106(4): 524-525.

CLAUSEN, O. P. F., BERG, K. A., KIRKHUS, B., De, ANGELIS. P. & HUITFELDT, H. 1992. BrdUrd incorporation studies for evaluation of spermatogenesis in the **blue fox**. *Cytometry*, 13(4): 374-380.

DENYS, C., KOWALSKI, K. & DAUPHIN, Y. 1992. Mechanical and chemical alterations of skeletal tissues in a recent Saharian accumulation of faeces from ***Vulpes rueppelli*** (Carnivora, Mammalia). *Acta Zoologica Cracoviensia*, 35(2): 265-283.

EBERHARDT, L. L. & PITCHER, K. W. 1992. further analysis of the Nelchina caribou and **wolf** data. *Wildlife Society Bulletin*, 20(4): 385-395.

HARRI, M. & HAAPANEN, K. 1992. Review on **red fox** reproduction and population biology. *Luonnon Tutkija*, 96(1): 12-20.

KENTTAMIES, H. & SMEDS, K. 1992. Repeatability of subjective grading in fur animals: III. Grading of live **blue foxes** in different environmental conditions. *Agricultural Science in Finland*, 1(3): 315-322.

KOSTRO, K. & WIKTOROWICZ, K. 1992. Comparative studies on in vitro mitogen-induced proliferation on peripheral blood lymphocytes in **dog** and breeding **fox**. *Acta Veterinaria Hungarica*, 40(1-2): 39-45.

ORIANI, A. 1992. Lynx (*Lynx lynx* L.) and a **wolf** (***Canis lupus* L.**) captured in the Lombardy Alps in the previous century. *Atti Della Societa Italiana Di Scienze Naturali E Del Museo Civico Di Storia Naturale Di Milano*, 133(6): 81-87.

OSADCHUK, L. V. & SHURKALOVA, T. A. 1992. Testosterone level in testes of the **silver fox** during prenatal development. *Ontogenez*, 23(4): 385-389.

OSADCHUK, L. V., & VOITENKO, N. N. 1992. The sex steroids and brain serotonin in **silver foxes** during estrus cycle. *Fiziologicheskii Zhurnal Sssr Imeni I M Sechenova*, 78(4): 118-123.

PEICHL, L. 1992. Morphological types of ganglion cells in the **dog** and **wolf** retina. *Journal of Comparative Neurology*, 324(4): 590-602.

POTVIN, F., JOLICOEUR, H., BRETON, L. & LEMIEUX, R. 1992. Correction of BA 95014919. Evaluation of an experimental **wolf** reduction and its impact on deer in Papineau-Labelle Reserve, Quebec. Correction of abstract. Erratum published in CAN J ZOOL Vol. 70. Iss. 12. 1992. p. 2501. *Canadian Journal of Zoology*, 70(8): 1595-1603.

PRESTRUD, P. 1992. Food habits and observations of the hunting behaviour of **arctic foxes, *Alopex lagopus***, in Svalbard. *Canadian*

Field-naturalist, 106(2): 225-236.

RUIZ-OLMO. J. 1992. Data on the breeding cycle and the sex-ratio of the **fox** (***Vulpes vulpes*** **L.**) in the Valles Oriental (NE of the Iberian Peninsula). *Historia Animalium*, 1(0): 121-127.

SHISHKIN, G. S., VOEDOVA, T. V., VALITSKAYA, R. I. & VALITSKIIYU. N. 1992. comparative study of parameters of bronchial tree of the **dog** and the **polar fox**. *Sibirskii Biologicheskii Zhurnal*, 0(1): 30-37.

STRUB, H. 1992. Swim by an **arctic fox**, ***Alopex lagopus***, in Alexandra Fiord, Ellesmere Island, Northwest Territories. *Canadian Field-naturalist*, 106(4): 513-514.

VOYEVODA, T. V., SHISHKIN, G. S., VALITSKAYA, R. I. & UMANTSEVA, N. D. 1992. Macrostructure differences of polar fox and dog lungs. *Anatomical Record*, 234(1): 89-92.

1993

AHLSTROM, O. & SKREDE, A. 1993. Herring scrap as feed for **silver foxes** and mink in the growing-furring period. *Norwegian Journal of Agricultural Sciences*, 7(2): 175-187.

ALLEN, D. L. 1993. Wolves of Minong: Isle Royale's wild community. University of Michigan Press, 500 pp.

ALLEN, S. H., SARGEANT, A. B. 1993. Dispersal patterns of **red foxes** relative to population density. *Journal of Wildlife Management*, 57(3): 526-533.

ARTOIS, M., MASSON, E., BARRAT, J. & AUBERT, M. F. A. 1993. Efficacy of three oral rabies vaccine-baits in the **red fox**: A comparison. *Veterinary Microbiology*, 38(1-2): 167-172.

BAKKEN, M. 1993. Reproduction in farmed **silver fox** vixens, ***Vulpes vulpes***, in relation to own competition capacity and that of neighbouring vixens. *Journal of Animal Breeding and Genetics*, 110(4): 305-311.

BARRAT, J. & AUBERT, M. F. A. 1993. Current status of **fox** rabies in Europe. *Onderstepoort Journal of Veterinary Research*, 60(4): 357-363.

BINGHAM, J. & FOGGIN, C. M. 1993. **Jackal** rabies in Zimbabwe. *Onderstepoort Journal of Veterinary Research*, 60(4): 365-366.

BINGHAM, J., PERRY, B. D., KING, A. A., SCHUMACHER, C. L., AUBERT, M., KAPPELER, A., FOGGIN, C. M., HILL, F. W. G. & AUBERT, A. 1993. Oral rabies vaccination of **jackals**: Progress in Zimbabwe. *Onderstepoort Journal of Veterinary Research*, 60(4): 477-478.

BLUMSTEIN, D. T. & FOGGIN, J. M. 1993. Playing with fire? Alpine choughs play with a **Tibetan red fox**. *Journal of the Bombay Natural History Society*, 90(3): 513-515.

BOYD, D. K., PLETSCHER, D. H. & BREWSTER, W. G. 1993. Evidence of **wolves**, ***Canis lupus***, burying dead wolf pups. *Canadian Field-naturalist*, 107(2): 230-231.

BOYD, D. K., REAM, R. R., PLETSCHER, D. H. & FAIRCHILD, M. W. 1993. Variation in denning and parturition dates of a wild **gray wolf**, ***Canis lupus***, in the Rocky Mountains. *Canadian Field-naturalist*, 107(3): 359-360.

BROCHIER, B. & PASTORET, P. P. 1993. Rabies eradication in Belgium by **fox** vaccination using vaccinia-rabies recombinant virus. *Onderstepoort Journal of Veterinary Research*, 60(4): 469-475.

BRAASTAD, B. O. 1993. Periparturient behaviour of successfully reproducing farmed **silver-fox** vixens. *Applied Animal Behaviour Science*, 37(2): 125-138.

BWANGAMOI, O., NGATIA, T. A. & RICHARDSON, J. D. 1993. Sarcocystis-like organisms in musculature of a **domestic dog** (***Canis familiaris***) and **wild dogs** (***Lycaon pictus***) in Kenya. *Veterinary Parasitology*, 49(2-4): 201-205.

COSCIA, E. M. 1993. Swimming and aquatic play by timber **wolf**, ***Canis lupus***, pups. *Canadian Field-naturalist*, 107(3): 361-362.

CYPHER, B. L. 1993. Food item use by **coyote** pups at Crab Orchard National Wildlife Refuge, Illinois. *Transactions of the Illinois State Academy of Science*, 86(3-4): 133-137.

CYPHER, B. L. 1993. Food item use by **three sympatric canids** in southern Illinois. *Transactions of the Illinois State Academy of Science*, 86(3-4): 139-144.

CYPHER, B. L., WOOLF, A. & YANCY, D. C. 1993. Summer food habits of **coyotes** at Union County Conservation Area, Illinois. *Transactions of the Illinois State Academy of Science*, 86(3-4): 145-152.

DERIX, R., VAN HOOFF. J., DE VRIESS. H. & WENSING, J. 1993. Male and female mating competition in **wolves**: Female suppression vs. male intervention. *Behaviour*, 127(1-2): 141-174.

ENGLISH, R. A., STALMANS, M., MILLS, M. G. L. & VAN WYK. A. 1993. Helicopter-assisted boma capture of **African wild dogs** ***Lycaon pictus***. *Koedoe*, 36(1): 103-106.

EWALD, D. & ECKERT, J. 1993. Distribution and frequency of *Echinococcus multilocularis* among **red fox** in north, south and east Switzerland as well as in the Principality of Liechtenstein. *Zeitschrift Fuer Jagdwissenschaft*, 39(3): 171-180.

FARSTAD, W., HYTTEL, P., GRONDAHL, C., MONDAIN-MONVAL, M. & SMITH, A. J. 1993. Fertilization and early embryonic development in the **blue fox** (***Alopex lagopus***). *Molecular Reproduction and Development*, 36(3): 331-337.

FRAFJORD, K. 1993. Reproductive effort in the **arctic fox** ***Alopex lagopus***: A review. *Norwegian Journal of Agricultural Sciences*, 7(3-4): 301-309.

FRAFJORD, K. 1993. Seasonal changes in activity of **arctic foxes** ***Alopex lagopus*** **L.** in Svalbard. *Fauna Norvegica Series A*, 14(0): 39-46.

FRAFJORD, K. 1993. Sexual size dimorphism in the skull of the Norwegian **red fox** ***Vulpes vulpes*** **L.** *Fauna Norvegica Series A*, 14(0): 59-60.

FRAFJORD, K. 1993. Agonistic behaviour and dominance relations of captive **arctic foxes** (***Alopex lagopus***) in Svalbard. *Behavioural Processes*, 29(3): 239-252.

FRAFJORD, K. 1993. Energy intake of captive adult-sized **arctic foxes** ***Alopex lagopus*** in Svalbard, in relation to body weight, climate, and activity. *Zeitschrift Fuer Saeugetierkunde*, 58(5): 266-274.

GASCOYNE, S. C., KING, A. A., LAURENSON, M. K., BORNER, M., SCHILDGER, B. & BARRAT, J. 1993. Aspects of rabies infection and control in the conservation of the **African wild dog** (***Lycaon pictus***) in the Serengeti region, Tanzania. *Onderstepoort Journal of Veterinary Research*, 60(4): 415-420.

GASCOYNE, S. C., LAURENSON, M. K., LELO, S. & BORNER, M. 1993. Rabies in **African wild dogs** (***Lycaon pictus***) in the Serengeti region, Tanzania. *Journal of Wildlife Diseases*, 29(3): 396-402.

GEFFEN, E., HEFNER, R., MACDONALD, D. W. & UCKO, M. 1993. Biotope and distribution of **Blanford's fox**. *Oryx*, 27(2): 104-108.

GEFFEN, E. & MACDONALD, D. W. 1993. Activity and movement patterns of **Blanford's foxes**. *Journal of Mammalogy*. 74: 455-463.

GEHRING, T. M. 1993. Adult black bear, *Ursus americanus*, displaced from a kill by a wolf, ***Canis lupus***, pack. *Canadian Field-naturalist*, 107(3): 373-374.

GENOV, P. W. & KOSTAVA, V. 1993. Investigations on the number of **wolves** and their effects on domestic animals in Bulgaria. *Zeitschrift Fuer Jagdwissenschaft*, 39(4): 217-223.

GESE, E. M. & ANDERSEN, D. E. 1993. Success and cost of capturing **coyotes**, ***Canis latrans***, from all-terrain-vehicles. *Canadian Field-naturalist*, 107(1): 112-114.

GIRMAN, D. J., KAT, P. W., MILLS, M. G. L., GINSBERG, J. R., BORNER, M., WILSON, V., FANSHAWE, J. H., FITZGIBBON, C., LAU, L. M. & WAYNE, R. K. 1993. Molecular genetic and morphological analyses of the **African wild dog** (***Lycaon pictus***). *Journal of Heredity*, 84(6): 450-459.

GODDARD, H. N. & REYNOLDS, J. C. 1993. Age determination in the **red fox** (***Vulpes vulpes* L.**) from tooth cementum lines. *Gibier Faune Sauvage*, 10(sept.): 173-187.

GRAY, D. R. 1993. The use of muskox kill sites as temporary rendezvous sites by **arctic wolves** with pups in early winter. *Arctic*, 46(4): 324-330.

GUBERTI, V., STANCAMPIANO, L. & FRANCISCI, F. 1993. Intestinal helminth parasite community in **wolves** (***Canis lupus***) in Italy. *Parassitologia (rome)*, 35(1-3): 59-65.

GORSKI, J., ZWIERZCHOWSKI, J., MIZAK, B. & DANIEL, A. 1993. Prevalence of parvoviral antibodies in **fox** breeding farms. *Acta Microbiologica Polonica*, 42(2): 157-162.

HAQUE, M. E., PANDIT, R. K., AHMAD, S. & BROOKS, J. E. 1993. Status of the **golden jackal** as an agricultural pest in Bangladesh. *Crop Protection*, 12(8): 563-564.

HARRISON, R. L. 1993. Survey of anthropogenic ecological factors potentially affecting **gray foxes** (***Urocyon cinereoargenteus***) in a rural residential area. *Southwestern Naturalist*, 38(4): 352-356.

HELLE, E. & KAUHALA, K. 1993. Age structure, mortality, and sex ratio of the **raccoon dog** in Finland. *Journal of Mammalogy*, 74(4): 936-942.

HERAN, I. 1993. Pathological skull of the **maned wolf**, ***Chrysocyon brachyurus***. *Acta Societatis Zoologicae Bohemicae*, 57(2): 105-107.

HOSODA, T., SUZUKI, H., YAMADA, T. & TSUCHIYA, K. 1993. Restriction site polymorphism in the ribosomal DNA of eight species of **Canidae** and Mustelidae. *Cytologia (Tokyo)*, 58(2): 223-230.

IKARMA, H. 1993. Status and management of the **wolf** in Poland. *Biological Conservation*, 66(3): 153-158.

JHALA, Y. V. 1993. Predation on blackbuck by **wolves** in Velavadar National Park, Gujarat, India. *Conservation Biology*, 7(4): 874-881.

JOHNSON, D. R. & HERSTEINSSON, P. 1993. Inheritance models of North American **red fox** coat color. *Canadian Journal of Zoology*, 71(7): 1364-1366.

KASHTANOV, S. N. 1993. The analysis of selection process in breeding of **polar fox** caging populations. *Genetika*, 29(10): 1755-1757.

KAUFMAN, G. A., BRILLHART, D. E. & KAUFMAN, D. W. 1993. Are deer mice a common prey of **coyotes**?. *Prairie Naturalist*, 25(4): 295-304.

KAUHALA, K. 1993. Growth, size, and fat reserves of the **raccoon dog** in Finland. *Acta Theriologica*, 38(2): 139-150.

KAUHALA, K., HELLE, E. & TASKINEN, K. 1993. Home range of the **raccoon dog** (***Nyctereutes procyonoides***) in southern Finland. Journal of Zoology (London), 231(1): 95-106.

KAUHALA, K., KAUNISTO, M. & HELLE, E. 1993. Diet of the **raccoon dog**, ***Nyctereutes procyonoides***, in Finland. *Zeitschrift Fuer Saeugetierkunde*, 58(3): 129-136.

KILONZO, B. S., GISAKANYI, N. D. & SABUNI, C. A. 1993. Involvement of **dogs** in plague epidemiology in Tanzania: serological observations in domestic animals in Lushoto District. *Scandinavian Journal of Infectious Diseases*, 25(4): 503-506.

KING, A. A., MEREDITH, C. D. & THOMSON, G. R. 1993. **Canid** and viverrid rabies viruses in South Africa. *Onderstepoort Journal of Veterinary Research*, 60(4): 295-299.

KOLESNIKOVA, L. A., YAGA, K., HATTORI, A. & REITER, R. 1993. Tissue content of melatonin in relatively wild and domesticated ***Vulpes fulvus***. *Zhurnal Evolyutsionnoi Biokhimii I Fiziologii*, 29(5-6): 482-486.

KORHONEN, H. & NIEMELA, P. 1993. Evalnation of the relationship between social status and reproductive performance in farmed **blne foxes**. *Reproduction Nutrition Development*, 33(3): 289-295.

LAIKRE, L., RYMAN, N. & THOMPSON, E. A. 1993. Hereditary blindness in a captive **wolf** (***Canis lupus***) population: frequency reduction of a deleterious allele in relation to gene conservation. *Conservation Biology*, 7(3): 592-601.

LEE, G. W., LEE, K. A. & DAVIDSON, W. R. 1993. Evaluation of **fox**-chasing enclosures as sites of potential introduction and establishment of Echinococcus multilocularis. *Journal of Wildlife Diseases*, 29(3): 498-501.

LINDEBERG, H., JALKANEN, L. & SAVOLAINEN, R. 1993. In vitro culture of **silver fox** embryos. *Theriogenology*, 40(4): 779-788.

LOMBARDI, J. A. & MOTTA Jn,. J. C. 1993. Seed dispersal of *Solanum lycocarpum* St. Hil. (Solanaceae) by the **maned wolf**, ***Chrysocyon brachyurus* Illiger** (Mammalia, Canidae). *Ciencia E Cultura (Sao Paulo)*, 45(2): 126-127.

MAAS, B. 1993. **Bat-eared fox** behavioural ecology and the incidence of rabies in the Serengeti National Park. *Onderstepoort Journal of Veterinary Research*, 60(4): 389-393.

MACDONALD, D. W. & COURTENAY, O. 1993. Wild and domestic **canids** as reservoirs of American Visceral Leishmaniasis in Amazonia. In: *Mammals as Predators*, Eds N. Dunstone & M. L. Gorman. *Proceedings of the Symposia of the Zoological Society of London*, 65: 465-479.

MACHIDA, N., KIRYU, K., OH-ISHI, K., KANADA, E., IZUMISAWA, N. & NAKAMURA, T. 1993. Pathology and epidemiology of canine distemper in **raccoon dogs** (***Nyctereutes procyonoides***). *Journal of Comparative Pathology*, 108(4): 383-392.

MANCIANTI, F., PAPINI, R. & POLI, A. 1993. Mycological survey from coats of **red foxes** in Italy. *Journal de Mycologie Medicale*, 3(2): 109-110.

MARAIS, E. & GRIFFIN, M. 1993. Range extension in the **bat-eared fox *Otocyon megalotis*** in Namibia. *Madoqua*, 18(2): 187-188.

MARTINEZ, D. R., RAU, J. R. & JAKSIC, F. M. 1993. Numerical response and diet selectivity of foxes (***Pseudalopex spp.***) faced with a prey decrease in northern Chile. *Revista Chilena De Historia Natural*, 66(2): 195-202.

MARTINEZ, D. R., RAU, J. R., MURUA, R. E. & TILLERIA, M. S. 1993. Selective predation of rodents by **gray foxes** (***Pseudalopex griseus***) in the Valdivian rainforest, Chile. *Revista Chilena De Historia Natural*, 66(4): 419-426.

McKENZIE, A. A. 1993. Biology of the **black-backed jackal *Canis mesomelas*** with reference to rabies. *Onderstepoort Journal of Veterinary Research*, 60(4): 367-371.

MECH, D. L 1993. Wolves of the high arctic. Airlife, 128 pp.

MEIA, J. S., MEYER, S. & AUBRY, S. 1993. **Red foxes** and hares in the Swiss Jura: no interspecific interaction. *Bulletin De La Societe Neuchateloise Des Sciences Naturelles*, 116(2): 41-46.

MEIA, J. S. & WEBER, J. M. 1993. Choice of resting sites by female **foxes *Vulpes vulpes*** in a mountainous habitat. *Acta Theriologica*, 38(1): 81-91.

MERCURE, A., RALLS, K., KOEPFLI & K. P., WAYNE, R. K. 1993. Genetic subdivisions among small canids: Mitochondrial DNA differentiation of **swift**, **kit**, and **arctic foxes**. *Evolution*, 47(5): 1313-1328.

MILLS, M. G. L. 1993. Social systems and behaviour of the **African wild dog *Lycaon pictus*** and the spotted hyaena *Crocuta crocuta* with special reference to rabies. *Onderstepoort Journal of Veterinary Research*, 60(4): 405-409.

MONONEN, J., HARRI, M., ROUVINEN, K. & NIEMELA, P. 1993. The use of resting platforms by young **silver foxes** (***Vulpes vulpes***). *Applied Animal Behaviour Science*, 38(3-4): 301-310.

NEL, J. A. J. 1993. The **bat-eared fox**: A prime candidate for rabies vector?. *Onderstepoort Journal of Veterinary Research*, 60(4):

395-397.

OKARMA, H. & BUCHALCZYK, T. 1993. Craniometrical characteristics of **wolves *Canis lupus*** from Poland. *Acta Theriologica*, 38(3): 253-262.

ORLOFF, S. G., FLANNERY, A. W. & BELT, K. C. 1993. Identification of **San Joaquin kit fox (*Vulpes macrotis mutica*)** tracks on aluminum tracking plates. *California Fish and Game*, 79(2): 45-53.

OSADCHUK, L. 1993. Sexual steroid hormones in the reproductive cycle of **silver fox**. *Norwegian Journal of Agricultural Sciences*, 7(2): 189-201.

PEDERSEN, V. 1993. Effects of different post-weaning handling procednres on the later behaviour of **silver foxes**. *Applied Animal Behaviour Science*, 37(3): 239-250.

PERRY, B. D. & WANDELER, A. I. 1993. The delivery of oral rabies vaccines to **dogs**: An African perspective. *Onderstepoort Journal of Veterinary Research*, 60(4): 451-457.

POULLE, M. L., CRETE, M., HUOT, J. & LEMIEUX, R. 1993. **Coyote, *Canis latrans***, predation on white-tailed deer, *Odocoileus virginianus*, in a declining wintering area of eastern Quebec. *Canadian Field-naturalist*, 107(2): 177-185.

PRASOLOVA, L. A. & TRUT, L. N. 1993. Effect of gene Star on melanoblast migration rate in **silver fox *Vulpes vulpes*** embryos. *Doklady Akademii Nauk*, 329(6): 787-789.

RADOMSKI, A. A. & PENCE, D. B.1993. Persistence of a recurrent group of intestinal helminth species in a **coyote** population from southern Texas. *Journal of Parasitology*, 79(3): 371-378.

RANDI, E. 1993. Effects of fragmentation and isolation on genetic variability of the Italian populations of **wolf *Canis lupus*** and brown bear *Ursus arctos*. *Acta Theriologica*, 38(suppl. 2): 113-120.

RANDI, E., LUCCHINI, V. & FRANCISCI, F. 1993. Allozyme variability in the Italian **wolf (*Canis lupus*)** population. *Heredity*, 71(5): 516-522.

REIG, S. 1993. Non aggressive encounter between a **wolf** pack and a wild boar. *Mammalia*, 57(3): 451-453.

REYNOLDS, J. C., GODDARD, H. N. & BROCKLESS, M. H. 1993. The impact of local **fox (*Vulpes vulpes*)** removal on fox populations at two sites in southern England. *Gibier Faune Sauvage*, 10(dec.): 319-334.

RICHARDS, D. T., HARRIS, S. & LEWIS, J. W. 1993. Epidemiology of *Toxocara canis* in **red foxes (*Vulpes vulpes*)** from urban areas of Bristol. *Parasitology*, 107(2): 167-173.

SAUNDERS, G., HARRIS, S. & EASON, C. T. 1993. Iophenoxic acid as a quantitative bait marker for **foxes**. *Wildlife Research*, 20(3): 297-302.

SKIRNISSON, K., EYDAL, E., GUNNARSSON, E. & HERSTEINSSON, P. 1993. Parasites of the **arctic fox (*Alopex lagopus*)** in Iceland. *Journal of Wildlife Diseases*, 29(3): 440-446.

SMIETANA, W. & KLIMEK, A. 1993. Diet of **wolves** in the Bieszczady Mountains, Poland. *Acta Theriologica*, 38(3): 245-251.

SMITS, C. M. M. & SLOUGH, B. G. 1993. Abundance and summer occupancy of **arctic fox, *Alopex lagopus***, and **red fox, *Vulpes vulpes***, dens in the northern Yukon Territory 1984-1990. *Canadian Field-naturalist*, 107(1): 13-18.

SOSNOVTSEV, S. V., IVANOV, S. V., SOLOV'EV, V. V., POTAPOV, V. A. & ROMASHCHENKO, A. G. 1993. Recombination events in evolution of satellite-like Bsp-repeats: Formation of subrepeat and monomer units predates the divergence of **Candidae** lineages. *Molekulyarnaya Biologiya (Moscow)*, 27(5): 992-1013.

STEPHENSON, S. W. & KENNEDY, M. L. 1993. Demography of a **coyote** population in western Tennessee. *Journal of the Tennessee Academy of Science*, 68(4): 122-124.

STUART, J. N. & ANDERSON, R. E. 1993. The **gray fox, *Urocyon cinereoargenteus***, on the Llano Estacado of New Mexico. *Texas Journal of Science*, 45(4): 354-355.

THOMSON, G. R. & MEREDITH, C. D. 1993. Rabies in **bat-eared foxes** in South Africa. *Onderstepoort Journal of Veterinary Research*, 60(4): 399-403.

THURBER, J. M. & PETERSON, R. O. 1993. Effects of population density and pack size on the foraging ecology of **gray wolves**. *Journal of Mammalogy*, 74(4): 879-889.

TRAVAINI, A., ALDAMA, J. J., LAFFITTE, R. & DELIBES, M. 1993. Home range and activity patterns of **red fox *Vulpes vulpes*** breeding females. *Acta Theriologica*, 38(4): 427-434.

TRAVAINI, A., ALDAMA, J. & DELIBES, M. 1993. **Red fox** capture locations in relation to home range boundaries. *Mammalia*, 57(3): 448-451.

TRUT, L. N., NESTEROVA, T. B. & ZAKIYAN, S. M. 1993. Comparative analysis of the level of heterozygosity for glucose phosphate isomerase (GPI) locus in **silver foxes (*Vulpes vulpes*)** of domesticated and control populations. *Genetika*, 29(4): 694-698.

VANEK, M. & KELLER, A. 1993. Morphology of cuticular cells of guard hairs of the adult **polar fox – *Alopex lagopus*** (Linne, 1758) in the scanning electron microscope (SEM). *Revue Suisse De Zoologie*, 100(4): 899-903.

VASILYEVA, L. L. & SVECHNIKOV, K. V. 1993. Blood serotonin level in domestic **silver foxes** as a major-gene marker of domestic behavior. *Genetika*, 29(3): 498-507.

VEITCH, A. M., CLARK, W. E. & HARRINGTON, F. H. 1993. Observations of an interaction between a barren-ground black bear, *Ursus americanus*, and a **wolf, *Canis lupus***, at a wolf Den in northern Labrador. *Canadian Field-naturalist*, 107(1): 95-97.

WANG, ANDERSEN. G., SKAARE, J. U., PRESTRUD, P. & STEINNES, E. 1993. Levels and congener pattern of PCBs in **arctic fox, *Alopex lagopus***, in Svalbard. *Environmental Pollution*, 82(3): 269-275.

WAWRZKIEWICZ, K., WAWRZKIEWICZ, J. & SADZIKOWSKI, Z. 1993. An experimental infection of breeding **foxes** with *Microsporum canis*: treatment and immunoprophylaxis. *Medycyna Weterynaryjna*, 49(12): 543-547.

WEAVER, J. L. 1993. Refining the equation for interpreting prey occurrence in **gray wolf** scats. *Journal of Wildlife Management*, 57(3): 534-538.

WHITE, P. J. & RALLS, K. 1993. Reproduction and spacing patterns of **kit foxes** relative to changing prey availability. *Journal of Wildlife Management*, 57(4): 861-867.

WOODALL, P. F., PAVLOV, P. & TOLLEY, L. K. 1993. Comparative dimensions of testes, epididymides and spermatozoa of Australian **dingoes (*Canis familiaris dingo*)** and **domestic dogs (*Canis familiaris familiaris*)**: some effects of domestication. *Australian Journal of Zoology*, 41(2): 133-140.

1994

AHLSTROM, O., SKREDE, A. & THOMASSEN, M. S. 1994. Effects of herring scraps feeding on body fat composition, growth and fur quality in **silver foxes**. *Norwegian Journal of Agricultural Sciences*, 8(1): 55-67.

ALEXANDER, K. A. & APPEL, M. J. G. 1994. **African wild dogs (*Lycaon pictus*)** endangered by a canine distemper epizootic among **domestic dogs** near the Masai Mara National Reserve, Kenya. *Journal of Wildlife Diseases*, 30(4): 481-485.

ALEXANDER, K. A., KAT, P. W., WAYNE, R. K. & FULLER, T. K. 1994. Serologic survey of selected canine pathogens among free-ranging **jackals** in Kenya. *Journal of Wildlife Diseases*, 30(4): 486-491.

ANGERBJORN, A., HERSTEINSSON, P., LIDEN, K. & NELSON, E. 1994. Dietary variation in **arctic foxes (*Alopex lagopus*)**: An analysis of stable carbon isotopes. *Oecologia (Berlin)*, 99(3-4):

226-232.

ANSORGE, H. 1994. Intrapopular skull variability in the **red fox**, ***Vulpes vulpes*** (Mammalia: Carnivora: Canidae). *Zoologische Abhandlungen (Dresden)*, 48(1-9): 103-123.

BARBOZA, P. S., ALLEN, M. E., RODDEN, M. & POJETA, K. 1994. Feed intake and digestion in the **maned wolf** (***Chrysocyon brachyurus***): Consequences for dietary management. *Zoo Biology*, 13(4): 375-381.

BLIZNYUK, A. I. 1994. On ***Vulpes corsac* L.**, 1768 variability. *Byulleten' Moskovskogo Obshchestva Ispytatelei Prirody Otdel Biologicheskii*, 99(1): 8-13.

BORKOWSKI, J. 1994. Food composition of **red fox** in the Tatra National Park. *Acta Theriologica*, 39(2): 209-214.

BOUNDS, D. L. & SHAW, W. W. 1994. Managing **coyotes** in U.S. National Parks: Human-coyote interactions. *Natural Areas Journal*, 14(4): 280-284.

BOYD, D. K., REAM, R. R., PLETSCHER, D. H. & FAIRCHILD, M. W. 1994. Prey taken by colonizing **wolves** and hunters in the Glacier National Park area. *Journal of Wildlife Management*, 58(2): 289-295.

BRAASTAD, B. O. 1994. Reproduction in **silver-fox** vixens in breeding boxes with and without an entrance tunnel. *Acta Agriculturae Scandinavica Section A Animal Science*, 44(1): 38-42.

BRADLEY, M. P. 1994. Experimental strategies for the development of au immunocontraceptive vaccine for the European **red fox, *Vulpes vulpes***. *Reproduction Fertility and Development*, 6(3): 307-317

BRILLHART, D. E. & KAUFMAN, D. W. 1994. Temporal variation in **coyote** prey in tallgrass prairie of eastern Kansas. *Prairie Naturalist*, 26(2): 93-105.

BROCHIER, B., BOULANGER, D., COSTY, F. & PASTORET, P. P. 1994. Towards rabies elimination in Belgium by **fox** vaccination using a vaccinia-rabies glycoprotein recombinant virus. *Vaccine*, 12(15): 1368-1371.

BURROWS, R., HOFER, H. & EAST, M. L. 1994. Demography, extinction and intervention in a small population: the case of the Serengeti **wild dogs**. *Proceedings of the Royal Society of London Series B Biological Sciences*, 256(1347): 281-292.

CAVALLINI, P. 1994. Faeces count as an index of **fox** abundance. *Acta Theriologica*, 39(4): 417-424.

CAVALLINI, P. & LOVARI, S. 1994. Home range, habitat selection and activity of the **red fox** in a Mediterranean coastal ecotone. *Acta Theriologica*, 39(3): 279-287.

CHAKRABORTY, G. & DAS, A. K. 1994. Xylazine-ketamine anaesthesia in a **Tibetan wolf** (***Canis lupus chanco***). *Indian Veterinary Journal*, 71(10): 1047.

CLARK, K. A., NEILL, S. U., SMITH, J. S., WILSON, P. J., WHADFORD, V. W. & McKIRAHAN, G. W. 1994. Epizootic canine rabies transmitted by **coyotes** in south Texas. *Journal of the American Veterinary Medical Association*, 204(4): 536-540.

CLUTTON-BROCK, J. & HAMMOND, N. 1994. Hot dogs: Comestible **canids** in preclassic Maya culture at Cuello, Belize. *Journal of Archaeological Science*, 21(6): 819-826.

CLUTTON-BROCK, J., KITCHENER, A. C. & LYNCH, J. M. 1994. Changes in the skull morphology of the **arctic wolf, *Canis lupus arctos***, during the twentieth century. *Journal of Zoology (London)*, 233(1): 19-36.

CONOVER, M. R. & KESSLER, K. K. 1994. Diminished producer participation in an aversive conditioning program to reduce **coyote** predation on sheep. *Wildlife Society Bulletin*, 22(2): 229-233.

COURTENAY, O., MACDONALD, D. W., LAINSON, R., SHAW, J. J. & DYE, C. 1994. Epidemiology of canine leishmaniasis: A comparative serological study of **dogs** and **foxes** in Amazon Brazil. *Parasitology*, 109(3): 273-279.

CROOKS, K. 1994. Demography and status of the **island fox** and the island spotted skunk on Santa Cruz Island, California. *Southwestern Naturalist*, 39(3): 257-262.

CYPHER, B. L., SPENCER, K. A. & SCRIVNER, J. H. 1994. Food-item use by **coyotes** at the Naval Petroleum Reserves in California. *Southwestern Naturalist*, 39(1): 91-95.

DALE, B. W., ADAMS, L. G. & BOWYER, R. T. 1994. Functional response of **wolves** preying on barren-ground caribou in a multiple-prey ecosystem. *Journal of Animal Ecology*, 63(3): 644-652.

DUBEY, J. P. & LIN, T. L. 1994. Acute toxoplasmosis in a **gray fox** (***Urocyon cinereoargenteus***). *Veterinary Parasitology*, 51(3-4): 321-325.

DYGALO, N. N. & KALININA, T. S. 1994. Tyrosine hydroxylase activities in the brains of wild Norway rats and **silver foxes** selected for reduced aggressiveness towards humans. *Aggressive Behavior*, 20(6): 453-460.

FRAFJORD, K. 1994. Daily activity patterns of captive **arctic foxes *Alopex lagopus*** in Svalbard. *Fauna (Oslo)*, 47(3): 236-241.

FRAFJORD, K. 1994. Growth rates and energy demands in captive juvenile **arctic foxes *Alopex lagopus*** in Svalbard. *Polar Biology*, 14(5): 355-358.

FRAFJORD, K. & HUFTHAMMER, K. 1994. Subfossil records of the **arctic fox** (***Alopex lagopus***) compared to its present distribution in Norway. *Arctic*, 47(1): 65-68.

FRITTS, S. V., BANGS, E. E. & GORE, J. F. 1994. The relationship of **wolf** recovery to habitat conservation and biodiversity in the northwestern United States. *Landscape and Urban Planning*, 28(1): 23-32.

GEFFEN, E. 1994. ***Vulpes cana* Blanford**, 1877: **Blanford's fox**. *Mammalian Species*, 0(462): 1-4.

GEORGI, S., BACHOUR, G., FAILING, K., ESKENS, U., ELMADFA, I. & BRUNN, H. 1994. Polychlorinated biphenyl congeners in **foxes** in Germany from 1983 to 1991. *Archives of Environmental Contamination and Toxicology*, 26(1): 1-6.

GORTAZAR, C., CASTILLO, J. A., LUCIENTES, J., BLANCO, J. C., ARRIOLABENGOA, A. & CALVETE, C. 1994. Factors affecting Dirofilaria immitis prevalence in **red foxes** in northeastern Spain. *Journal of Wildlife Diseases*, 30(4): 545-547.

GOTTELLI, D., SILLERO-ZUBIRI. C., APPLEBAUM, G. D., ROY, M. S., GIRMAN, D. J., GARCIA-MORENO. J., OSTRANDERS & E. A., WAYNE, R. K. 1994. Molecular genetics of the most endangered canid: the **Ethiopian wolf *Canis simensis***. *Molecular Ecology*, 3(4): 301-312.

HANCOX, M. 1994. Dental loss, disease and abnormalities in Scottish **red foxes**. *Glasgow Naturalist*, 22(4): 375-378.

HARTLEY, F. G. L., FOLLETT, B. K., HARRIS, S., HIRST, D. & McNEILLY, A. S. 1994. The endocrinology of gestation failure in **foxes** (***Vulpes vulpes***). *Journal of Reproduction and Fertility*, 100(2): 341-346.

HATTER, I. W. & JANZ, D. W. 1994. Apparent demographic changes in the black-tailed deer associated with **wolf** control on northern Vancouver Island. *Canadian Journal of Zoology*, 72(5): 878-884.

HEIN, E. W. & ANDELT, W. F. 1994. Evaluation of **coyote** attractants and an oral delivery device for chemical agents. *Wildlife Society Bulletin*, 22(4): 651-655.

HERNANDEZ, L. & DELIBES, M. 1994. Seasonal food habits of **coyotes, *Canis latrans***, in the Bolson de Mapimi, Southern Chihuahuan Desert, Mexico. *Zeitschrift Fuer Saeugetierkunde*, 59(2): 82-86.

HERNANDEZ, L., DELIBES, M. & HIRALDO, F. 1994. Role of reptiles and arthropods in the diet of **coyotes** in extreme desert areas of northern Mexico. *Journal of Arid Environments*, 26(2): 165-170.

HEWSON, R. 1994. The use of dens by hill **foxes** (***Vulpes vulpes***). *Journal of Zoology (London)*, 233(2): 331-335.

HOLZ, P., HOLZ, R. M. & BARNETT, J. E. F. 1994. Effects of atropine on medetomidine/ketamine immobilization in the **gray wolf** (***Canis lupus***). *Journal of Zoo and Wildlife Medicine*, 25(2): 209-213.

ISOGAI, E., ISOGAI, H., KAWABATA, H., MASUZAWA, T., YANAGIHARA, Y., KIMURA, K., SAKAI, T., AZUMA, Y., FUJII, N. & OHNO, S. 1994. Lyme disease spirochetes in a wild **fox** (*Vulpes vulpes schrencki*) and in ticks. *Journal of Wildlife*, Diseases 30(3): 439-444.

JAY, M. T., REILLY, K. F., DEBESS, E. E., HAYNES, E. H., BADER, D. R. & BARRETT, L. R. 1994. Rabies in a vaccinated **wolf-dog hybrid**. *Journal of the American Veterinary Medical Association*, 205(12): 1729-1732,1719.

JEDRZEJEWSKA, B., OKARMA, H., JEDRZEJEWSKI, W. & MILKOWSKI, L. 1994. Effects of exploitation and protection on forest structure, ungulate density and **wolf** predation in Bialowieza Primeval Forest, Poland. *Journal of Applied Ecology*, 31(4): 664-676.

JOHNSON, M. R., BOYD, D. K. & PLETSCHERE, D. H. 1994. Serologic investigations of canine parvovirus and canine distemper in relation to **wolf** (***Canis lupus***) pup mortalities. *Journal of Wildlife Diseases*, 30(2): 270-273.

JOHNSON, W. E. & FRANKLIN, W. L. 1994. Spatial resource partitioning by sympatric **grey fox** (***Dusicyon griseus***) and **culpeo fox** (***Dusicyon culpaeus***) in southern Chile. *Canadian Journal of Zoology*, 72(10): 1788-1793.

JOHNSON, W. E. & FRANKLIN, W. L. 1994. Role of body size in the diets of sympatric gray and culpeo foxes. *Journal of Mammalogy*, 75(1): 163-174.

KLIR, J. J. & HEATH, J. E. 1994. Thermoregulatory responses to thermal stimulation of the preoptic anterior hypothalamus in the **red fox** (***Vulpes vulpes***). *Comparative Biochemistry and Physiology a Comparative Physiology*, 109(3): 557-566.

KOEHLER, J. K., PLATZ, C. C. Jr., WADDELL, W., JONES, M. H., SMITH, R. & BEHRNS, S. 1994. Spermophagy in semen in the **red wolf**, ***Canis rufus***. *Molecular Reproduction and Development*, 37(4): 457-461.

KOLESNIKOVA, L. A., SEROVA, L. I., YAGA, K., HATTORI, A. & REITER, R. 1994. Peculiarities of melatonin biosynthesis in the pineal gland of relatively wild and domesticated **silver foxes** ***Vulpes fulva***. *Zhurnal Evolyutsionnoi Biokhimii I Fiziologii*, 30(3): 338-343.

KORHONEN, H. & ALASUUTARI, S. 1994. Social relationships and reproductive performance in group-living **arctic blue foxes**. *Agricultural Science in Finland*, 3(1): 49-58.

KORHONEN, H. & NIEMELA, P. 1994. Preferences of farmed **blue foxes** for platforms, nestbox and cage floor. *Agricultural Science in Finland*, 3(5): 467-472.

KOROLEVA, I. V., KHLEBODAROVA, T. M., RUBTSOV, N. B. & ZAKIYAN, S. M. 1994. Mapping of **silver fox** genome: IV. Location of ornithine carbamoyltransferase and prion protein genes in chromosomes. *Genetika*, 30(6): 839-842.

KUNKEL, K. E. & MECH, L. D. 1994. **Wolf** and bear predation on white-tailed deer fawns in northeastern Minnesota. *Canadian Journal of Zoology*, 72(9): 1557-1565.

LEON-LOBOS. P. M. & KALIN-ARROYO. M. T. 1994. Germination of *Lithrea caustica* (Mol.) H. et A. (Anacardiaceae) seeds dispersed by ***Pseudalopex spp***. (Canidae) in the Chilean Matorral. *Revista Chilena De Historia Natural*, 67(1): 59-64.

LEWIS, T. L., JENSEN, W. F., KEEHR, K. A. & SEABLOOM, R. W. 1994. Summer and fall food habits of **coyotes** in southwestern North Dakota. *Prairie Naturalist*, 26(4): 287-292.

LICHT, D. S. & FRITTS, S. H. 1994. **Gray wolf** (***Canis lupus***) occurrences in the Dakotas. *American Midland Naturalist*, 132(1): 74-81.

LIKHOTOP, R. I. 1994. Cranial and dentition anomalies in **wolf** of the Ukrainian territory. *Vestnik Zoologii*, 0(3): 45-50.

LIMA, W. S., GUIMARAES, M. P. & LEMOS, I. S. 1994. Occurrence of *Angiostrongylus vasorum* in the lungs of the **Brazilian fox** ***Dusicyon vetulus***. *Journal of Helminthology*, 68(1): 87.

LINDSTROM, E. R. 1994. Placental scar counts in the **red fox** (***Vulpes vulpes*** L.) revisited. *Zeitschrift Fuer Saeugetierkunde*, 59(3): 169-173.

LINDSTROM, E. R. 1994. Large prey for small cubs on crucial resources of a boreal **red fox** population. *Ecography*, 17(1): 17-22.

LINDSTROM, E. R., ANDREN, H., ANGELSTAM, P., CEDERLUND, G., HORNFELDT, B., JADERBERG, L., LEMNELL, P. A., MARTINSSON, B., SKOLD, K. & SWENSON, J. E. 1994. Disease reveals the predator: sarcoptic mange, **red fox** predation, and prey populations. *Ecology (Tempe)*, 75(4): 1042-1049.

LINDSTROM, E. R. & HORNFELDT, B. 1994. Vole cycles, snow depth and **fox** predation. *Oikos*, 70(1): 156-160.

LOPEZ PENA. M., QUIROGA, M. I., VAZQUEZ, S. & NIETO, J. M. 1994. Detection of canine distemper viral antigen in **foxes** (***Vulpes vulpes***) in northwestern Spain. *Journal of Wildlife Diseases*, 30(1): 95-98.

LOVARI, S., VALIER, P. & LUCCHI, M. R. 1994. Ranging behaviour and activity of **red foxes** (***Vulpes vulpes***: Mammalia) in relation to environmental variables, in a Mediterranean mixed pinewood. *Journal of Zoology (London)*, 232(2): 323-339.

LUCHERINI, M. & CREMA, G. 1994. Seasonal variation in diet and trophic niche of the **red fox** in an Alpine habitat. *Zeitschrift Fuer Saeugetierkunde*, 59(1): 1-8.

MACDONALD, D. W., BROWN, L., YERLI, S. & CANBOLAT, A. F. 1994. Behavior of **red foxes**, ***Vulpes vulpes***, caching eggs of loggerhead turtles, *Caretta caretta*. *Journal of Mammalogy*, 75(4): 985-988.

MACDONALD, D. W. & HALLIWELL, E. C. 1994. The rapid spread of **red foxes**, ***Vulpes vulpes***, on the Isle of Man. *Global Ecology & Biogeography Letters*, 4: 9-16.

MADDOCK, A. H. & MILLS, M. G. L. 1994. Population characteristics of **African wild dogs** ***Lycaon pictus*** in the eastern Transvaal Lowveld, South Africa, as revealed through photographic records. *Biological Conservation*, 67(1): 57-62.

MADEYSKA, LEWANDOWSKA. A., KURYL, J. & ZDUNKIEWICZ, T. 1994. Polymorphism of blood serum proteins in the **fox**. *Animal Science Papers and Reports*. 12(2): 73-77.

MALLORY, F. F., HILLIS, T. L., BLOMME, C. G. & HURST, W. G. 1994. Skeletal injuries of an adult timber **wolf**, ***Canis lupus***, in northern Ontario. *Canadian Field-naturalist*, 108(2): 230-232.

MANCIANTI, F., MIGNONE, W. & GALASTRi, F. 1994. Serologic survey for Leishmaniasis in free-living red foxes (***Vulpes vulpes***) in Italy. *Journal of Wildlife Diseases*, 30(3): 454-456.

MARQUARD-PETERSEN. U. 1994. Dens and summer pack size of **arctic wolves** in Hold with Hope, East Greenland. *Polar Record*, 30(172): 46-49.

MASEGI, T., YANAI, T., SAKAI, T., MATSUMOTO, C., YAMAZOE, K., NUKAYA, A., KUNIMUNE, Y. & UEDA, K. 1994. Hypertrophic pulmonary osteoarthropathy in a **raccoon dog** (***Nyctereutes procyonoides***) with chronic pulmonary inflammatory lesions. *Journal of Wildlife Diseases*, 30(4): 612-615.

McLAREN, B. E. & PETERSON, R. O. 1994. **Wolves**, moose, and tree rings on isle royale. *Science (Washington D C)*, 266(5190): 1555-1558.

MECH, L. D. 1994. Regular and homeward travel speeds of **arctic wolves**. *Journal of Mammalogy*, 75(3): 741-742.

MECH, L. D. 1994. Buffer zones of territories of **gray wolves** as regions of intraspecific strife. *Journal of Mammalogy*, 75(1): 199-202.

MITRO, S. 1994. Results of oral immunization of **foxes** against rabies in former CSSR (Short communication). *Monatshefte Fuer Veterinaermedizin*, 49(2): 77-78.

MOCSARI, E., KEREKES, B., HELTAY, I., SZALAY, D. & CSABAY, L. 1994. Experiences on the oral vaccination of **foxes** against rabies in Hungary. *Magyar Allatorvosok Lapja*, 49(1): 10-15.

MOTTA Jn., J. C., LOMBARDI, J. A. & TALAMONI, S. A. 1994. Notes on **crab-eating fox** (***Dusicyon thous***) seed dispersal and food habits in southeastern Brazil. *Mammalia*, 58(1): 156-159.

MURRAY, D. L., BOUTIN, S. & O'DONOGHUE, M. 1994. Winter habitat selection by lynx and **coyotes** in relation to snowshoe hare abundance. *Canadian Journal of Zoology*, 72(8): 1444-1451.

NELSON, M. E. & MECH, L. D. 1994. single deer stands-off three **wolves**. *American Midland Naturalist*, 131(1): 207-208.

NIELSEN, S. M., PEDERSEN, V. & KLITGAARD, B. B. 1994. **Arctic fox** (***Alopex lagopus***) dens in the Disko Bay area, West Greenland. *Arctic*, 47(4): 327-333.

NUNAN, C. P., MACINNES, C. D., BACHMANN, P., JOHNSTON, D. H. & WATT, I. D. 1994. Background prevalence of tetracycline-like fluorescence in teeth of free ranging **red foxes** (***Vulpes vulpes***), striped skunks (*Mephitis mephitis*) and raccoons (*Procyon lotor*) in Ontario, Canada. *Journal of Wildlife Diseases*, 30(1): 112-114.

OMMUNDSEN, P. D. 1994. Problem-solving by a foraging wild **red fox**, ***Vulpes vulpes***. *Canadian Field-naturalist*, 108(2): 232-233.

OSADCHUK, L. V. 1994. Testosterone production in fetal testes of the **silver fox**. *Theriogenology*, 42(2): 279-286.

PALOMARES, F. & RUIZ-MARTINEZ. I. 1994. The density of **red fox** and the effect of its preying on small game during the kit season in southeastern Spain. *Zeitschrift Fuer Jagdwissenschaft*, 40(3): 145-155.

PAPAGEORGIOU, N., VLACHOS, C., SFOUGARIS, A. & TSACHALIDIS, E. 1994. Status and diet of **wolves** in Greece. *Acta Theriologica*, 39(4): 411-416.

PEDERSEN, V. 1994. Long-term effects of different handling procedures on behavioural, physiological, and production-related parameters in **silver foxes**. *Applied Animal Behaviour Science*, 40(3-4): 285-296.

PENCE, D. B. & WINDBERG, L. A. 1994. Impact of a sarcoptic mange epizootic on a **coyote** population. *Journal of Wildlife Management*, 58(4): 624-633.

PETERS, G. & RODEL, R. 1994. **Blanford's fox** in Africa. *Bonner Zoologische Beitraege*, 45(2): 99-111.

POULLE, M. L., ARTOIS, M. & ROEDER, J. J. 1994. Dynamics of spatial relationships among members of a **fox** group (***Vulpes vulpes***: Mammalia: Carnivora). *Journal of Zoology (London)*, 233(1): 93-106.

PRESTRUD, P., NORHEIM, G., SIVERTSEN, T. & DAAE, H. L. 1994. Levels of toxic and essential elements in **arctic fox** in Svalbard. *Polar Biology*, 14(3): 155-159.

PROULX, G., PROULX, P., GROENEWEGEN, J. M. & GROENEWEGEN, L. 1994. Yearling black bear, *Ursus americanus*, gives right-of-way to adult **coyote**, ***Canis latrans***. *Canadian Field-naturalist*, 108(2): 229.

ROOK, L. 1994. The Plio-Pleistocene Old World ***Canis*** (***Xenocyon***) ex gr. ***falconeri***. *Bollettino Della Societa Paleontologica Italiana*, 33(1): 71-82.

ROY, M. S., GEFFEN, E., SMITH, D., OSTRANDER, E. A. & WAYNE, R. K. 1994. Patterns of differentiation and hybridization in North American **wolflike canids**, revealed by analysis of microsatellite loci. *Molecular Biology and Evolution*, 11(4): 553-570.

SAITO, M. & ITAGAKI, H. 1994. Experimental infection of **raccoon dogs** with *Sarcocystis cruzi* and *S. miescheriana*. *Journal of Veterinary Medical Science*, 56(4): 671-674.

SASAKI, H. & KAWABATA, M. 1994. Food habits of the **raccoon dog** ***Nyctereutes procyonoides viverrinus*** in a mountainous area of Japan. *Journal of the Mammalogical Society of Japan*, 19(1): 1-8.

SCHMITT, D. N. & JUELL, K. E. 1994. Toward the identification of **coyote** scatological faunal accumulations in archaeological contexts. *Journal of Archaeological Science*, 21(2): 249-262.

SCHREIBER, A. & DMOCH, R. 1994. Chromosomes of two rare species of neotropical mammals: Southern pudu (*Pudu puda*) and **bush dog** (***Speothos venaticus***). *Zeitschrift Fuer Saeugetierkunde*, 59(5): 317-320.

SILLERO-ZUBIRI. C. & & GOTTELLI, D. 1994. ***Canis simensis***. *Mammalian Species*, 0(485): 1-6.

SKJOTH, F., LOHI, O. & THOMAS, A. 1994. Genetic models for the inheritance of the silver colour mutation of **foxes**. *Genetical Research*, 64(1): 11-18.

SMIRNOV, M. N. & SHURYGIN, V. V. 1994. Winter coloration of hair-covering of **wolves** (***Canis lupus* L.**, 1758) from Tuva. *Byulleten' Moskovskogo Obshchestva Ispytatelei Prirody Otdel Biologicheskii*, 99(1): 14-16.

STEINBACH, G., WELZEL, A., KEYSERLINGK, M. V. & STOYE, M. 1994. On the helminthic fauna of the **red fox** (***Vulpes vulpes* L.**) in southern Lower Saxony. *Zeitschrift Fuer Jagdwissenschaft*, 40(1): 30-39.

STEVENS, T. H., MORE, T. A. & GLASS, R. J. 1994. Public attitudes about **coyotes** in New England. *Society & Natural Resources*, 7(1): 57-66.

TAKEUCHI, M. & KOGANEZAWA, M. 1994. Age distribution, sex ratio and mortality of the **red fox *Vulpes vulpes*** in Tochigi, Central Japan: an estimation using a museum collection. *Researches on Population Ecology (Kyoto)*, 36(1): 37-43.

TANNERFELDT, M., ANGERBJORN, A. & ARVIDSON, B. 1994. The effect of summer feeding on juvenile **arctic fox** survival: a field experiment. *Ecography*, 17(1): 88-96.

THEBERGE, J. B., FORBES, G. J., BARKER, I. K. & BOLLINGER, T. 1994. Rabies in **wolves** of the Great Lakes region. *Journal of Wildlife Diseases*, 30(4): 563-566.

THOMAS, P. A. 1994. Dosimetry of 210Po in humans, caribou, and **wolves** in northern Canada. *Health Physics*, 66(6): 678-690.

THOMAS, P. A., SHEARD, J. W. & SWANSON, S. 1994. Transfer of 210Po and 210Pb through the lichen-caribou-**wolf** food chain of northern Canada. *Health Physics*, 66(6): 666-677.

THOMPSON, J. A. & FLEMING, P. J. S. 1994. Evaluation of the efficacy of 1080 poisoning of **red foxes** using visitation to non-toxic baits as an index of fox abundance. *Wildlife Research*, 21(1): 27-39.

THURBER, J. M., PETERSON, R. O., DRUMMER, T. D. & THOMASMA, S. A. 1994. **Gray wolf** response to refuge boundaries and roads in Alaska. *Wildlife Society Bulletin*, 22(1): 61-68.

TRAVAINI, A. & DELIBES, M. 1994. Immobilization of free-ranging **red foxes** (***Vulpes vulpes***) with tiletamine hydrochloride and zolazepam hydrochloride. *Journal of Wildlife Diseases*, 30(4): 589-591.

VAGE, D. I., OLSAKER, I., RONNINGEN, K. & LIE, O. 1994. Partial sequence of an expressed major histocompatibility complex gene (DQA) from **arctic fox** (***Alopex lagopus***). *Animal Biotechnology*, 5(1): 65-68.

VALBERG-NORDRUM. N. M. 1994. Effect of inbreeding on reproductive performance in **blue fox** (***Alopex lagopus***) vixens. *Acta Agriculturae Scandinavica Section A Animal Science*, 44(4): 214-221.

VAN HEERDEN. J., BOOMKER, J., BOOYSE, D. G. & MILLS, M. G. L. 1994. The **wild dog** (***Lycaon pictus***): A new host for *Ancylostoma caninum*. *Journal of the South African Veterinary Association*, 65(1): 18-19

VAN VALKENBURGH. B. & WAYNE, R. K. 1994. Shape divergence associated with size convergence in sympatric East African **jackals**. *Ecology (Tempe)*, 75(6): 1567-1581.

VILA, C., URIOS, V. & CASTROVIEJO, J. 1994. Use of faeces for scent marking in **Iberian wolves** (***Canis lupus***). *Canadian Journal of Zoology*, 72(2): 374-377.

VOS, A. C. 1994. Reproductive performance of the **red fox**, ***Vulpes vulpes***, in Garmisch-Partenkirchen, Germany, 1987-1992. *Zeitschrift Fuer Saeugetierkunde*, 59(6): 326-331.

VOS, A. C. 1994. Dental loss in the **red fox *Vulpes vulpes*** in Garmisch-Partenkirchen, Germany. *Lutra*, 37(1): 46-53.

WANG, X. 1994. Phylogenetic systematics of the **Hesperocyoninae** (Carnivora: **Canidae**). *Bulletin of the American Museum of Natural History*, 0(221): 1-207.

WANG, X. & TEDFORD, R. H. 1994. Basicranial anatomy and phylogeny of **primitive canids** and closely related miacids (Carnivora: Mammalia). *American Museum Novitates*, 0(3092): 1-34.

WAWRZKIEWICZ, J., MAJER-DZIEDZIC. B. & SADZIKOWSKI, Z. 1994. Listeriosis in breeding **foxes**. *Medycyna Weterynaryjna*, 50(10): 480-482.

WEBER, J. M., MEIA, J. S. & AUBRY, S. 1994. Activity of **foxes**, ***Vulpes vulpes***, in the Swiss Jura mountains. *Zeitschrift Fuer Saeugetierkunde*, 59(1): 9-13.

WESSBECHER, H., DALCHOW, W. & STOYE, M. 1994. The helminth fauna of the **red fox** (***Vulpes vulpes*** LINNE 1758) in the German federal administration area of Karlsruhe. Part 2: Nematodes. *Dtw (Deutsche Tieraerztliche Wochenschrift)*, 101(9): 362-364.

WESSBECHER, H., DALCHOW, W. & STOYE, M. 1994. The helminth fauna of the red fox (***Vulpes vulpes*** LINNE 1758) in the German Federal Administrative area of Karlsruhe: Part 1. Cestodes. *Dtw (Deutsche Tieraerztliche Wochenschrift)*, 101(8): 322-326

WHITE, P. C. L. & HARRIS, S. 1994. Encounters between **red foxes** (***Vulpes vulpes***): Implications for territory maintenance, social cohesion and dispersal. *Journal of Animal Ecology*, 63(2): 315-327

WHITE, P. J., RALLS, K. & GARROTT, R. A. 1994. **Coyote - kit fox** interactions as revealed by telemetry. *Canadian Journal of Zoology*, 72(10): 1831-1836.

ZHAO, W., WEI, Z. & SHI, L. 1994. MtDNA polymorphism and differentiation of subspecies of Chinese **raccoon dog** (***Nyctereutes procyonides***). *Acta Genetica Sinica*, 21(1): 7-16.

1995

AHLSTROM, O. & SKREDE, A. 1995. Comparative nutrient digestibility in blue foxes (***Alopex lagopus***) and mink (*Mustela vison*) fed diets with diverging fat: carbohydrate ratios. *Acta Agriculturae Scandinavica Section A Animal Science*, 45(1): 74-80.

BOULANGER, D., BROCHIER, B., CROUCH, A., BENNETT, M., GASKELL, R. M., BAXBY, D. & PASTORET, P. P. 1995. Comparison of the susceptibility of the **red fox** (***Vulpes vulpes***) to a vaccinia-rabies recombinant virus and to cowpox virus. *Vaccine*, 13(2): 215-219.

BROWN, L. &MACDONALD, D. W. 1995. Predation on green turtle *Chelonia mydas* nests by wild **canids** at Akyatan Beach, Turkey. *Biological Conservation*, 71(1): 55-60.

BUONAVOGLIa, D., SAGAZIO, P., GRAVINO, E. A., DE CAPRARIIS. D., CERUNDOLO, R. & BUONAVOGLIA, C. 1995. Serological evidence of *Ehrlichia canis* in **dogs** in southern Italy. *Microbiologica (Pavia)*, 18(1): 83-86.

DERIX, R. R. W. M. & VAN HOOFF. J. A. R. A. M. 1995. Male and female partner preferences in a captive **wolf** pack (***Canis lupus***): specificity versus spread of sexual attention. *Behaviour*, 132(1-2): 127-149.

FENN, M. G. & MACDONALD, D. W. 1995. Use of middens by **red foxes**: risk reverses rhythms of rats. *Journal of Mammalogy*, 76: 130-136.

GESE, E. M. & GROTHE, S. 1995. Analysis of **coyote** predation on deer and elk during winter in Yellowstone National Park, Wyoming. *American Midland Naturalist*, 133(1): 36-43.

HARRI, M., REKILA, T. & MONONEN, J. 1995. Factor analysis of behavioural tests in farmed **silver** and **blue foxes**. *Applied Animal Behaviour Science*, 42(3): 217-230.

HEIN, E. W. & ANDELT, W. F. 1995. Estimating **coyote** density from mark-resight surveys. *Journal of Wildlife Management*, 59(1): 164-169.

HELTAY, I. 1995. Active immunization of **foxes** against rabies by distribution of vaccine baits from airplanes. *Magyar Allatorvosok Lapja*, 50(2): 102-105.

HENNING, K., CZERNY, C. P., MEYER, H., MUELLER, T. & KRAMER, M. 1995. seroepidemiological survey for orthopox virus in the **red fox** (***Vulpes vulpes***). *Veterinary Microbiology*, 43(2-3): 251-259.

McCLURE, M. F., SMITH, N. S. & SHAW, W. W. 1995. Diets of **coyotes** near the boundary of Saguaro National Monument and Tucson, Arizona. *Southwestern Naturalist*, 40(1): 101-104.

MECH, L. D. 1995. The challenge and opportunity of recovering **wolf** populations. *Conservation Biology*, 9(2): 270-278.

MEYER, W. & TSUKISE, A. 1995. Lectin histochemistry of snont skin and foot pads in the **wolf** and the **domesticated dog** (Mammalia: Canidae). *Annals of Anatomy*, 177(1): 39-49.

MLADENOFF, D. J., SICKLEY, T. A., HAIGHT, R. G. & WYDEVAN, A. P. 1995. Regional landscape analysis and prediction of favorable **gray wolf** habitat in the northern Great Lakes region. *Conservation Biology*, 9(2): 279-294.

NAGY, A., KEREKES, B. & HELTAY, I. 1995. Oral immunization of **foxes** (wildlife carnivores) – results in Hungary. *Magyar Allatorvosok Lapja*, 50(2): 95-100.

NOVARO, A. J. 1995. Sustainability of harvest of **culpeo foxes** in Patagonia. *Oryx*, 29(1): 18-22.

PATRICK, M. J. & HARRISON, R. L. 1995. Fleas on **gray foxes** in New Mexico. *Journal of Medical Entomology*, 32(2): 201-204.

QUINN, T. 1995. Using public sighting information to investigate **coyote** use of urban habitat. *Journal of Wildlife Management*, 59(2): 238-245.

SILLERO-ZUBIRI, C. & GOTTELLI, D. 1995. Diet and feeding behaviour of **Ethiopian wolves** (***Canis simensis***). *Journal of Mammalogy*, 76(2): 531-541.

SILLERO-ZUBIRI, C. & GOTTELLI, D. 1995. Spatial organization in the **Ethiopian wolf *Canis simensis***: largs packs and small stable home ranges. *Journal of Zoology (London)*, 237: 65-81.

SILLERO-ZUBIRI. C., TATTERSALL, F. H. & MACDONALD, D. W. 1995. Habitat selection and daily activity of giant molerats *Tachyoryctes macrocephalus*: significance to the **Ethiopian wolf *Canis simensis*** in the Afroalpine ecosystem. *Biological Conservation*, 72(1): 77-84.

SOVADA, M. A., SARGEANT, A. B. & GRIER, J. W. 1995. Differential effects of **coyotes** and **red foxes** on duck nest success. *Journal of Wildlife Management*, 59(1): 1-9.

WEILER, G. J., GARNER, G. W. & RITTER, D. G. 1995. Occurrence of rabies in a wolf population in northeastern Alaska. Journal of Wildlife Diseases, 31(1): 79-82.

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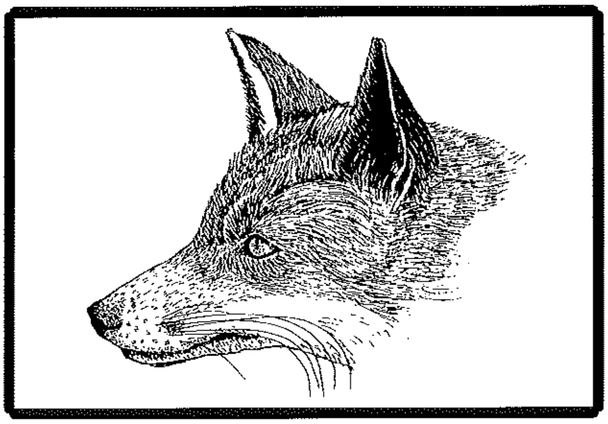

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