Foxes, Wolves, Jackals, and Dogs

An Action Plan for the Conservation of Canids

J.R. Ginsberg and D.W. Macdonald

IUCN/SSC Canid Specialist Group
IUCN/SSC Wolf Specialist Group (L.D. Mech, Chair)

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Forewords and Acknowledgements

Perhaps it is insight into their individualism won through our association with domestic dogs, perhaps it is the ability of some of them to withstand the worst that man can throw at them, perhaps it is that we see some reflection of ourselves in their opportunism, or perhaps it is simply the transfixing elegance of their jaunty grace. Whatever the pot-pourrie of reasons that blend into their appeal, the 34 species that comprise the family Canidae are special. They are special because they have, as perceived friend or foe, preoccupied the imaginations of mankind for millennia. They are special because the breadth of their adaptations makes them enthralling to science. They are special because the contradictory facets of their relations with people perplex the conservationist. The possibility that we are heedlessly, perhaps needlessly, mismanaging many of them is saddening; the probability that our negligence will force several more to extinction should fill us with bottomless dismay. It demands action, and that is why we have written the Canid Action Plan.

Species action plans are produced by the Specialist Groups of the Species Survival Commission (SSC), a branch of the International Union for Conservation of Nature and Natural Resources (IUCN). The idea is that they should focus on the conservation priorities for a particular group of animals. By highlighting problems, debating priorities and suggesting action, the authors of these plans aspire to stimulate the conservation of their group of species. More often than not, the task of preparing these plans points more to the breadth of our ignorance than to the depth of our knowledge, but even that can be stimulating and useful. This booklet, "The Canid Action Plan," has grown from the deliberations of the IUCN/SSC Canid Specialist Group. The Group was formed in 1981. Fearing the unwieldiness of large committees, its core membership is small—approximately one dozen international specialists (see Appendix I). However, the Group is supported by an army of affiliates around the world, whose efforts have produced the data on which this action plan is based (see Apendix 2).

The Canid Specialist Group has held major meetings in Helsinki (1982), in Edmonton (1985), and in Rome (1989), each time in conjunction with the International Theriological Congress. We also met in Krakow, Poland, in 1988 in association with the International Union of Game Biologists. These meetings have been very fruitful, each introducing a flush of new experts to join those stalwarts who have managed to attend them all. At each, we have benefitted from spoken papers and stimulating discussion. Nonetheless, I think it honest to conclude that we have felt frustrated that our efforts have led to nothing more substantial than debate.

To combat this, our first endeavour was to compile a Canid Conservation Dossier. This involved the compilation of species-specific papers which were added to the growing dossier and circulated quite widely. Notable amongst those early members of the Canid Specialist Group for the effort they put into the dossier were James Dietz, Lory Frame, Pall Hersteinsson, A.J.T. Jonsingh, James Malcolm, and Patti Moehlman. Our plan had been for the Dossier to grow to a point at which it could be published as a book. However, that plan was overtaken by events as the top priority became completion of this action plan, which has, in some respects, usurped some of the role originally envisaged for the Canid Conservation Dossier. Time will tell how best we should proceed from here, but the important point is to acknowledge how the efforts of those who prepared dossier papers contributed to the evolution of this action plan.

In writing this action plan, Joshua Ginsberg and I have, time and again, been thwarted in our efforts to phrase simple conclusions, although we have been vividly aware that, to be effective, the action suggested in such a document should be straightforward. This dilemma is at least partly a reflection of the nature of the Canidae and their diverse dealings with people. The Simien jackal appears to need seclusion from people and their dogs, if it is to survive in its highland refuges. The African wild dog's intolerance of human intrusion, and its need for vast space spell certain conflict with modern man. The bush dog is so rarely seen that we have no idea about its circumstances, but fear the worst. On the other hand, red foxes are notorious for their success in urban settings, and plenty of other canids, ranging from coyotes to crab-eating zorros, seem able to thrive amidst human settlements. Management of various canids (largely prompted by rabies control and fur harvest, along with attempts to limit perceived depredation upon domestic stock) leads to the slaughter of hundreds of thousands of foxes annually, thousands of wolves and a handful of African wild dogs. But then, there are many foxes and a fair number of wolves to withstand this onslaught (ill-conceived although it may sometimes be), whereas there is scarcely a handful of wild dogs left. When the issues are so disparate, what logical rules are we to use in assigning priorities between the management of the many and the conservation and management of the few? The logical morass thickens with the realization that the fox trotting across your field of view may be, simultaneously, a resource for the trapper, a health hazard to the rabies official, a quarry to the huntsman, a subject to the photographer, vermin to the poultry farmer, and a joy to behold to the aesthete. What is more, their judgements are neither right nor wrong according to some self-appointed prophet—each could argue a case, but would do so using incomparable currencies (how are we to equate units of jobs versus units of cultural heritage versus units of suffering versus money etc?). Again and again, scientific judgement trips over ethical judgement.

In writing this booklet we have tried at least to untangle these issues, even if we could not resolve them. For me, progress in this task took a major bound forward with the arrival in Oxford of Dr. Joshua Ginsberg. Dr. Ginsberg joined the Wildlife Conservation Research Unit at Oxford University in 1988, and soon afterwards became Deputy Chairman of the Canid Specialist Group. His energy and clarity of thought have had an enormous impact on this text. He and I would both like to acknowledge especially Miss Lynn Clayton, whose groundwork laid the foundations for our writing. Wolves are watched over by a separate Specialist Group, and we are grateful to that group and, in particular, its chairman, Dr. David Mech, for supplying the information we presenton wolves. Furthermore, we are grateful for grants from the International Fur Trade Federation, the People's Trust for Endangered Species and from the IUCN through the good offices of Dr. Simon Stuart, without which this work could not have been done. Preparation of the Plan has involved a mountainous correspondence, the burden of which fell largely on Dr. Ginsberg's shoulders. He received much able assistance from Karen da Silva. We list in Appendix 2 the names and addresses of all those around the world who have corresponded with us, and we thank them all. In addition, we thank Amie Bräutigam, Jeff McNeely, Ulie Seal, Simon Stuart and Rosemary Woodruff for their help with various chapters, and Juliet Clutton-Brock for proofreading the final version.

Clearly it is my aim, as Chairman of the Group, and co-author of the Plan, to foster sensitive and scientific conservation of the Canidae. The road to this aim involves considerations of many turnings: there are the special roles of disease, depredation on stock, and fur harvests in canid conservation; there is the difficulty of inter-specific competition between similar species, and the perplexing issue of hybridization with domestic dogs. We have raised each of these issues in Chapters 9 to 12. We have been unimpressed by some of the cases made against canids, and by the unimaginative nature of many traditional solutions. Yet we have been heartened by some innovative ideas (such as the oral vaccination of foxes against rabies, and the use of aversive conditioning to forestall predation). However, before deciding which turn to take along the road to conservation of canids, one must first ask why travel that road at all. I could answer with comments on the stability of communities, the diversity of gene pools, the minimum sizes of viable populations and other more or less abstruse notions. But at the bottom of it, I want canids conserved because I like them. If you like them too, then hopefully you will find some merit in our recommendations. If you do not like them, then my task is to change your mind, and because I suspect that this is more likely the more you learn about canids, I am hopeful that this booklet may speed your conversion.

David W. Macdonald, Chairman
IUCN/SSC Canid Specialist Group
and Wildlife Conservation Research Unit

One of the species this action plan covers is the grey wolf (*Canis lupus*). As a species, the wolf still survives in large numbers. However, that is only because it happens to have had the most extensive original range of any land mammal. The wolf has been exterminated from most of western Europe, the United States, and Mexico.

Wolf conservation efforts, then, must be devoted both to bolstering remnant populations that are threatened or endangered, and to restoring wolves to ecosystems intact enough to support them. In the United States, Yellowstone National Park, where wolves were wiped out over 50 years ago, stands out as a prime example of the latter. Central Scandinavia represents a similar challenge in Europe; less than 10 remain there, including only a single breeding female. The closely related red wolf *(Canis rufus)* of the southeastern United States is gone from the wild except for a few animals recently reintroduced to North Carolina.

Thus this Action Plan proposes such efforts as these, but it also calls attention to the many other wolf populations throughout the northern hemisphere whose status is tenuous or unknown. The human population pressures anticipated during the next few decades may well threaten several of these poorly known wolf populations.

This makes the Action Plan especially timely. If the wolf recovery and research efforts proposed herein can be carried out during the next decade, they probably will make the difference between further loss of the wolf and holding the line against such a loss.

L. David Mech
Chairman
IUCN/SSC Wolf Specialist Group

Grey wolf (*Canis lupus*). (Photo by L.D. Mech)

1. Objectives, Structure, and Limitations of the Canid Action Plan

Introduction

The Canid Action Plan is one in a series of such plans commissioned by the International Union for Conservation of Nature and Natural Resources (IUCN) and written by members of the Species Survival Commission's Specialist Groups. The authors of action plans have a clear remit: to provide current and accurate information that will help individuals, institutions, and governments to make educated decisions with the aim of ensuring the long-term survival of the species in question. To succeed in this objective, the authors of an action plan must first collect, collate, and synthesize the information available on the status, abundance, and distribution of the taxon under consideration. Only then can priorities be established and a plan for action developed.

Of course, before proceeding to these higher goals, there are some basics to be agreed upon. First, which species are to be recognized, and second, by which names are we to refer to them? These questions are not as trifling as they might at first appear, because classification of the family Canidae is moderately controversial (Wayne et al. 1989), and because there is a profusion of confusing common and Linnaean names. In Chapter 2, we discuss canid taxonomy, and outline the classification that we have adopted here at the species level. Although we have not, for the most part, gathered sufficient information to analyze conservation priorities at the level of subspecies, we have included a list of recognized subspecies and appropriate citations for those who wish to pursue questions of taxonomy and biogeography.

Structure of the Canid Action Plan—Geographic

Some other Specialist Groups have organized the contents of their action plans on a regional basis. This makes good sense: for many species, policies are formulated on a regional basis. Hence, a regional approach allows policy makers in different areas to find, quickly, data which apply to their countries. Some action plans (e.g. the antelope plans, East 1988) are further divided into regional reports, each of which covers a small geographic area, providing a level of detail that is enviable. However, such an approach is not appropriate for the canids, and we have opted to organize the canid action plan differently. The reasons for this are several and stem from the basic biology of carnivores: first, predatory species occur at lower densities than prey; second, at any one location, the diversity of carnivore species is usually rather low, while third, the geographic ranges of many species of carnivore are rather large. In east and northeast Africa, for instance, there are 59 species of antelope; on average, each country supports 26 species (East 1988). In contrast, these 59 species of antelope live side-by side with only six species of canid. Each country in the region supports, on average, four species.

These traits of canid distribution are not just regional, but global. There are only 34 canid species worldwide. The two continents with the highest species diversity, Africa and South America, each support a mere 10 species. Most species within the Canidae have distributions that span at least a whole continent. One species, the red fox, is found throughout the Northern Hemisphere (and in Australia).

In deciding how to present our information we were impressed by the generalization that the status of a particular canid species appears to be remarkably consistent throughout its range. Red foxes are common, and thriving, wherever they occur; side-striped jackals are rare, but not threatened, throughout their range; the African hunting dog is nearly extirpated in every country where it is still found. There is a single exception with which to prove the rule: the grey wolf, common in northern Canada and Siberia, is threatened to a point verging on extirpation in much of its range.

Given the expansive geographical ranges of many canid species, and their relatively low species diversity, a country by country analysis of status, abundance, and distribution would be unwarranted and repetitive. Furthermore, it would be unworkable insofar as information on the status of canids is very scattered. For most countries, one simply could not write detailed reports because detailed information is unavailable. Our generalizations about status are based on the reports of our correspondents, who have reported species as being rare, threatened, or abundant. Only in that small minority of cases for which detailed surveys have been completed (e.g. the African wild dog (Frame and Fanshawe in prep.)) or where an entire Specialist Group is devoted to a single species (the grey wolf) is the quality of the information remotely satisfactory.

Nonetheless, policies often have a regional focus. Many people involved in biological conservation are shifting their attention from a species-oriented to an ecosystem-oriented approach. A catalogue of the world's canids, arranged alphabetically, would be cumbersome, and would necessitate a morass of cross references. Therefore, in what we hope is a sensible and utilitarian compromise between the realities of canid biology, the limitations of the data, and the necessity for a geographical framework, we have organized the first part of the Canid Action Plan by geographic regions. The regions we have devised reflect, in broad terms, the biogeographical distribution of Canidae. In some cases, following the lead of the canids, we have crossed continental boundaries. North Africa has been paired with the Middle East, Europe with North America.

Each of the world's canid species has been assigned to one of the following five chapters. The arrangement of species sections within chapters follows a regional approach:

Chapter 4. Sub-Saharan Africa: African wild dog; bat-eared fox; black-backed jackal; Cape fox; golden jackal; side-striped jackal; Simien jackal.

Chapter 5. South America: Azara's zorro; bush dog; crab-eating zorro; culpeo; grey zorro; hoary zorro; maned wolf; Sechuran zorro; small-eared zorro.

Chapter 6. Holarctic: Arctic fox; coyote; grey fox; grey wolf; island grey fox; raccoon dog; red fox; red wolf; swift or kit fox.

Chapter 7. North Africa and the Middle East: Blanford's fox; fennec; pale fox; Rüppell's fox.

Chapter 8. South and Southeast Asia and Australasia: Bengal fox; corsac fox; dhole; Tibetan fox; dingo.

An area as large and heterogeneous as "Eurasia and North America" may seem excessive for a single chapter. We are not oblivious to the potential absurdity of a single section which embraces almost all of the Northern Hemisphere. However, only 11 species are found therein, and, of that 11, the distributions of three of the species (the red fox, the grey wolf, and the grey fox) exceed even the arbitrary boundaries we have set. Similarly, the range of the golden jackal includes much of north Africa, the Middle East, south and east Asia, and part of Europe. However, most of our information on this species comes from sub-Saharan Africa, so it seemed appropriate to locate the species account in Chapter 4. The structure of each geographically organized chapter is explained in Chapter 3, "Introduction to Geographic Chapters and Species Summaries."

Structure of the Canid Action Plan—General

Foxes, wolves, and jackals have much in common—both in their biology, and in their relationships with man. Hence, following the geographical chapters, we have written four chapters on topics almost universally germane to the Canidae as a whole. The topics are trade, captive breeding, predation on stock and game, and disease.

Perhaps the most frequent contact between many urban dwellers and wild canids is when the latter are encountered in the form of a fur coat. Clearly the fur trade is a conspicuous aspect of canid management, and although an exhaustive analysis of that trade is overdue, and much needed, it would be too large an undertaking for this book. Rather, we have focused here on the immediate impact of the trade in endangered and threatened species. Chapter 10 presents an analysis of the trade in canid species listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). We summarize the absolute levels of trade recorded from 1980-1986, and discuss the patterns of trade and use of canids in commerce.

For many endangered species, captive breeding and subsequent reintroduction may offer a final, albeit expensive and circuitous, form of redemption. Exterminated in the wild, the red wolf (*Canis rufus*) has recently been bred in captivity and reintroduced in North Carolina (Phillips and Parker 1988). Similarly, kit foxes, extirpated from the northern end of their range are now being reintroduced to Canada (Carbyn pers. comm.).

A successful captive breeding programme is often a prerequisite for reintroduction. So, in Chapter 11, we analyze data from the International Zoo Yearbooks (1963-1984) to discover the current level of effort directed at breeding canids in captivity, and the success of these endeavours.

The very opportunism and mobility that is the hallmark of success for many members of the dog family is also responsible for throwing them into conflict with people. This conflict leads us to consider two further topics: first, competition between man and canids through depredations on game and domestic stock; and second, canids as victims of, and often vectors for, several zoonoses, of which rabies is undeniably the most notable. In addition to rabies, there are several other pathogens of direct (e.g. leishmaniasis) and indirect (e.g. sarcoptic mange) concern to man, the latter threatening the fur trade, the former threatening life.

The traditional response to perceived problems of predation and disease has been to attempt to reduce canid numbers by killing them. This time-honoured approach has two notable drawbacks: it tends to throw different factions into conflict (e.g. fur traders object to their commodity being blasted by irate shotgun-toting stockmen, and those concerned with animal welfare object to both groups killing canids); and it may not work (either because the problem was merely perceived but not real, or because the solution was inappropriate).

The issues raised by predation and disease are biologically and economically complicated. We have tried, in Chapters 12 and 13, to expose the salient arguments. In Chapter 12, we consider aspects of predation by wild canids on livestock and game. Although many canid species are widely held to have a significant economic impact on the numbers of valuable herbivores, dispassionate analyses of these accusations are few. Because data are often scanty and unevenly spread between species, our review is biased towards those few canids for which more information is available. Our intention is to identify problems common to many canids, real and imaginary, to seek some indication of their magnitudes, and to evaluate the effectiveness of existing solutions and the practicability of novel ones, all from the point of view of species conservation.

In Chapter 13 we discuss disease amongst canids, and its implications for their conservation and for public health. Disease poses both direct and indirect threats to populations of wild canids. In the case of direct threats, the burden of our argument is that disease can decimate small populations of canids (and other animals) irrespective of any security they might apparently be guaranteed by being protected in reserves and parks. We present this argument by assessing the prevalence of disease in various canid populations, along with evidence that disease operates as a population regulation mechanism in canids and, hence, has the potential to wipe out "viable" populations.

Disease is also an indirect threat to the conservation of canids. Many canids may act as vectors for pathogens that pose a threat to humans (or their livestock and pets). Hence, canids are frequently killed in attempts to control zoonoses. Our arguments are based on a review of the evidence that diseases are harboured in canid populations, consideration of the effects of "control" programmes on canid populations, and the efficacy (and hence, economic/ecological wisdom) of such "control" measures.

Notes on Data Collection

The species accounts presented here were compiled by the following process: census forms were sent to people known to be interested in canids; these forms posed questions about the distribution and status of wild canids, and solicited information on the names and addresses of other authorities whom we should contact; data garnered through this survey and from a review of published literature were combined in a draft entry for each species; each such draft was sent to several reviewers; reviewers were selected, where possible, to span the geographic region covered by the species in question; and corrections made by reviewers were incorporated in the preparation of a final version of each species' entry. The Canid Action Plan could not have been completed without the help of these correspondents, and we have tried to represent their views accurately. Nonetheless, we alone are responsible for any errors that may remain in the text.

Many of our correspondents have emphasized the potential usefulness of a register of those involved with canid research. In response, we have included such a list in Appendix 2. Doubtless we have not searched widely enough in compiling this directory, but if there are embarrassing omissions we can only hope that this will prompt readers to advise us of them so that they may be remedied in future editions.

Limitations of the Canid Action Plan

The structure we have imposed upon this first edition of the Canid Action Plan has suited our purpose, but it has drawbacks. For example, by making our focus regional and global, we have largely ignored aspects of conservation at the level of subspecies or of local populations. In defense of this, we would argue that, for the most part, patterns of extinction are regional: a succession of sub-populations disappears, survivors become fragmented, and local extirpations start the slippery slide to extinction. In addition, for many species such as the bush dog or the fennec, data are so inadequate that the available materials swiftly determined the scope of our summary. While we may have struggled to float our ideas at a regional level, they would undoubtedly have sunk at any finer resolution. However, for a minority of species, such as the wolf and the African wild dog, we have presented a summary of information for each subpopulation, made a stab at assigning priorities among the subpopulations, and directed readers to publications that cover these species in greater detail.

The nomination of priorities also lures us into an imponderable mirage dividing biology and ethics. It may be tempting to seek criteria on which to decide whether it is more important to save the Simien jackal than the red wolf. But both are irreplaceable. We might be able to guess the order in which endangered canid species will go extinct, but we have tried not to place relative value on the loss of one versus another. Nonetheless, as funds and time are limited, we have tried to focus our action planning on those species most threatened with imminent extinction.

Finally, we are mindful that this is the first edition of the Canid Action Plan. We see its publication as a starting point, a job begun rather than one completed. We hope that it will stimulate a steady stream of information to the Canid Specialist Group, and that this information will lead to a subsequent edition in which our lens can focus at a finer level of resolution. Ideally, a future edition will treat every species at the level that has been possible here only for the wolf and wild dog. In the meantime, while we should plan for the worst, we can hope for the best. Perhaps the gaps in our information house the reservoirs of elusive species; perhaps the fennec fox is abundant somewhere in north Africa, the dhole in Burma, the wild dogs in Ethiopia. Let us hope so, indeed, let us try hard to find out, but let us not bank upon it.

2. Sorting out the Canidae

The Importance of Taxonomy

In this chapter, we describe the classification of the family Canidae which we are using for this action plan. Classification, or taxonomy, is all too often viewed as an arcane branch of biology. Taxonomy reflects our understanding of evolution and ecology, and therefore is critical to developing sound conservation practices and priorities (Wilson 1988a). Taxonomy goes well beyond naming animals; it allows us to make relatively objective statements about the relationships within and between groups of organisms. It enables us to place boundaries around variation so that we can make the judgement, for example, that a fox found in Korea is a subspecies of the red fox and not an entirely new species. Making such distinctions is a prerequisite to planning how to conserve the greatest natural diversity.

Ideally, we would preserve a representative sample of an entire species' genetic diversity. The distinction between species and subspecies, or even between subspecies and race would be irrelevant (Ryder 1989). Ideally, sufficient funds, sufficient land, and sufficient interest would exist so that we could preserve species as the evolutionary units that they are, or once were. Unfortunately, and invariably, conservation is practised in a world far removed from this Utopia. Conservation priorities, both in the field and in zoos, must be judged with a pragmatic eye to the allocation of resources and manpower (Conway 1986; Leader-Williams and Albon 1988).

At the very least, preserving sufficient intra-specific variation to sustain a species is, almost by definition, a prerequisite to its conservation. The goal of many conservation efforts, often unstated, appears to be to preserve as many species as possible (see papers in Wilson 1988b). While biologists may argue the benefits of conserving the greatest intra-specific diversity or the greatest inter-specific diversity, such an argument assumes that political decisions are made with regard to biology. Often they are not. Policy makers, constrained by funds, space, and politics, must often base their actions on political, not ecological, priorities. As biologists, the least we can do is clearly define what we consider the species, or subspecies, involved in the equation.

Laws are often written to protect species, not subspecies. Clearly, the theoretical matter of how species are defined becomes critical, as does the practical matter of whether a given pair of populations differ at the species level. Acknowledging that the species is the taxonomic unit or level at which many biological debates are conducted, it becomes crucial to consider whether it is also the level at which to address legislation. Yet the fact remains that before we can discuss the conservation status of a particular species, or group of species, we must be certain that what we are calling a species is really just that, and not "merely" a subspecies of something else.

Classification of Species

Table 1 lists the species of Canidae and the names by which we refer to them. The classification follows closely that of Corbet and Hill (1980) (following that of Clutton-Brock et al. 1976) with several exceptions discussed below.

We hope that this classification will be regarded as a constructive compromise in the context of conservation strategies. In the 14 years since the publication of Clutton-Brock et al.'s paper, of the 34 species listed, we have adopted only three changes in specific status. These include two types of changes: two (or more) species listed by Clutton-Brock et al. may have been amalgamated into a single species; or specific status may be granted to a group which Clutton-Brock et al. considered a subspecies of a larger species group. The three changes we have made are:

1. *Dusicyon culpaeus/culpaeolus.* Following Corbet and Hill (1980), we have included *Dusicyon culpaeolus* as a subspecies of *D. culpaeus.* The description of *D. culpaeolus* was made from a single skull and skin in the British Museum collection (Clutton-Brock et al. 1976). The major difference between the two species is one of size, and *D. culpaeus* exhibits large variation in size.

2. *Dusicyon griseuslfulvipes. D. fulvipes,* morphologically very similar to *D. griseus* (Clutton-Brock et al. 1976), was until recently thought to be restricted to the island of Chiloe. A recent discovery shows, however, that there are mainland populations of this group (Medel et al. 1990). Given this evidence, there is a strong argument for separating the two species. Indeed, we strongly recommend further analysis (genetic and/or morphological) to confirm the specific status of *D. fulvipes.* However, in the interests of parsimony, and until such analyses are undertaken, we follow the classification of Corbet and Hill (1980) and group it with *D. griseus.*

3. *Vulpes veloxlmacrotis.* Corbet and Hill (1980) treat these two as separate species. Recent reviews (O'Farrell 1987, Scott-Brown et al. 1987) follow this classification. However, Hall (1981) suggests that the two are, in fact, a single species. In the southern part of their range, the two are sympatric and hybrids have been recorded in New Mexico (Rohwer and Kilgore 1973) and Texas (Thornton et al.

Table 1. Common English names used in the Canid Action Plan

Scientific Name	Common Name
Alopex lagopus	Arctic fox
Canis adustus	Side-striped jackal
Canis aureus	Golden Jackal
Canis familiaris dingo	Dingo
Canis latrans	Coyote
Canis lupus	Grey Wolf
Canis mesomelas	Black-backed jackal
Canis rufus	Red wolf
Canis simensis	Simien Jackal
Cerdocyon thous	Crab-eating zorro
Chrysocyon brachyurus	Maned wolf
Cuon alpinus	Dhole
Dusicyion culpaeus	Culpeo
Dusicyon griseus	Grey zorro
Dusicyon gymnocercus	Azara's zorro
Dusicyon sechurae	Sechuran zorro
Dusicyon vetulus	Hoary zorro
Dusicyon microtis	Small-eared zorro
Fennecus zerda	Fennec fox
Lycaon pictus	African wild dog
Nyctereutes procyonoides	Raccoon dog
Otocyon megalotis	Bat-eared fox
Speothos venaticus	Bush dog
Urocyon cinereoargenteus	Grey fox
Urocyon littoralis	Island grey fox
Vulpes bengalensis	Bengal fox
Vulpes cana	Blanford's fox
Vulpes chama	Cape fox
Vulpes corsac	Corsac fox
Vulpes ferrilata	Tibetan fox
Vulpes pallida	Pale fox
Vulpes rueppelli	Rüppell's fox
Vulpes velox	Swift, or kit fox
Vulpes vulpes	Red fox

1971). Furthermore, recent genetic evidence indicates that these two are, in fact, a single species (Dragoo pers. comm.). Given both the genetic and biogeographic evidence, we have followed Hall's (1981) classification.

In addition to changes in specific status, we differ from Corbet and Hill (1980) in several generic classifications. These, arguably, are less important in their implications for conservation. For example, none of our recommendations, nor any legislation real or imagined, is likely to be affected whether we allocate the fennec fox to the genus *Fennecus* or *Vulpes.* At least for the moment, nobody has proposed conservation triage decisions at the level of the genus. Nonetheless, for the sake of completeness, we have included the results of recent research by adopting the following changes:

1. *Urocyon* species. Corbet and Hill (1980) list both *Urocyon* species as members of the genus *Vulpes.* However, morphological, karyological, palaeontological, and allozyme evidence (Wayne and O'Brien 1987; Collins in press) all suggest that *Urocyon* is a distinct genus which has a relatively early origin (6-9 million years ago) and that the island and mainland grey foxes are distinct species. Following this evidence, we have assigned both species of North American grey fox to *Urocyon.*
2. *Fennecus zerda.* Corbet and Hill (1980) refer to the fennec fox as a member of the genus *Vulpes* on the basis of its skeletal and cranial characteristics. Genetic evidence, while placing the fennec in the *Vulpes* group, indicates that generic status is probably warranted (Wayne and O'Brien 1987).
3. *Cerdocyon thous.* The South American crab-eating fox is frequently placed in its own genus, *Cerdocyon* (see Berta 1982). However, Corbet and Hill (1980) suggest that the differences between the crab-eating fox and other members of the *Dusicyon* group are insufficient to warrant a separate genus. Recent genetic studies do little to resolve the generic status of this species, beside confirming that it is closely related to members of the *Dusicyon* group (Wayne and O'Brien 1987). Given the widespread use of the *Cerdocyon* classification, and considering the equivocal nature of the genetic evidence, but acknowledging that the genetic studies tend to indicate some degree of divergence from the *Dusicyon* group, we have opted to avoid confusion by using the genus *Cerdocyon.*

In Table 2, we list 223 subspecies of the world's canids. This list is by no means definitive, nor is it meant to be a revision of the family. Rather, we hope it will provide a guide to the subspecific diversity of the Canidae. Further information on the distribution of each subspecies is given in the primary references cited in the minority of cases where it is available.

Common English Names

This text is written in anticipation of an international readership. This poses a problem in so far as national names are wildly ambiguous. On the other hand, to resort solely to Linnaean, or scientific, names might be considered the hallmark of a turgid text. In our compromise, we have opted for those common English and Spanish names that minimize ambiguity. Nonetheless, the reader should be aware that one person's silver fox refers to *Vulpes vulpes* while another's is *Vulpes chama.* Equally, in our lifetimes, and in British English, *Canis simensis* has been known, successively, as the Abyssinian wolf, the Simien fox, and, most recently, as the Simien jackal. The message, perhaps counterintuitive to the non-specialist, is that it is generally simpler to work with scientific names.

The names we use to identify a particular species must be recognizable to all our readers, whether we use the common name in English or the scientific name. In this context, we alert the reader to particular confusion in the use of common names for the small canids in South America. Frequently, small South American canids in the genera *Dusicyon* and *Cerdocyon* are called foxes, although this term might best be applied to species in the genus *Vulpes.* Furthermore, both *Dusicyon culpaeus* and *Vulpes vulpes* are commonly called the red fox. Likewise, both *Dusicyon griseus* and *Urocyon cinereoargenteus* are commonly called the grey fox. One cumbrous solution would be to call these animals the South American grey and red foxes. Our solution reflects our geographical bias in retaining the word "fox" for the Northern Hemisphere species and referring to *Dusicyon culpaeus* as the culpeo and *Dusicyon griseus* as the grey zorro. Hopefully readers will be tolerant of our use of anglicized Spanish in an attempt to develop English common names which will be unambiguously understood.

Table 2. Recognized subspecies in the Family Canidae

Scientific Name	Taxonomist	Year	Reference
Alopex lagopus beringensis	Merriam	1902	Ellerman and Morrison-Scott 1966
Alopex lagopus fuliginosus	Bechstein	1799	Ellerman and Morrison-Scott 1966
Alopex lagopus groenlandicus	Bechstein	1799	Hall 1981
Alopex lagopus hallensis	Merriam	1900	Hall 1981
Alopex lagopus lagopus	Linnaeus	1758	Hall 1981
Alopex lagopus pribilofensis	Merriam	1902	Hall 1981
Alopex lagopus sibiricus	Dybowski	1922	Ellerman and Morrison-Scott 1966
Alopex lagopus spitzbergensis	Barret-Hamilton & Bonhote	1898	Ellerman and Morrison-Scott 1966
Alopex lagopus ungava	Merriam	1884	Hall 1981
Canis adustus adustus	Sundevall	1846	Coetzee 1977
Canis adustus bweha	Heller	1914	Coetzee 1977
Canis adustus centralis	Schwarz	1915	Coetzee 1977
Canis adustus kqffensis	Neumann	1902	Coetzee 1977
Canis adustus lateralis	Scalter	1840	Coetzee 1977
Canis aureus algirensis	Wagner	1841	Coetzee 1977
Canis aureus anthus	Cuvier	1820	Coetzee 1977
Canis aureus aureus	Linnaeus	1758	Coetzee 1977
Canis aureus bea	Heller	1914	Coetzee 1977
Canis aureus lupaster	Hemprich & Ehrenberg	1833	Coetzee 1977
Canis aureus maroccanus	Cabrera	1921	Coetzee 1977
Canis aureus riparius	Hemprich & Ehrenberg	1832	Coetzee 1977
Canis aureus soudanicus	Thomas	1903	Coetzee 1977
Canis familiaris dingo	Meyer	1793	Corbett and Newsome 1975
Canis latrans cagottis	Hamilton-Smith	1839	Hall 1981
Canis latrans clepticus	Elliot	1903	Hall 1981
Canis latrans dickeyi	Nelson	1932	Hall 1981
Canis latrans frustor	Woodhouse	1851	Hall 1981
Canis latrans goldmani	Merriam	1904	Hall 1981
Canis latrans hondurensis	Goldman	1936	Hall 1981
Canis latrans impavidus	Allen	1903	Hall 1981
Canis latrans incolatus	Hall	1934	Hall 1981
Canis latrans jamesi	Townsend	1912	Hall 1981
Canis latrans latrans	Say	1823	Hall 1981
Canis latrans lestes	Merriam	1897	Hall 1981
Canis latrans mearnsi	Merriam	1897	Hall 1981
Canis latrans ndcrodon	Merriam	1897	Hall 1981
Canis latrans ochropus	Eschscholtz	1829	Hall 1981
Canis latrans peninsulae	Merriam	1897	Hall 1981
Canis latrans texensis	Bailey	1897	Hall 1981
Canis latrans thamnos	Jackson	1949	Hall 1981
Canis latrans umpquensis	Jackson	1949	Hall 1981
Canis latrans vigilis	Merriam	1897	Hall 1981
Canis lupus albus	Kerr	1792	Ellerman and Morrison-Scott 1966
Canis lupus alces	Goldman	1941	Hall 1981
Canis lupus arabs	Pocock	1934	Ellerman and Morrison-Scott 1966
Canis lupus arctos	Pocock	1935	Hall 1981
Canis lupus baileyi	Nelson & Goldman	1929	Hall 1981
Canis lupus bernardi	Anderson	1943	Hall 1981
Canis lupus campestris	Dwigubski	1804	Ellerman and Morrison-Scott 1966
Canis lupus chanco	Gray	1863	Ellerman and Morrison-Scott 1966
Canis lupus columbianus	Goldman	1941	Hall 1981
Canis lupus crassodon	Hall	1932	Hall 1981
Canis lupus fuscus	Richardson	1839	Hall 1981
Canis lupus griseoalbus	Baird	1823	Hall 1981
Canis lupus hudsonicus	Goldman	1941	Hall 1981
Canis lupus irremotus	Goldman	1937	Hall 1981
Canis lupus labradorius	Goldman	1937	Hall 1981
Canis lupus ligoni	Goldman	1937	Hall 1981

Table 2. (continued)

Scientific Name	Taxonomist	Year	Reference
Canis lupus lupus	Linnaeus	1758	Ellerman and Morrison-Scott 1966
Canis lupus tycoon	Schreber	1775	Hall 1981
Canis lupus mackenzii	Anderson	1908	Hall 1981
Canis lupus nubilus	Say	1823	Hall 1981
Canis lupus occidentalis	Richardson	1829	Hall 1981
Canis lupus orion	Pocock	1935	Hall 1981
Canis lupus pallipes	Sykes	1831	Ellerman and Morrison-Scott 1966
Canis lupus pambasileus	Elliot	1905	Hall 1981
Canis lupus signatus	Cabrera	1907	Ellerman and Morrison-Scott 1966
Canis lupus tundrarium	Miller	1912	Hall 1981
Canis mesomelas achrotes	Thomas	1926	Coetzee 1977
Canis mesomelas arenarum	Thomas	1926	Coetzee 1977
Canis mesomelas elgonae	Heller	1914	Coetzee 1977
Canis mesomelas mesomelas	Schreber	1778	Coetzee 1977
Canis mesomelas schmidti	Noack	1897	Coetzee 1977
Canis rufus gregoryi	Goldman	1937	Hall 1981
Canis rufus rufus	Bachman	1851	Hall 1981
Canis simensis citernii	de Beaux	1922	Coetzee 1977
Canis simensis simensis	Ruppel	1835	Coetzee 1977
Chrysocyon brachyurus	Illiger	1811	Cabrera 1961
Cuon alpinus adustus	Pocock	1941	Ellerman and Morrison-Scott 1966
Cuon alpinus alpinus	Pallas	1811	Ellerman and Morrison-Scott 1966
Cuon alpinus dukhunensis	Sykes	1831	Ellerman and Morrison-Scott 1966
Cuon alpinus fumosus	Pocock	1936	Ellerman and Morrison-Scott 1966
Cuon alpinus hesperius	Afanasiev & Zolotareu	1935	Ellerman and Morrison-Scott 1966
Cuon alpinus infuscus	Pocock	1936	Ellerman and Morrison-Scott 1966
Cuon alpinus javanocus	Desm	1820	Chasen 1940
Cuon alpinus laniger	Pocock	1936	Ellerman and Morrison-Scott 1966
Cuon alpinus Upturns	Heude	1892	Ellerman and Morrison-Scott 1966
Cuon alpinus primaevus	Hodgson	1833	Ellerman and Morrison-Scott 1966
Cuon alpinus sumatrensis	Hardw	1821	Chasen 1940
Dusicyon culpaeus andinus	Thomas	1914	Cabrera 1961
Dusicyon culpaeus culpaeolus	Thomas	1914	Corbet & Hill 1980
Dusicyon culpaeus culpaeus	Molina	1782	Cabrera 1961
Dusicyon culpaeus lycoides	Phillippi	1896	Cabrera 1961
Dusicyon culpaeus magellanicus	Gray	1836	Cabrera 1961
Dusicyon culpaeus reissii	Hilzheimer	1906	Cabrera 1961
Dusicyon culpaeus smithersi	Thomas	1914	Cabrera 1961
Dusicyon griseus domeykoanus	Phillippi	1901	Cabrera 1961
Dusicyon griseus fulvipes	Martin	1837	Corbet & Hill 1980
Dusicyon griseus gracilis	Burmeister	1861	Cabrera 1961
Dusicyon griseus griseus	Gray	1836	Cabrera 1961
Dusicyon griseus maullinicus	Phillipi	1903	Cabrera 1961
Dusicyon gymnocercus antiquus	Ameghino	1889	Cabrera 1961
Dusicyon gymnocercus gymnocercus	Fischer	1814	Cabrera 1961
Dusicyon gymnocercus inca	Thomas	1914	Corbet & Hill 1980
Dusicyon sechurae	Thomas	1914	Cabrera 1961
Dusicyon vetulus	Lund	1842	Cabrera 1961
Dusicyon microtis	Sclater	1882	Cabrera 1961
Cerdocyon thous aquilus	Bangs	1898	Cabrera 1961
Cerdocyon thous azarae	Wied	1824	Cabrera 1961
Cerdocyon thous entrerianus	Burmeister	1861	Cabrera 1961
Cerdocyon thous germanus	Allen	1923	Cabrera 1961
Cerdocyon thous thous	Linnaeus	1758	Cabrera 1961
Fennecus zerda	Zimmermann	1780	Coetzee 1977
Lycaon pictus lupinus	Thomas	1902	Coetzee 1977
Lycaonpictus manguensis	Matschie	1915	Coetzee 1977
Lycaon pictus pictus	Temminck	1820	Coetzee 1977
Lycaonpictus sharicus	Thomas and Wroughton	1907	Coetzee 1977

Table 2. (continued)

Scientific Name	Taxonomist	Year	Reference
Lycaon pictus somalicus	Thomas	1904	Coetzee 1977
Nyctereutes procyonoides koreensis	Mori	1922	Ellerman and Morrison-Scott 1966
Nyctereutes procyonoides orestes	Thomas	1923	Ellerman and Morrison-Scott 1966
Nyctereutes procyonoides procyonoides	Gray	1834	Ellerman and Morrison-Scott 1966
Nyctereutes procyonoides ussuriensis	Matschie	1907	Ellerman and Morrison-Scott 1966
Nyctereutes procyonoides viverrinus	Temminck	1844	Ellerman and Morrison-Scott 1966
Otocyon megalotis megalotis	Desmarest	1821	Coetzee 1977
Otocyon megalotis virgatus	Miller	1909	Coetzee 1977
Speothos venaticus venaticus	Lund	1839	Cabrera 1961
Speothos venaticus wingei	Ihering	1911	Cabrera 1961
Urocyon cinereoargenteus borealis	Merriam	1903	Hall 1981
Urocyon cinereoargenteus californicus	Mearns	1897	Hall 1981
Urocyon cinereoargenteus cinereoargenteus	Schreber	1775	Hall 1981
Urocyon cinereoargenteus colimensis	Goldman	1938	Hall 1981
Urocyon cinereoargenteus costaricensis	Goodwin	1938	Hall 1981
Urocyon cinereoargenteus floridanus	Rhoads	1895	Hall 1981
Urocyon cinereoargenteus fraterculus	Elliot	1896	Hall 1981
Urocyon cinereoargenteus furvus	Allen and Barbour	?	Hall 1981
Urocyon cinereoargenteus guatemalae	Miller	1899	Hall 1981
Urocyon cinereoargenteus madrensis	Burt and Hopper	1941	Hall 1981
Urocyon cinereoargenteus nigrirostris	Lichvenstein	1850	Hall 1981
Urocyon cinereoargenteus ocythous	Bangs	1899	Hall 1981
Urocyon cinereoargenteus orinomus	Goldman	1938	Hall 1981
Urocyon cinereoargenteus peninsularis	Huey	1928	Hall 1981
Urocyon cinereoargenteus scottii	Merriam	1891	Hall 1981
Urocyon cinereoargenteus townsendi	Merriam	1899	Hall 1981
Urocyon cinereoargenteus venezuelae	Allen	1911	Cabrera 1961
Urocyon littoralis catalinae	Merriam	1903	Hall 1981
Urocyon littoralis clementae	Merriam	1903	Hall 1981
Urocyon littoralis dickeyi	Grinnell and Lindsdale	1930	Hall 1981
Urocyon littoralis littoralis	Baird	1858	Hall 1981
Urocyon littoralis sanatacruzae	Merriam	1903	Hall 1981
Urocyon littoralis santarosae	Grinnell and Lindsdale	1930	Hall 1981
Vulpes bengalensis	Shaw	1800	Ellerman and Morrison-Scott 1966
Vulpes cana	Blanford	1877	Ellerman & Morrison-Scott 1966
Vulpes chama	Smith	1833	Coetzee 1977
Vulpes corsac corsac	Linn	1758	Ellerman and Morrison-Scott 1966
Vulpes corsac kalmykorum	Ognev	1935	Ellerman and Morrison-Scott 1966
Vulpes corsac turkmenica	Ognev	1935	Ellerman and Morrison-Scott 1966
Vulpes ferrilata	Hodgson	1842	Ellerman & Morrison-Scott 1966
Vulpes pallida edwardsi	Rochebrune	1883	Coetzee 1977
Vulpes pallida harterti	Thomas and Hinton	1921	Coetzee 1977
Vulpes pallida oertzeni	Matschie	1910	Coetzee 1977
Vulpes pallida pallida	Cretzschmar	1826	Coetzee 1977
Vulpes rueppelli caesia	Thomas and Hinton	1921	Coetzee 1977
Vulpes rueppelli cufrana	de Beaux	1939	Coetzee 1977
Vulpes rueppelli rueppelli	Schinz	1825	Coetzee 1977
Vulpes rueppelli somaliae	Thomas	1918	Coetzee 1977
Vulpes velox arsipus	Elliot	1904	Hall 1981
Vulpes velox devia	Nelson and Goldman	1909	Hall 1981
Vulpes velox hebes	Merriam	1902	Hall 1981
Vulpes velox macrotis	Merriam	1888	Hall 1981
Vulpes velox mutica	Merriam	1902	HaU 1981
Vulpes velox neomexicana	Merriam	1902	Hall 1981
Vulpes velox nevadensis	Goldman	1931	HaU 1981
Vulpes velox tenuirostris	Nelson and Goldman	1931	Hall 1981
Vulpes velox velox	Say	1823	Hall 1981
Vulpes velox zinseri	Benson	1938	Hall 1981
Vulpes vulpes abietorum	Merriam	1900	Hall 1981

Table 2. (continued)

Scientific Name	Taxonomist	Year	Reference
Vulpes vulpes aeygptiaca	Sonnini	1816	Ellerman and Morrison-Scott 1966
Vulpes vulpes alascensis	Merriam	1900	Hall 1981
Vulpes vulpes alpherakyi	Satunin	1906	Ellerman and Morrison-Scott 1966
Vulpes vulpes alticola	Ognev	1926	Ellerman and Morrison-Scott 1966
Vulpes vulpes anatolica	Thomas	1920	Ellerman and Morrison-Scott 1966
Vulpes vulpes arabica	Thomas	1902	Ellerman and Morrison-Scott 1966
Vulpes vulpes atlantica	Wagner	1843	Ellerman and Morrison-Scott 1966
Vulpes vulpes barbaras	Shaw	1800	Ellerman and Morrison-Scott 1966
Vulpes vulpes beringiana	Middendorff	1875	Ellerman and Morrison-Scott 1966
Vulpes vulpes cascadensis	Merriam	1852	Hall 1981
Vulpes vulpes caucasica	Dinnik	1914	Ellerman and Morrison-Scott 1966
Vulpes vulpes crucigera	Bechstein	1789	Ellerman and Morrison-Scott 1966
Vulpes vulpes daurica	Ognev	1931	Ellerman and Morrison-Scott 1966
Vulpes vulpes diluta	Ognev	1924	Ellerman and Morrison-Scott 1966
Vulpes vulpes dolichocrania	Ognev	1926	Ellerman and Morrison-Scott 1966
Vulpes vulpes dor sails	Gray	1838	Ellerman and Morrison-Scott 1966
Vulpes vulpes flavescens	Gray	1843	Ellerman and Morrison-Scott 1966
Vulpes vulpes fulva	Desmarest	1820	Hall 1981
Vulpes vulpes griffithi	Blyth	1854	Ellerman and Morrison-Scott 1966
Vulpes vulpes harrimani	Merriam	1900	Hall 1981
Vulpes vulpes hoole	Swinhoe	1870	Ellerman and Morrison-Scott 1966
Vulpes vulpes ichnusae	Miller	1907	Ellerman and Morrison-Scott 1966
Vulpes vulpes induta	Miller	1907	Ellerman and Morrison-Scott 1966
Vulpes vulpes jakutensis	Ognev	1923	Ellerman and Morrison-Scott 1966
Vulpes vulpes japonica	Gray	1868	Ellerman and Morrison-Scott 1966
Vulpes vulpes karagan	Erxleben	1777	Ellerman and Morrison-Scott 1966
Vulpes vulpes kenaiensis	Merriam	1900	Hall 1981
Vulpes vulpes krimeamontana	Brauner	1914	Ellerman and Morrison-Scott 1966
Vulpes vulpes kurdistanica	Satunin	1906	Ellerman and Morrison-Scott 1966
Vulpes vulpes macroura	Baird	1900	Hall 1981
Vulpes vulpes montana	Pearson	1836	Ellerman and Morrison-Scott 1966
Vulpes vulpes necator	Merriam	1900	Hall 1981
Vulpes vulpes ochroxantha	Ognev	1926	Ellerman and Morrison-Scott 1966
Vulpes vulpes palaestina	Thomas	1920	Ellerman and Morrison-Scott 1966
Vulpes vulpes peculiosa	Kishida	1924	Ellerman and Morrison-Scott 1966
Vulpes vulpes pusilla	Blyth	1854	Ellerman and Morrison-Scott 1966
Vulpes vulpes regalis	Merriam	1900	Hall 1981
Vulpes vulpes rubricosa	Bangs	1897	Hall 1981
Vulpes vulpes schrencki	Kishida	1924	Ellerman and Morrison-Scott 1966
Vulpes vulpes silacea	Miller	1907	Ellerman and Morrison-Scott 1966
Vulpes vulpes splendidissima	Kishida	1924	Ellerman and Morrison-Scott 1966
Vulpes vulpes stepensis	Brauner	1914	Ellerman and Morrison-Scott 1966
Vulpes vulpes tobolica	Ognev	1926	Ellerman and Morrison-Scott 1966
Vulpes vulpes tschiliensis	Matschie	1907	Ellerman and Morrison-Scott 1966
Vulpes vulpes vulpes	Linnaeus	1758	Ellerman and Morrison-Scott 1966

3. Introduction to Species Summaries and Geographical Chapters

Format of Regional Chapters

To facilitate access to information, much of the data on the status, abundance, and distribution of the world's 34 canid species are organized in Chapters 4-8. Each of these chapters is organized in a similar format.

In the following section, we have reproduced the headings used in each of the geographic chapters. Under each heading, we discuss the information included in that part of the chapter.

Introduction

The introduction to each chapter includes a general discussion of the geographic area included therein, the number of species in the chapter, and which species occur in the region covered. If a species occurs in the region, but is included in a different chapter, this is cross-referenced.

Current Status of Species

A brief summary of the current conservation status of each species is presented in this part of each chapter. Full details of the conservation status of all the canid species, and recommended conservation actions, can be found in Chapter 13.

Species Accounts

Following the summary sections at the beginning of each chapter, we include an entry for each species found in that particular geographic region. For each species, an account has been prepared which uses the following format. Data are included for each variable where available.

Name. English, scientific,French, German, local names (where known). Where more than one English name is commonly used, we include the preferred name in the title, and list others in this section. Local names are also presented.

Description. General physical description for identification including: head-and-body length, tail length, shoulder height, weight.

Reproduction. Data on time of mating, gestation, litter size, period of lactation, age at sexual maturity, and longevity.

Social Behaviour. Information concerning general patterns of activity, mating system, parental behaviour, patterns of dispersal.

Diet. Range of diet and feeding preferences.

Distribution. Geographical range of the species. For rare species, or species about which little is known, specific locations may be included.

Habitat. Ecological range of the species.

Population and Status. Known patterns of distribution and abundance. For common species, information is general and notes the species' ability to coexist with man outside protected areas are included. For threatened species, detailed status reports have been included. Single sightings of rare or unknown species may be included if data are few.

Commercial Use. Details of commercial uses, both locally and in terms of international trade.

Other Threats. Threats to the species other than trade.

Current Research Programmes. Details of research programmes known to be active listing objectives and principal investigators.

Proposed Research Programmes. Proposals for further research.

Conservation Measures Taken. Occurrence of viable populations in National Parks and reserves. For common species, up to five protected areas providing viable populations are listed. Details of specific legal protection for threatened species are given. For rare species, all reserves in which a species is known to occur are listed. General legal status in each country (restrictions on internal trade, hunting/trapping regulations, etc.) will not usually be included.

Reviewers. Names of scientists who have reviewed our draft versions of this section.

4. Sub-Saharan Africa

Introduction

Sub-Saharan Africa covers a vast area which encompasses examples of nearly every tropical and sub-tropical biome. Nonetheless, only seven species of canid are found in this part of the continent. Five of these species are found only in sub-Saharan Africa: the side-striped jackal (*Canis adustus*); the black-backed jackal (*Canis mesomelas*); the Simien jackal (*Canis simensis*); the bat-eared fox (*Otocyon megalotis*); and the Cape fox (*Vulpes chama*). The African hunting dog (*Lycaon pictus*) was formerly found in parts of north and northwest Africa, but is now extirpated in these regions. The golden jackal (*Canis aureus*) is still found in many areas of the Middle and Near East and southern Europe. However, because much of the information available for the species is derived from research conducted in sub-Saharan Africa, we have summarized the information available on the golden jackal in this section.

Side-striped jackal (*Canis adustus*). (Photo by J.R. Malcolm)

Current Status of Species

The overall status of canids in sub-Saharan Africa is good. Five of seven species are abundant and face no serious threats. Two species, the wild dog and the Simien jackal, however, are in danger of extinction. Whatever the status of a particular species, however, our knowledge of the behaviour and ecology of most species which occur in sub-Saharan African is good, surpassed as a group only by the general knowledge we have about species occurring in Eurasia and North America. Furthermore, there are active population monitoring efforts in many parts of Africa. Finally, in much of Africa, there is great concern, both local and international, about the fate of wildlife. Although concern does not always translate into protection, it is unlikely that an extinction could occur without sufficient warning to address the causes of decline.

Species Accounts

Detailed biological studies of each species are listed in the reference section following this chapter. Although there has been no thorough review of African canids, several texts provide basic information about the distribution, abundance, and biology of African mammals. These include Haltenorth and Diller (1980); Kingdon (1977); Smithers (1983); and Stuart (1981).

Side-striped jackal (*Canis adustus*)

French: Le Chacal à flancs rayés. German: Streifenschakal. Afrikaans: Witwasjakkals. Karamojong: Oloo. Kikinga: Ngwe. Kinyakyusa: Akambwe, Imbira. Kinyiha: Habila. Kiswahili: Bweha, Bweha miraba. Luganda: Akabowa, Ekihe. Lugbara: Bowa. Lwo: Too. Madi: Uba. Runyankole: Emuha. Runyoro: Eboha. Sebei: Bleyit.

Description. A greyish yellow coat with a white stripe from elbow to hip with a white tip on the tail (may be absent). Stripes not always obvious. Head-and-body length: 65-81 cm. Tail length: 30-41 cm. Shoulder height: 41-50 cm. Weight: 6.5-14 kg, males somewhat larger than females, males mean of 9.4 kg, females 8.3 kg.

Reproduction. Time of mating: Jun.-Jul./Sept.-Oct. (E. Africa); Jun-Nov. (S. Africa). Gestation: 57-70 days. Litter size: 3-6, mean 5.4. Lactation: 8-10 weeks. Age at sexual maturity: 6-8 months, disperse at 11 months. Longevity: 10-12 years.

Social Behaviour. Mated pair and their young, young disperse at 11 months before the next litter. Nocturnal. Not averse to moving in close proximity to dwellings and have been sighted, like the red fox, in city centres.

Diet. Omnivorous, taking a variety of invertebrates, small vertebrates, carrion, and plant material. Data from animals taken in agricultural areas of northern Botswana (Smithers and Wilson 1979, in Smithers 1983) show a predominantly vegetable diet, supplemented by rodents and insects. Included cow and goat hair suggest scavenging of domestic livestock found as carrion.

Habitat. Avoids open savanna, preferring thickly wooded areas but not forest. Sea level up to 2700 m in East Africa.

Distribution. Tropical Africa, moist woodlands, 15°N to 23°S, not in the rain forests of west and central Africa. Prefers moister parts of savannas, thickets, forest edge, cultivated areas; up to 2700 m. West African range is largely unknown but includes northern Nigeria (Gombe, north of Benue and Borgu Game Reserve in the west). Occurs in the Central African Republic, south Sudan, and parts of Ethiopia, central and southern Kenya, Uganda, and along Lake Victoria. Widespread in Tanzania and Zambia, northern Mozambique, Malawi, south, west, and east Zaire and into Gabon. Also Angola, northern Namibia, northern Botswana, throughout Zimbabwe, and in the Transvaal southwards into Kwazulu and Natal provinces. See Figure 1.

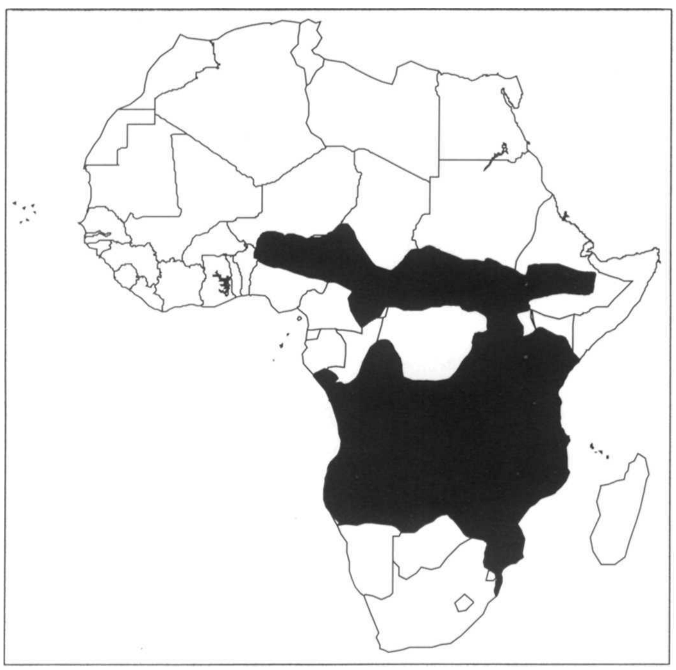


Figure 1. Distribution of the side-striped jackal (*Canis adustus*).

Population and Status. Rare throughout its range, but no direct threat is known.

Commercial Use. None known, although uses in traditional medicine are known. The heart is used to treat epilepsy in the Buganda tribe. Skins and nails are used to ward off evil spirits.

Threats. Jackals have historically (1950s) been trapped and poisoned during rabies outbreaks in Uganda. They are also thought to have died in large numbers during early parts of the century due to distemper.

Current Research Programmes

1. Studies are being conducted on diet in the Akagera National Park, Rwanda, by J. Kalpers.
2. Long-term research on the black-backed and golden jackals in the Serengeti by P.D. Moehlman has been expanded to include the side-striped jackal.

Conservation Measures Taken. Occurs in numerous national parks and reserves including: Serengeti National Park, Tanzania; Akagera National Park, Rwanda

Reviewers. P. Moehlman; D. Rowe-Rowe.

Golden jackal (*Canis aureus*). (Photo by A.J.T. Johnsingh)

Golden or Asiatic jackal (*Canis aureus*)

French: Le Chacal commun. German: Goldschakal. Kiswahili: Bweha wa mbuga, Bweha Dhahabu.

Description. Coat varies with season and region, but is usually a pale gold-brown, or brown tipped yellow. Fur is coarse, and not very long. Dorsal area is black and grey; head, ears, and sides can be rufous. Underside is frequently ginger or nearly white. The tip of the tail is black. There is sexual dimorphism of approximately 15% in body weight. Head-and-body length: 60-106cm. Tail length: 20-30 cm. Shoulder height: 38-50 cm. Weight: 7-15 kg.

Reproduction. Time of mating: Oct.-Nov. (Tanzania occasionally June-July, Moehlman pers. comm.); Feb.-Mar. (USSR); Oct.-Feb. (Israel). Timed so birth occurs at peak of food abundance (e.g. Thomson's gazelle fawns in the Serengeti, Jan.-Feb.). Gestation: 63 days. Litter size: 1-9, usually 5-6. Lactation: 8-10 weeks. Age at sexual maturity: 11 months (female);

up to 2 years (male) but may delay reproduction. Longevity: 16 years in captivity (Yom-Tov pers. comm.), up to 13 years in the wild (Moehlman pers. comm.).

Social Behaviour. Usually in mated pairs, territorial, territory size 0.5 to 2.5 km^2. Helpers (last year's young) can increase reproductive success, but not as much as in the black-backed jackal (Moehlman 1983). In many areas, *C. aureus* is nocturnal and diurnal, but it becomes strictly nocturnal in areas inhabited by humans. Deviation from usual social organization is found in areas where food is abundant, with up to 20 members in a group and with home range areas of 0.11 km^2 (Macdonald 1979).

Diet. Omnivorous: fruits; invertebrates; reptiles; amphibia; birds; small mammals; carrion. Opportunistic foragers, but cooperation between mated pairs can greatly increase hunting success. In areas around human habitation, it can subsist on garbage (Macdonald 1979).

Habitat. Open country with trees and brush, grass and copse. Occur up to 2,000 m (though recently sighted at nearly twice that altitude). Also found in oases and human settlements in the Israeli desert. Habitat can vary immensely, including areas around human habitation.

Distribution. Widely distributed in north and east Africa, southeast Europe, south Asia to Burma and Thailand. In Africa, there is some evidence of the golden jackal extending its range in recent times, having lately been sighted in the Bale Mountains National Park, Ethiopia, up into the heather belt (3,800 m), also in the south in the Harenna forest.(J.C. Hillman, pers. comm.). Recently sighted in eastern Italy (L. Boitani pers. comm.). See Figure 2.

Population and Status. Locally abundant and widespread. Accurate estimates of numbers rare, but surveys in the Serengeti (May 1986) estimated approximately 1,600 individuals, with no significant change in the last decade (Campbell and Borner 1986).

Commercial Use. None known.

Threats. None known.

Current Research Programmes. Long-term research in the Serengeti, Tanzania, by Dr. P.D. Moehlman.

Conservation Measures Taken. Occurs in numerous National Parks and reserves in Africa and Asia.

Reviewers. P. Moehlman; Y. Yom-Tov.

Black-backed jackal (*Canis mesomelas*)

French: Le Chacal à chabraque. German: Schabrackenschakal. Afrikaans: Rooijakkals. Ateso: Ekwee. Karamojong: Kwee. Kigogo: Nhyewe. Kihehe: Nchewe. Kikinga: Ngewe. Kiliangulu: Gedala. Kinyaturu: Mola. Kisagara: Kewe. Kiswahili: Bweha Nyakundu, Bweha Shaba. Kitaita: Muzozo.

Description. A reddish brown or ginger canid with a distinctive black saddle running from the nape of the neck to the tail. The tail is reddish-brown and black and bushy. Head-and-body length: 45-90 cm., means: 72 cm males, 67.3 cm females (Zimbabwe—Smithers 1983); 78.5 cm males, 74.5 cm females (Cape Province, Stuart 1981). Tail length: 26-40 cm., means: 32.9 cm males, 31.4 cm females (Zimbabwe, Smithers 1983); 32.6 cm males, 31.6 cm females (Cape Province, Stuart 1981).

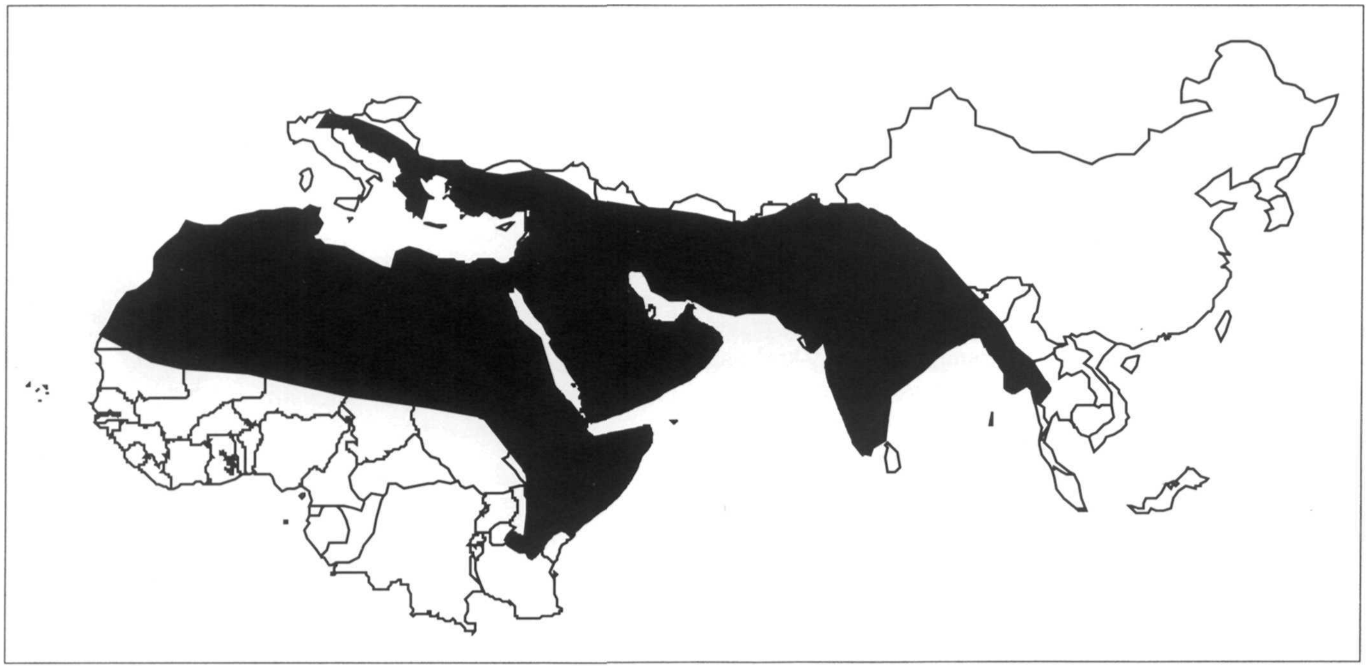


Figure 2. Distribution of the golden jackal (*Canis aureus*).

Black-backed jackal (*Canis mesomelas*). (Photo by J. Nel)

Shoulder height: 30-48 cm., mean 38 cm (Zimbabwe, Smithers 1983). Weight: 6-12 kg, means: 7.9 kg males, 6.6 kg females (all classes, Zimbabwe, Smithers 1983); 8.4 kg males, 7.4 kg females (adults, Natal, Rowe-Rowe 1978); 8.15 kg males, 7.4 kg females (adults, Cape Province, Stuart 1981).

Reproduction. Time of mating: May-Aug. May-Jun. (Natal, Rowe-Rowe 1978); July (Botswana, Smithers 1971). Gestation: 60 days. Litter size: 1 to 8, mean 4, 1-3 survive. Lactation: 8-10 weeks. Age at sexual maturity: 11 months, but may delay reproduction (Moehlman 1979,1983). Longevity: 14 years in captivity, but probably usually at most 7 years in the wild (Rowe-Rowe 1982).

Social Behaviour. Monogamous pairs which mate for life (Moehlman 1983). Often hunt in pairs. Diurnal and crepuscular (see Ferguson et al. 1988 for details); may become nocturnal in areas around human habitation and in some conservation areas (Kalahari, Kruger National Park). Home range size 2 to 33 km^2, but larger sizes are rare (references in Moehlman 1986; Ferguson et al. 1983). Rowe-Rowe (1982) found that mated adults had home ranges of 19 km^2, young (< 1 year) 9 km^2, and unmated adults 33 km^2. Helpers (last year's young) may contribute to rearing of pups and greatly increase pup survival (Moehlman 1979,1983). Sometimes old termite mound or aardvark holes are used as dens, and are usually moved among several dens.

Diet. Omnivorous and varied. In South Africa, Rowe-Rowe (1983) reports that in a study in Giant's Castle National Reserve, 55% of the diet was from small mammals, 11 % antelopes; 9% hare-sized mammals; 9% birds; and 16% miscellaneous including domestic animals, invertebrates, amphibians, grubs, and fruit. In the Serengeti, a similar diet is taken, with variation in the amount of mammalian prey being a function of seasonal abundance (Lamprecht 1978). Moehlman (1979) reports a preference for rodents and the fruit of *Balanites aegyptiaca*, which may serve as **a** natural worming agent. Stuart (1976) found that in the Namib Desert, fruit constituted a large proportion of the diet. Some food may be cached (Lamprecht 1978).

Habitat. Variable, ranging from human habitation and suburbs of large cities to the desert of the Namib. Found in areas with up to 2,000 mm of rain per annum (Rowe-Rowe 1976), tend to be replaced by the side-striped jackal in moister areas. Common in areas with less than 100 mm per annum.

Distribution. Widespread in east and southern Africa. Two populations (not connected) exist. In the north, it is found from the Gulf of Aden south to Tanzania. In the south, the population ranges from the Cape north to southwestern Angola and east to Zimbabwe and Mozambique. See Figure 3.

Population and Status. Population density figures are available for only a few sites. In the plains areas of the Serengeti National Park, Tanzania the species may have exhibited a decline in population from 1976 to 1986 (488 to 50 individuals (Cambell and Borner 1986) with densities as low as one individual per 100 km^2. However, *C. mesomelas* populations are recovering in those areas surveyed. Furthermore, this survey did not include many transects in habitat used by *C. mesomelas*, and hence may underestimate the real population size (Moehlman pers. comm.). Rowe-Rowe (1982) estimates that jackal densities in the Giant's Castle Game Reserve are approximately one per 2.5 km^2.

Figure 3. Distribution of the black-backed jackal (*Canis mesomelas*).

Commercial Use. Fur exploited. Trapping, hunting with hounds, and the use of "coyote getter" toxic collars on sheep are legal in South Africa. In South Africa, it may be hunted throughout the year.

Threats. In South Africa, and elsewhere in Africa, the black-backed jackal has a reputation as a voracious killer of lambs and sheep, a reputation that may, in part, be deserved. However, as the identification of carcasses killed by jackals and other canids is often not undertaken, deaths caused by domestic dogs may be attributed to wild canids. Predation on sheep is seasonal, and occurs most frequently during lambing (Rowe-Rowe 1986). In South Africa, control measures include trapping and hunting. Extirpation is difficult, however, and the nature conservation department suggests killing only those jackals causing damage (Rowe-Rowe 1986).

Current Research Programmes

1. Long-term research being conducted by P.D. Moehlman in the Serengeti National Park, Tanzania. No other active research projects known.
2. Investigations on improving ways of assessing damage to livestock, preventing damage, and improving methods by selectively eliminating stock-killers are being carried out by researchers from the University of Natal under the supervision of M.R. Perrins and D.T. Rowe-Rowe.
3. C. and T. Stuart of the African Carnivore Survey are involved in a project to survey the effect of predator control measures on all carnivore populations in southern Africa.

Conservation Measures Taken. Occurs in numerous protected areas, including the Serengeti National Park, Tanzania, and the Kruger National Park and Giant's Castle Game Reserve, South Africa.

Reviewers. G. Mills; P. Moehlman; D. Rowe-Rowe; C. and T. Stuart.

Simien jackal (*Canis simensis*)

English: Simien fox, Abyssinian wolf, red jackal, Ethiopian wolf. French: Loup asyssinie. Amharic: Ky Kebero. Oromo: Jedalla Farda.

Description. Bright reddish (coat lighter in juveniles and females) with white patches on throat, neck and chest, and basal half of tail white underside. Lower half of tail black. Relatively long legs and a long, thin muzzle. Head-and-body length: 100 cm. Tail length: 33 cm. Shoulder height: 60 cm. Weight: approximately 15-18 kg males, 13-16 kg females.

Reproduction. Time of mating: Aug-Dec (Sillero-Zubiri and Gottelli unpubl. data) Gestation: 60+3 days. Litter size: 2-6 (N=7, Sillero-Zubiri and Gottelli unpubl. data). Lactation: 6-8 weeks. Age at sexual maturity: 2 years, females. Longevity: unknown.

Social Behaviour. Most frequently seen alone while foraging by day. Pairs and groups of 2-12 congregate at morning, noon and evening with noisy greetings. Adult animals have been observed with sub-adults (9 months) sleeping together as a group. Several adult-sized animals were seen together at a den site that contained pups (Malcolm 1988). The largest group sighted consisted of 7 adults and 6 pups. Mean group size is 7, often multi-male groups. Fifteen dens have been observed: dens usually consist of a much-used system of burrows beneath a rock-overhang or cliffs; other burrows located in a flat, grassy area have several entrances, possibly interconnected. Dens are attended both by parents and sub-adult helpers. All members of the pack regurgitate food to the young. All information is from Sillero-Zubiri and Gottelli (1989).

Simien jackal (*Canis simensis*). (Photo by D. Gottelli)

Diet. Subsists primarily on mammals ranging in size from hares and the giant mole-rat *Tachyoryctes macrocephalus* (900g) to the common species of grass rat (*Arvicanthis blicki, Otomys typus*) at 90-120g. Also includes *Lophuromys melanonyx, Stenocephalemys albocaudata,* and *Lepus starcki* in diet (Malcolm 1982; Sillero-Zubiri and Gottelli unpublished). The Simien jackal is a key predator in the food chain of this high altitude ecosystem, and its role in regulating the dynamics of rodent populations is important. In Bale, one jackal was seen feeding off a cow carcass. Caching prey and scavenged material in shallow holes is common (Sillero-Zubiri and Gottelli unpublished). The species has been observed hunting reedbuck and mountain nyala calves. Evidence of other prey has not been found in scat analysis (Hillman 1986).

Habitat. Common in open moorlands where vegetation is less than 0.25 m high. Also seen in heather moorlands.

Distribution. Mountains of Ethiopia at altitude range 3,000-4,377 m. Arssi and Bale mountains of southeast Ethiopia; the Simien mountains, northeast Shoa, Gojjam (1932 sighting) and Mt. Guna (Yalden et al. 1980). See Figure 4.

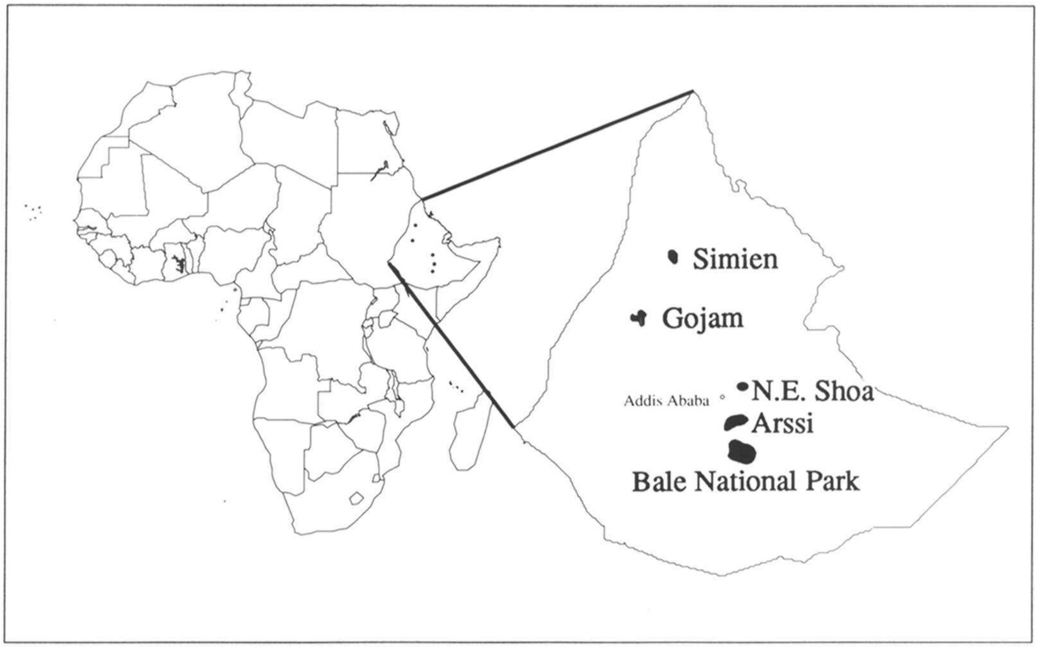


Figure 4. Distribution of the Simien jackal (*Canis sinensis*).

Population and Status. Total population under 1,000 individuals. The Bale Mountains National Park supports the only known population of any size, estimated at 500-600 individuals (Sillero-Zubiri and Gottelli 1989; Malcolm 1988 estimated 450-600). Within the Park, the distribution is as follows: eastern area (Sanetti and Shaiya) 200-250 individuals; western area (Web Valley and Peaks) 150-200; other areas 50-100 individuals (Malcolm 1988 as modified by data from Sillero-Zubiri and Gottelli). The maximum number of individuals in the Park is estimated at 704 (Hillman 1986). Population in Bale is stable (Malcolm 1988) or perhaps increasing (Sillero-Zubiri and Gottelli unpublished). In the Simien Mountains, the total population was estimated to be less than 20 individuals in 1976. This area has been closed for security reasons for some time, and the current status of the population there is unknown (Malcolm pers. comm.). In Arsi, there are no more than 100 individuals, and the population is decreasing (Malcolm 1982). In northeast Shoa, recent sightings suggest a small scattered population (Sillero-Zubiri and Gottelli pers. comm.).

Commercial Use. None known.

Threats

1. Loss of suitable habitat.
2. The existence of just three small populations immediately suggests that disease is an equally great threat to the species. A single outbreak of distemper, parvo, and/or anthrax could decimate the last remaining large population in the Bale Mountains. Potential vectors for disease include domestic dogs (*C. familiaris*).
3. In the Web Valley of Bale, two forms of human-induced competition also threaten the species. Domestic dogs have been observed hunting rats and may compete with the Simien jackal (Gottelli pers. comm.). Overgrazing may affect food available for rodents, the jackal's primary food (Malcolm 1988). There is some evidence that some types of human activity (grazing) may increase the habitat available to the jackals (Sillero-Zubiri and Gottelli unpublished data).
4. In the northern parts of their range, jackals have historically been hunted as pests. Evidence exists that they are responsible for lamb predation (Sillero-Zubiri and Gottelli: one observation of predation on domestic stock), but this has only been observed within protected areas.
5. Genetic introgression by cross-breeding with domestic dogs threatens to pollute the Bale population gene pool.
6. Competition with the golden jackal may, in the future, present a problem, although there is no evidence at present of interspecific competition.

Current Research Programmes. A study has been funded by Wildlife Conservation International (begun in March 1988) on the ecology, behaviour, and conservation of this species and is currently being conducted by C. Sillero-Zubiri and D. Gottelli.

Conservation Measures Taken. The Bale and Simien populations are completely protected by inclusion in National Parks. The species is protected in Ethiopia by law (Wildlife Conservation Regulations 1974: Schedule VI). The law states that the species "may only be hunted with special permit for scientific purposes—only to be issued by the Minister of Agriculture." No poaching, hunting and/or trade of live animals has been observed.

Reviewers. D. Gottelli; J. C. Hillman; J. Malcolm; C. Sillero-Zubiri. We would like to thank D. Gottelli and C. Sillero-Zubiri for their generous contribution of unpublished data.

African wild dog (*Lycaon pictus*)

English: Cape hunting dog. French: Lycaon, Le cynhyène, Loup-peint German: Hyänenhund. Afrikaans: Wildehond. Ateso: Apeete. Kalenjin: Suyo. Kibena: Liduma. Kibungu: Eminze. Kichagga: Kite kya negereni. Kihehe: Ligwami. Kijita: Omusege. Kikamba: Nzui. Kikuyu: Muthige. Kikuyu, Kimeru: Mbawa. Kiliangulu: Eeyeyi. Kimaragoli: Imbwa. Kinyaturu: Mbughi. Kinyiha: Inpumpi. Kinyiramba: Mulula. Kisukuma: Mhuge. Kiswahili: Mbwa mwitu. Kitaita: Kikwau. Kizigua: Mauzi. Lwo: Sudhe, Prude. Masai: Osuyiani. Samburu: Suyian. Sebei: Kulwe, Suyondet.

Description. Unmistakable colour patterns with splotches of yellow, black, white and grey covering the entire body. Some regional variation in colours, but intraspecific variation is large in all places. Large rounded ears, long legs, broad bushy tails with tips usually, but not always, white. Head-and-body length: 76-112 cm. Tail length: 30-41 cm. Shoulder height: 61-78 cm. Weight: 17-36 kg (monomorphic—mean 25 kg), somewhat larger in the south.

Reproduction. Time of mating: Very variable. In the Serengeti, mating starts in November, with 75% of litters born between January and June. In Kruger National Park, mating occurs in April-May. Gestation: 69-73 days. Littersize: 2 to 19, average 7 to 10. Lactation: 10 weeks. Age at sexual maturity: females disperse at approximately 18 months (Frame and Frame 1976), but due to suppression of breeding in all but dominant female and male, actual age at first reproduction usually much greater.

Social Behaviour. African wild dogs live in packs composed of several related adult males, and one to several related adult females originating from a different pack. Pups remain in the den for two to three weeks, then emerge to receive food from returning pack members. The wild dog exhibits a complex social organization in which all members of the pack feed young and mother at den. The number of adults and yearlings in each pack varies locally, with a mean of 6.6 in the Serengeti (Malcolm and Marten 1982), 8.8 in the Zambesi Valley (Childes 1985), 14.8 in Hwange National Park, Zimbabwe (Childes 1985), and 7.3 in Kruger National Park (Reich 1981). Total pack size, including pups, can be quite variable and will depend on pack fecundity and pup survival. The species is perhaps one of the few truly nomadic animals. Pack home range varies considerably, ranging from 500 km^2 at its smallest (Reich 1981) up to 1500 km^2 (Frame et al. 1979). Pack home range overlap varies from 50% to 80%. In most circumstances, in any particular pack, only the dominant female will rear pups successfully. The dominant bitch will remain at the den with the pups and be fed, along with the pups, by other members of the pack who regurgitate food after returning from a kill.

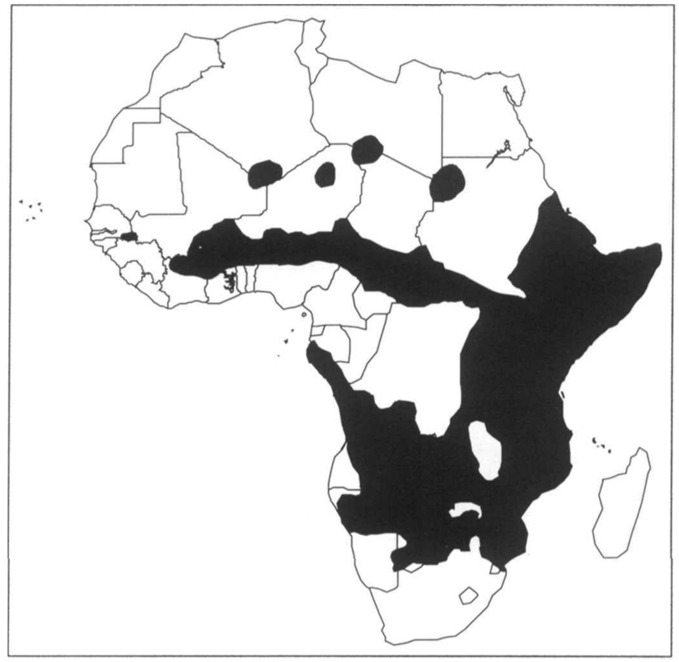


Figure 5. Distribution of the African wild dog (*Lycaon pictus*) 1983—after Smithers 1983.

African wild dog (*Lycaon pictus*). (Photo by J. R. Ginsberg)

Diet. Variable according to prey species most abundant in area. Dominant species include: impala in Kruger National Park (Reich 1981); duiker and reedbuck in Zambia (Shenton and Uys in Smithers 1983); Thomson's gazelle and wildebeest in the Serengeti (Schaller 1972; Frame 1986); impala and kudu in Hwange National Park, Zimbabwe (Childes 1985).

Habitat. Very catholic in its requirements, being found in areas of moderately dense bush, open plains habitat, and up into the lower forests of Mt. Kenya.

Distribution. African wild dogs are never even locally abundant, and their nomadic movements make even simple estimates of distribution difficult. The population status for each country is listed below. As the status of this species appears to be changing rapidly, we have included two distribution maps (Figures 5 and 6). Until very recently (Smithers 1983; Figure 5) the range of the wild dog included much of Africa, as far west as Ivory Coast, southern Nigeria, Burkina Faso, around Lake Chad, and in western Chad. Disjunct populations formerly occurred in southern and southwestern Algeria, the Tanzerouft and Adrrar des Forar in Air in Niger, and near Tibesti in extreme

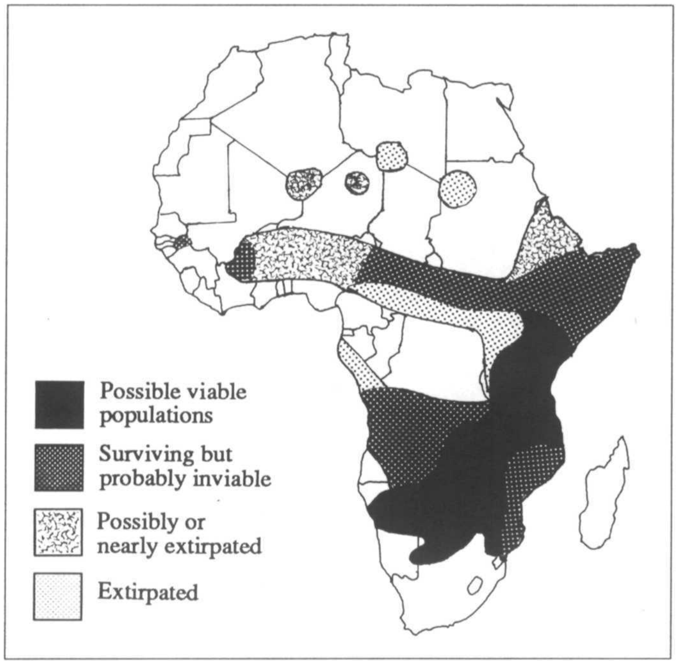


Figure 6. Distribution of the African wild dog (*Lycaon pictus*)—data from Frame and Fanshawe in prep.

north Chad. The species ranged from the Central African Republic, into southern Sudan, across southern Ethiopia and into Somalia. They were found throughout Kenya, Tanzania, eastern Rwanda, southeastern and eastern Zaire, Zambia, Malawi, Mozambique, Zimbabwe, Botswana, and Angola. The southernmost populations were found in Namibia, Botswana and northern South Africa. Although formerly widely distributed in South Africa, by 1983 the wild dog was only found in Kruger National Park.

The wild dog is one of the few canids for which good data are available on the historical contraction of the species range. The species ranged over much of what is now South Africa, occurring at relatively high densities compared to those now observed. The species probably occurred as far south as the Cape in 1684 (Smithers 1983). In Zimbabwe, the distribution is now limited to areas in and around national parks, reserves, and hunting areas, having been exterminated from all other areas.

One must remember that even in 1983, within the boundaries of this vast area, the distribution of the wild dog was very patchy. Since then, the distribution of the wild dog has contracted rapidly. Within the boundaries delineated in the map above, perhaps 2000 wild dogs can be found. Figure 6 is a graphic depiction of the data presented in the next section.

Population and Status. Frame and Fanshawe (in prep.) are in the process of summarizing the data collected from a continent-wide mail survey investigating the status of the wild dog. A very brief summary of their findings follows:

Algeria: suspected to be extirpated.

Angola: very rare, near extirpation.

Benin: suspected to be extirpated.

Botswana: still present and moderately abundant for *Lycaon*. However, despite legal protection, can be shot if a threat to livestock.

Burkina Faso: present, but very rare, in southern part of the country.

Burundi: suspected to be extirpated or nearly so.

Cameroon: small numbers and populations stable. Possibility for recovery.

Central African Republic: rare, but present. Not protected in any way.

Chad: Lake Chad and the west. Little known of populations.

Congo: suspected to be extirpated.

Djibouti: probably extirpated.

Ethiopia: present but rare in most areas. Relatively common in the southwest, but rare nonetheless.

Gabon: suspected to be extirpated.

Ghana: suspected to be extirpated or will soon be so.

Ivory Coast: very rare.

Kenya: present and in decline. Much interest in conservation in this country, but increasing human population size and livestock numbers are a threat.

Malawi: present only in national parks. Viable population only in Kasungu National Park.

Mali: very rare; suspected to be extirpated.

Mozambique: endangered and soon to be extirpated.

Namibia: declining population due to hunting/shooting as vermin. Population perhaps viable, but under threat (C. and T. Stuart, pers. comm.).

Niger: if present, only in south of country. Soon to be extinct.

Nigeria: nearly extinct.

Rwanda: suspected to be extinct.

Senegal: rare, but present in several locations. Populations threatened.

Somalia: present in south and northeast, but probably declining.

South Africa: endangered (R.S.A. Red Data Book) and eradicated from much of the country. Still viable in Kruger National Park. Despite the size of the park, however, individuals stray. One farmer bordering the park is known to have shot 20 dogs during 1988 (G. Mills, pers. comm.). Another radio-collared individual was shot in Mozambique. Population introduced to Umfolozi/Hluhluwe complex, Natal.

Sudan: present in the south, rare to common. Civil war, hence no knowledge of population trends.

Tanzania: present in many parks and reserves, populations small and fluctuating (18 to 100 in the Serengeti). Legally protected.

Togo: suspected to be extirpated.

Uganda: extirpated, except for occasional visitors from Tanzania or Sudan (Olivier pers. comm.).

Zaire: suspected to be extirpated.

Zambia: present in many areas, but declining. Have been affected by recent outbreak of anthrax in the Luanga Valley (Saigawa pers. comm.).

Zimbabwe: rare and declining, but may be increasing in Hwange National Park. Recently afforded legal protection. Strong opposition to conservation measures by both traditional and game ranchers.

In their summary, Frame and Fanshawe (in prep.) have not estimated population sizes for any of the countries in which *Lycaon* is found. They note that the species will be extinct in 20-40 years if nothing is done to reverse present trends. As an example, Childes (1988) estimates 300-400 individuals remain in all of Zimbabwe, a decline of 40% in a decade.

Commercial Use. None.

Threats

1. The most severe threat to the wild dog has been, and will continue to be, its mostly undeserved reputation as a voracious and indiscriminate killer of game and livestock. This reputation is long-standing, as is evidenced by the often quoted passage from R.C.F. Maugham's *Wild Game in Zambezia* (1914): "Let us consider for a while that abomination—that blot upon the many interesting wild things... the murderous wild dog. It will be an excellent day for African game and its preservation when means can be devised for this unnecessary creature's complete extermination." Means have been devised. A combination of events, in particular hunting, poisoning, and disease, threaten the survival of the wild dog. Protection has been provided in many countries (e.g. Tanzania, Kenya), but only after populations have been pushed to the edge of extinction.

2. Disease: Wild dogs appear to be susceptible to many diseases, particularly canine distemper (Serengeti, Schaller 1972), rabies (Zimbabwe, Foggin pers. comm.), and anthrax (Zambia, Saigawa pers. comm.).

3. Wild dogs may also be prone to low levels of genetic heterozygosity (R. Wayne, in litt); this may, in turn, render them more susceptible to various diseases and parasites. R. Wayne (pers. comm.) has also determined that eastern and southern sub-populations are genetically distinct. Because each line is rather inbred, the divergence may have evolutionary implications. These findings have important implications for projects contemplating reintroduction. In particular, if specimens proposed for reintroduction are zoo bred, the origin of these specimens must be determined. We also recommend genetic screening of individuals proposed for reintroduction.

Current Research Programmes

1. Long-term monitoring of wild dogs in the Serengeti National Park is following up on studies by L. Frame, Dr. G. Frame, Dr. J. Malcolm, and H. van Lawick. The Serengeti population has been monitored since the late 1960s, with a hiatus in 1979-1984. Since 1985, when the long-term study was re-established by J. Fanshawe and Dr. C. FitzGibbon of the Serengeti Wildlife Research Institute, full-time monitoring has been continuing. Work is currently executed by K. Laurenson and Dr. M. Borner of the Serengeti Ecological Monitoring Programme. This work involves keeping a photographic file of each individual in the population, radio-collaring and blood sampling dogs for disease and genetic analysis, and monthly radio-tracking flights to locate packs on a regular basis.

2. The Kruger National Park is home to another long-term study which was concentrated around the work of A. Reich (Reich, 1981). The study is now coordinated by Dr. G. Mills. Three levels of research are underway: Dr. Mills is conducting a study of predator-prey relationships in the park and a pack of dogs has been included in this; a photographic file is being established with help from the public (in collaboration with another researcher, A. Maddock); the use of satellite transmitters is being developed in association with Dr. M. Gorman. This last aspect should allow monitoring the packs, especially if they leave the park and come into conflict with fanners.

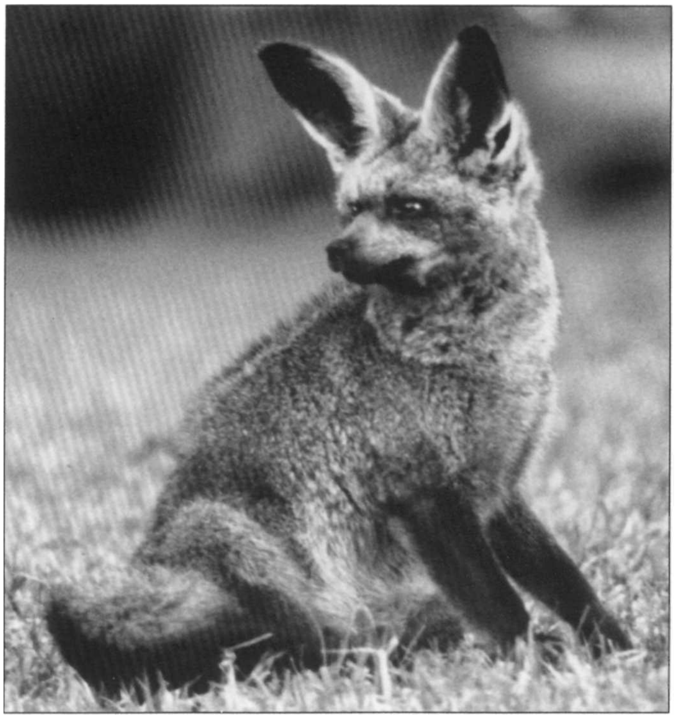
3. Researchers have begun to assess population trends throughout Botswana, but work has concentrated in the north, within Chobe and Ngamiland Districts, an area of approximately 120,000 km^2, which includes the protected areas of Moremi National Reserve, Chobe National Park, Nxai Pan National Park and Makgadikgadi Game Reserve. Data are being gathered by a combination of tactics that include extensive surveying of people (tourists, guides) entering the study area, and the radio-collaring and tracking of packs. A key aim is to assess the nature of wild dog interactions with livestock. All of this should lead to conservation recommendations for wild dogs throughout Botswana. The field research director is J. Bulger and the project director is W. J. Hamilton.

4. In Kenya, P. Kat, National Museum of Kenya, Nairobi, has begun a study which aims to assess the genetic structure of several packs in Kenya. The project, at present, does not include an ecological component. Genetic analyses on specimens collected here, and elsewhere in east and southern Africa are being analyzed by R. Wayne. J. Fanshawe and P. Kat are also continuing long-term monitoring of other packs of wild dogs throughout Kenya.

5. A project in Hwange National Park, and the adjacent hunting and forestry areas, has been started by J.R. Ginsberg, Oxford Wildlife Conservation Research Unit. The aims of this project are to assess the genetic structure of the population and screen for disease and parasites, study the ecological basis of nomadism and its implications for conservation, and investigate the conflicts (disease, crop raiding) between human and wild dog populations. The project is funded by the National Geographic Society and the American Philosophical Society.

6. Monitoring of hunting, trade, and population trends by the African Carnivore Survey, C. and T. Stuart.

7. A project to reintroduce the wild dog to the area around Mkomazi, Tanzania, is being studied by T. FitzJohn.



Bat-eared fox (*Otocyon megalotis*). (Photo by J. R. Malcolm)

Conservation Measures Taken. The wild dog is legally protected in many areas, but enforcement is uniformly poor and local resentment against the wild dog is strong. Protection of the species is particularly difficult. Outside of protected areas, wild dogs are frequently shot, yet no reserve appears large enough to contain the nomadic wanderings of even a small population of wild dogs. In Kruger National Park, for instance, out of a total park population of 300-350 (Reich 1981) one farmer who borders the park is believed to have shot 20 wild dogs in 1988 (Mills pers. comm.). In the same year, a radio collared female was found dead in Mozambique.

Parks and reserves which include populations of wild dogs thought to be larger than 100 individuals include: *South Africa:* wild dogs are thought to exist only within the boundaries of Kruger National Park. *Botswana:* thecomplex including Moremi National Reserve, Chobe National Park, Nxai Pan National Park and Makgadikgadi Game Reserve; *Zimbabwe:* Hwange National Park and adjacent hunting blocks; *Zambia:* wild dogs are believed to frequent the Luangwa Valley National Park. *Kenya/Tanzania:* Serengeti Ecosystem (including Serengeti National Park, Masai Mara Game Reserve, Ngorongoro Conservation Area); complex including Mikumi National Park and Selous Game Reserve. Several other protected areas may include populations numbering greater than 100 including Etosha National Park in Namibia.

Reviewers. J. Fanshawe; L. Frame; G. Mills; C. and T. Stuart. Much of the information in this section has been drawn from the survey conducted by J. Fanshawe and L. Frame.

Bat-eared fox (*Otocyon megalotis*)

English: Delalande's fox. French: L'Otocyon. German: Löffelhund. Afrikaans: Bakoor. Karamojong: Ameguri. Kichagga: Kipara. Kigogo: Nchenjeji. Kikomo: Mchutu. Kinyaturu: Bii. Kiramba: Bili. Tswana: mo-Tlhose.

Description. Ears large to 12 cm, teeth insectivorous without differentiated camasials, extra molars give 46-50 total. **Coat** grey buff above, paler and more beige below. Black on face mask, muzzle, ear tips, front legs, lower back legs, terminal 35% of tail. Black mid-dorsal stripe. Head-and-body length: 46-66 cm. Tail length: 23-34 cm. Shoulder height: 30-40 cm. Weight: 2.2-4.5 kg.

Reproduction. Time of mating: June-Sept. (Serengeti and Botswana); Jan. in Uganda; appears to be seasonally and locally adjusted so that births occur during the rains when peak insect densities exist. Gestation: 60-75 days. Litter size: 1-6 Lactation: 14-15 weeks (Lamprecht 1979). Age at sexual maturity: 8-9 months, most disperse at breeding season, some young females may stay with their natal group and breed. In these cases cubs are reared and cared for in a communal den and suckled indiscriminantly by all the females (Maas, pers. comm.). Longevity: up to 13 years in captivity.

Social Behaviour. Serengeti groups usually consisted of pairs accompanied by young of that year (Lamprecht 1979). More than two adults were regularly seen at breeding dens and polygyny may occur at least occasionally (Malcolm 1986). Breeding dens of neighbouring groups are sometimes clumped in areas of good habitat. Animals usually forage in groups to exploit termites, which occur in clumps. During the day, foxes rest in groups and conduct extensive grooming. In the Masai Mara and the southwestern Kalahari, home range size varies from 0.5 to 3.0 km^2 with extensive overlap in home range (Malcolm 1986; Nel 1984). In the Serengeti, smaller home ranges were observed (0.25 to 2.0 km^2) with somewhat less overlap (Lamprecht 1979). Population density may reach 28 per km^2, but usually ranges from just less than 1.0 per km^2 to 6.0 per km^2 (Malcolm 1986).

Diet. Termites and beetles (adults and larvae) form the majority of the diet in all studies to date (Malcolm 1986). The bat-eared fox is the only canid to have largely abandoned mammalian prey. Termites (*Hodotermes*) can constitute more than 50% of the diet. Vertebrate prey (lizards, mice, etc.) are eaten when available, but they seldom constitute more than 10% of the diet (Nel 1978).

Habitat. This species prefers open grassland, but can be found in semi-desert and in bush country. The bat-eared fox tends to avoid long grass areas, perhaps due to the risk of predation. In the Serengeti, bat-eared foxes appear to be particularly abundant in woodland boundary habitats. They do not occur on the shortgrass plains, but are numerous, although hard to see, in the northern woodlands. Numbers seem to be highest where there is a high density *of Hodotermes,* their preferred prey, and **bat-**

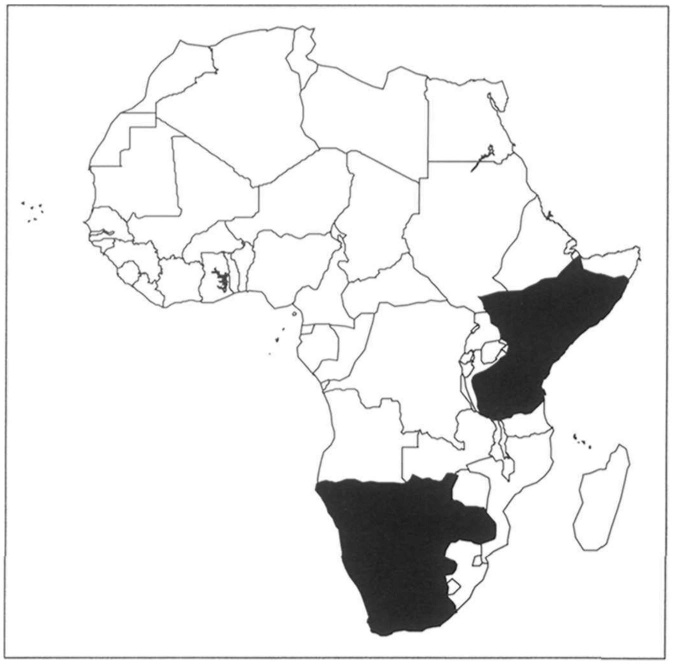


Figure 7. Distribution of the bat-eared fox (*Otocyon megalotis*).

eared foxes ranges totally overlap with *Hodotermes* distributions (Maas, pers. comm.).

Distribution. The distribution of the bat-eared fox is divided into two populations, one from southern Zambia and Angola to South Africa, the other from Ethiopia and south Sudan to Tanzania. In recent times, the fox has apparently extended its range eastward into Mozambique and parts of Zimbabwe and Botswana. A bat-eared fox was sighted in the Chobe National Park, Botswana, for the first time in 1965 (Smithers 1971); they are now locally common in that area. Distribution coincides with that of their major prey item (*Hodotermes mossambicus*). See Figure 7.

Population and Status. Serengeti study: Fluctuations in two study populations due to outbreaks of rabies, which can occur several times a year. Approximately 25% of the study population was affected in each bout (Maas pers. comm.). Major population fluctuations have been reported in the Serengeti, Tanzania (Leakey 1969; Moehlman pers. comm.). During this decline, no major environmental deterioration (e.g. reduction in termite density/numbers) was seen, hence epidemics are the most likely cause of mortality in the Serengeti population. M. Jones reports a decline in the Hwange area, Zimbabwe, in 1985. This decline was coincident with an outbreak of rabies, supporting the suggestion that disease is responsible for population regulation. *Otocyon* coexists with domestic animals. In some areas, populations have proliferated as cattle ranching has increased areas of short grass habitat, thus increasing numbers of harvester termites (Berry 1982).

Commercial Use. No commercial use, but hunted in Botswana April to July for pelts by indigenous people.

Threats. None known.

Current Research Programmes. Behavioural research by B. Maas in the Serengeti.

Conservation Measures Taken. Occurs in reserves throughout east and southern Africa.

Reviewer. J. Malcolm; P. Moehlman; B. Maas.

Cape fox (*Vulpes chama*)

English: Silver jackal. French: Le Renard du Cap. German: Kapfuchs. Afrikaans: Silwervos, Slwerjakkals. Tswana: leSie. Xhosa: uGqeleba.

Description. A small canid, grey or silver grey with a long bushy tail, approximately half the length of the head and body. Upper forelimbs are reddish, as are the head and ears. There are white patches on the cheeks, dark brown or black patches on the thighs, the throat is buffy and the underparts are nearly white. Females are approximately 5% smaller than males. Head-and-body length: 55 cm. Tail length: 34.4 cm. Shoulder height: 36.0 cm. Weight: 2.6 kg.

Reproduction. Time of mating: Peaks in September (Orange Free State); no season in the Kalahari. Gestation: 51-52 days. Litter size: 3-5. Lactation: unknown. Age at sexual maturity: 9 months. Longevity: unknown.

Social Behaviour. The Cape fox forms pairs, but each fox forages separately (Bester 1982). Young are raised in burrows or under rocks, frequently denning in areas of sandy soil or burrows and crevices in rock scree (Stuart 1981; Bester 1982). Pups first begin to hunt on their own at 16 weeks. Young remain with the female until independence at five months (Bester 1982). Rarely seen in larger groups, but they have been observed denning communally in South Kalahari (Mills pers. comm.). Mainly nocturnal. Home range size is 1.0 to 4.6 km^2 and may show overlap where prey density is high (Bester 1982).

Diet. Omnivorous, but mainly small rodents (murids), rabbits, insects, beetle larvae, and reptiles, with small amounts of vegetable matter. Some variation between locations sampled with use of prey being proportional to abundance of those species available (Smithers 1983, p. 415). Will cache surplus food (Bester 1982). Predation on domestic stock (young lambs) has been well documented (Bester 1982). However, in another study, of six observed cases of feeding on lambs, at least two were cases of scavenging (Stuart 1981).

Habitat. Prefers open habitat, including semi-desert scrub. Often found in grassland areas surrounding pans which, in the wet season, may hold water. Also found in the arid wheatlands of the southwest Cape (Stuart 1981).

Distribution. Widespread from the Cape Province, north through Namibia, east through southern Botswana, into southwestern and southern Transvaal, and western and northwestern Natal, throughout the Orange Free State (Lynch 1983). Has recently spread eastward into Albany district. See Figure 8.

Figure 8. Cape fox distribution.

Population and Status. Appears to be locally abundant throughout its range, but little information has been collected on present population levels. Stuart (1981) reports that numbers are increasing in the wheatlands of south-western Cape province, South Africa. In the Orange Free State, Bester (1982) estimated an average density of 0.3 foxes/km^2, with a total population of over 31,000 individuals. Between 2,000 and 3,000 foxes have been killed annually by the Oranjejag (see below), with another 2,000 killed by farmers and automobiles. Despite these heavy losses (16% per annum), no significant declines were observed until 1985.

Commercial Use. Pelt occasionally used in fur blankets.

Threats. The main known threat to the Cape fox is killing as a response to presumed predation on domestic stock. However, data summarized in Smithers (1983) suggest that the Cape fox may perhaps scavenge carcasses, but is rarely responsible for killing domestic animals. Bester (1982), however, found that, on average, 4.5% of the annual lamb crop was lost to predation in areas where the Cape fox was abundant. Stuart (1981) also observed predation, but at least 30% of observed "predation" was scavenging. Furthermore, the extent of predation on lambs (3-4 days old) is often exaggerated (Stuart pers. comm.). By Orange Free State Ordinance O.8 of 1969, the Oranjejag, a registered hunting club, has been charged with removing animals causing damage to livestock. If the rancher/farmer on whose land the fox is killed neither belongs to nor has contracted with Oranjejag, Oranjejag is paid a fine of 150 Rand per fox killed. In 1974, in the Orange Free State, 4,000 foxes were killed accidentally and/or intentionally during pest control operations whose aim was to control jackals (Bester 1978 in Smithers 1983). Starting in 1975, 2,000 to 3,000 foxes were killed annually. Since 1985, this has led to a decline in fox numbers and, adramatic increase in black-backed jackal numbers (Ferreira pers. comm.).

Current Research Programmes. The Provincial Administration of the Orange Free State monitors the number of foxes killed annually.

Conservation Measures Taken. Cape Province: Protected wild animal (ordinary game species) but can be legally killed as a problem animal in many districts. The Cape fox is found in the Soetdoring Nature Reserve (1.2/km^2), and the Willem Pretorius Game Reserve (southern section, 0.65/km^2, northern section 0.12/km^2).

Reviewers. G. Mills; D. Rowe-Rowe; C. and T. Stuart. We would particularly like to thank N. Ferreira for data extracted and translated from the M.Sc. thesis of his late colleague, J. Bester.

5. South America

Introduction

The fauna and flora of South America are remarkable for their endemism. The canids of South America are no exception. Ten species occur on the continent, of which nine are found nowhere else. The tenth, the grey fox (*Urocyon cinereoargenteus*) occurs in North America, south to the northern extremes of South America, just south of where the Central American land bridge joins South America (Bisbal 1982).

The majority of the canids found in South America are commonly referred to as foxes. This is something of a misnomer as none of them belong to the genus the English speaking world usually associates with the true foxes, *Vulpes.* To emphasize this distinction, in this report, we refer to the South American "foxes" by their Spanish name, "zorro" (see Chapter 2). Six species belong to the genus *Dusicyon:* the grey zorro (*D. griseus*); the small-eared zorro (*D. microtis*); the Sechuran zorro (*D. sechurae*); the hoary zorro (*D. vetulus*); the culpeo (*D. culpaeus*); and Azara's zorro (*D. gymnocercus*). A seventh species, the crab-eating zorro, is often considered to be another species of *Dusicyon,* but more commonly is referred to as *Cerdocyon thous* (see Chapter 2).

The zorros are found in every habitat on the continent, from the coastal deserts (Sechuran zorro), to the open savanna (grey zorro, culpeo, Azara's zorro). While elsewhere (Asia, Africa) canids invariably shun the rain forest, one species of South American zorro is found in the rain forests (small-eared zorro) and another (the crab-eating zorro) inhabits coastal and lowland forests. In addition to the zorros, there are two rather unusual canids in South America: the maned wolf (*Chrysocyon brachyurus*) and the bush dog (*Speothos venaticus*).

While research in Africa has focused primarily (but not exclusively) on social behaviour, studies of South American canids have emphasized ecological aspects of their biology, particularly feeding ecology. A recent review of the ecology of South American canids (Medel and Jaksic 1988) provides a good summary of what is known to date.

Current Status of Species

Nearly every species in South America requires careful monitoring and individual consideration. While no species appears to be endangered, little is known about the absolute and relative abundance of most species. For instance, while we place three species in the category Vulnerable or Rare, each of these species presents very different problems. Little is known about the status, or even the accurate distribution of the bush dog; efforts at captive breeding the species have met with little success (see Chapter 10). The maned wolf, although rare, is being carefully monitored both in Brazil and Argentina. Successful captive breeding programmes have been established and attempts are being made to provide further protection. Finally, the grey zorro is considered by some as extremely common and abundant; yet, other correspondents report that it is rare and declining in much of its range. Given the large international trade in the species (100,000 pelts per year 1980-1985, IUCN 1988, Chapter 9), the potential for rapid and irreversible loss of the species is great.

Maned wolf (*Chrysocyon brachyurus*). (Photo by M. Baccaceci)

Species Accounts

Maned wolf (*Chrysocyon brachyurus*)

German: Manhed Wolf. Spanish: Lobo de crin, lobo guará, boroche. Guarani: aguará-guazú, guará.

Description. The maned wolf is immediately recognizable by its extremely long limbs, long bushy fur, and large ears. It is often described as a red fox on stilts. The coat is a reddish yellow, and there is an erect mane. The feet are black, which give the effect of black stockings. A darker colour starts at the nape of the neck and runs down the back. The muzzle and legs are dark, sometimes almost black. The tail is usually dark, but may be light, even white. Head-and-body length: 124-132 cm. Tail length: 28-45 cm. Shoulder height: 74-87 cm. Weight: 20-23 kg.

Reproduction. Time of mating: December to June, peak in May-June. Gestation: 62-66 days. Average number in a litter: 1-5, mean 2. Duration of lactation: 3-4 months (Beccaceci pers. comm.). Age at sexual maturity: 1 year, doesn't breed until second year. Longevity: 12-15 years.

Social Behaviour. Crepuscular/nocturnal. Facultatively monogamous: a mated pair will share **a** territory, but are rarely found in association. Family groups are rarely observed, a single parent usually cares for the pups. Pups are bom in a natal nest usually located in thick brush. The den is above ground, often in the crevice between rocks.

Diet. Omnivorous. Dietz (1984) examined 740 scat samples and found that the most frequently occurring item was material from the plant *Solarium iycocarpou* (57% of volume, occurred in 33% of all samples). Other items occurring at a frequency of greater than 5% include (in descending order of importance): small mammals, birds, foliage, fruit, and insects. Plant and animal materials occurred in nearly equal volumes. Prey on domestic stock is very limited, but may occasionally include newborn lambs, young pigs, and very rarely carrion. Chickens are frequently attacked, perhaps at a greater level during the breeding season (Dietz 1984).

Habitat. Grassland and scrubland, also in agricultural areas. Found in a great variety of habitats, all open. Not found at high altitudes or in rain forests.

Distribution. Central and eastern South America including northern Argentina (to approximately 30° S.), south and central Brazil, eastern Bolivia, Paraguay, southeastern Peru (Dietz 1983). See Figure 1.

Population and Status. In all parts of its range, the maned wolf occurs at low densities. Although home range area for two individuals is approximately 20 to 30 km^2, 1960s population density estimates for 650,000 km^2 in Brazil (IUCN 1976) indicate densities of 1 individual per 300 km^2. This suggests that either much habitat remains uncolonized or that small areas of suitable habitat are interspersed amongst much larger areas of unsuitable habitat. Dietz (1983) presents good evidence that the range of the species is expanding with changes in habitat availability brought about by the expansion of agricultural use of land. However, further agricultural development may lead to habitat loss for the species.

Bolivia: Sightings are rare and the species is considered endangered (Tello unpublished data). Disease, not hunting, is blamed for population decline. This remains unconfirmed and there is some suspicion that hunting may indeed play a part in the decline of the species. Fencing of ranches and hunting as a pest species have been documented.

Figure 1. Distribution of the maned wolf (*Chrysocyon brachyurus*).

Argentina: Montes (1981) estimated that 1,000-1,500 individuals were present in the late 1970s. Found mainly in the following provinces: Corrientes, southern Misiones, Chaco, northern Santa Fe, and Formosa (Beccaceci pers. comm.). Common in the eastern part of Formosa province. Known to occur recently westwards of Palo Santo, in Ibarreta (70 km west of Palo Santo), on the banks of the Pilcomayo River, on the border between Argentina and Paraguay, and on the border between Formosa and Chaco Provinces, south to the Bermejo River.

Uruguay: Verdier (pers. comm.) has reviewed both the historical and present distribution of the species. He concludes that although the species may have occurred widely in Uruguay, it is now extinct in all but the north of the country.

Brazil: In Minas Gerais, numbers of maned wolves in the Serra da Canastra appear to have increased in the last decade, perhaps as a result a reduction in the frequency of fires leading to increased grassland areas (Dietz pers. comm.).

Commercial Use. Hunted, but fur not highly valued for commercial purposes. Flesh and pelt unusable.

Threats

1. Disease is one of the greatest threats to the species' survival. Anecdotal information blames disease for population decline in Bolivia. Dietz (1983) notes that captive breeding attempts have frequently been plagued by disease, particularly parvovirus.
2. Conflict with humans. Although the pelt is of little value, it appears that hunting for pest control continues throughout the range.

3. Habitat loss. The maned wolf probably benefits from initial stages of forest clearing for agricultural use. However, intensive use of land for agricultural purposes may preclude use of that area by maned wolves (Beccaceci pers. comm.). Furthermore, use of areas by humans will, without education, lead to conflict.
4. May be kept as pets in Argentina (Beccaceci pers. comm.).

Current Research Programmes

1. A survey of the status of maned wolves in Argentina is underway (Beccaceci pers. comm.). The project will assess the distribution and abundance of the maned wolf and conduct public education.
2. L.A. Dietz is producing an educational audiovisual package.
3. Proposed co-operative research project between the University of Belo Horizonte and the Oxford Wildlife Conservation Research Unit to study the maned wolf, hoary zorro, and crab-eating zorro in Minais Gerais.

Conservation Measures Taken. Classified in most of its range as endangered, legally protected in Brazil. The species has been declared endangered by the Argentine Wildlife Board (Beccaceci pers. comm.).

Reviewers. M. Beccaceci.

Crab-eating zorro (*Cerdocyon thous*)

English: Crab-eating fox, common zorro, common fox, forest fox. Spanish: Zorro común, zorro de monte, zorro sabanero (Venezuela); zorro perro (Uruguay); Portuguese: raposa, cachorro de mata.

Description. Coat colour on back is grey-brown. Face, ears, and legs are rufous, throat and underbelly white. Tail tip, tips of ears, and back of legs are black. Within the species, there is much individual variation (Berta 1982). Head-and-body length: 64 cm (Langguth 1975). Tail length: 29 cm (Langguth 1975). Shoulder height: Unknown. Weight: 5-8 kg.

Reproduction. Time of mating: November/December (Berta 1982). Gestation: 52-59 days. Litter size: 3-6. Lactation: approximately 90 days (Brady 1978). Age at sexual maturity: 9 months.

Social Behaviour. Monogamous pairs or small groups, which often forage individually. Crepuscular/nocturnal. Occur at densities of 4 per km^2 (Bisbal and Ojasti 1980). In Brazil loose-knit families of parents and their adult offspring of both sexes occupy 5-10 km^2 territories.

Diet. Omnivorous. Diet may vary seasonally (Brady 1979) but includes insects, rodents, fruit, reptiles, birds, and, of course, crabs. Bisbal (1979) found remains of possum (*Didelphis*), but confirmed that the diet is extremely varied with fruit, insects, and small mammals being favoured. Both studies found seasonal variation in response to change in abundance. In a study of the trophic requirements of *C. thous*, Bisbal and Ojasti (1980) did not find any evidence of predation on livestock.

Habitat. Savanna, llanos, and woodland. Many references state that the species is not found in the lowland rain forest of the Amazon basin (Berta 1982). However, J.M. Ayres (pers. comm.) notes that the species occurs in the forests of Brazil. It also occurs in lowland forest at sea level on Marajó Island, Brazil.

Distribution. Widely distributed through Colombia, Venezuela, Suriname, eastern Peru, Bolivia, Paraguay, Uruguay, Brazil, and northern Argentina. See Figure 2.

Population and Status. Widely distributed and common. In Venezuela, population densities are approximately 1 individual per 25 hectares (Eisenberg et al. 1979) and the species is common in all areas except Territorio Federal Amazonas, T.F. Delta Amacur, and Estado Nueva Esparta (Bisbal 1987).

Commercial Use. Hunted for pelt, although pelt has little value.

Threats. Occasionally shot by farmers and ranchers.

Current Research Programmes. Research on the ecology of *C. thous* and its role in the epidemiology of visceral leishmaniases is being conducted by D. Macdonald and O. Courtenay on Marajó Island, Brazil.

Conservation Measures Taken. The species has been declared out of danger (especie no amenazada) by the Argentine Wildlife Board (Direccion Nacional de Fauna Silvestre).

Reviewers. M. Beccaceci; O. Courtenay; I. Verdier.

Figure 2. Distribution of the crab-eating zorro.

Culpeo (*Dusicyon culpaeus*). (Photo by J. R. Malcolm)

Culpeo (*Dusicyon culpaeus*)

English: South American red fox, culpeo fox. French: Culpeau. Spanish: Zorro Colorado (Argentina), zorro culpeo, zorro rojo (Chile), zorro grande, lare.

Description. Coat is grizzled grey on back and shoulders; head, neck, ears and legs are tawny and the tip of the tail is black. Head-and-body length: 60-115 cm, increases from 70 cm to 90 cm from 34° S to 54° S. Tail length: 30-45 cm. Shoulder height: unknown. Weight: 5.0-13.5 kg, males 10-15% larger than females.

Reproduction. Time of mating: Aug.-Oct. Gestation: 55-60 days. Litter size: 3-8 recorded in Chile. Lactation: 4-5 weeks (F.A.C.I.F., 1987). Age at sexual maturity: males, less than one year old. Young reach adult size and weight at about 7 months. Longevity: unknown.

Social Behaviour. Unknown.

Diet. Omnivorous: rodents, lagomorphs, berries, and lambs (Johnson 1987). A study in Neuquen, Argentina found hare, *Lepus europaeus*, to be the most important single prey item, comprising 35% of the total diet. Rodents and lagomorphs constituted 62% of the total diet, with domestic animals, mostly sheep, comprising 27% and wild birds 6% (Crespo and DeCarlo 1963). In central Chile, rodents comprised 70-75 % of the total diet and rabbits (*Oryctolagus cuniculus*) made up 18%. Berries of the bushes *Cryptocarya alba* and *Lithraea caustica* were found in 12% of the scats examined, with an increase in amounts consumed towards autumn (Jaksic et al. 1980).

The extent to which there is predation on domestic livestock appears to vary widely, but the culpeo is certainly regarded as a voracious livestock killer in many parts of its range. Culpeos were responsible for only a small part of the mortality of lambs less than one week old (1-14%, mean 7.1%; Bellati pers. comm.). The culpeo is the dominant predator of older lambs (7-60 days) in Argentine Patagonia. Bellati (pers. comm.) has found that the culpeo is responsible for killing up to 7% of the annual crop of lambs. However, many of the lambs taken may be dead or weakened by illness (Bellati 1985 in Medel and Jaksic 1988)

Habitat. Mountains and pampas. The species was originally found only in the Andean foothills, but has now spread throughout Patagonia (Bellati pers comm.). It is reported to favour open habitats, but in Patagonia it is apparently more an animal of wooded areas, its place in the open plains being taken by *Dusicyon griseus* (IUCN 1988: Cattan, pers. comm.).

Distribution. Andean and Patagonian regions of South America in Ecuador, Peru, Bolivia, Chile, Argentina, and possibly Colombia (IUCN 1988). In Argentina, it occurs throughout mainland Patagonia (Chubut, Rio Negro, and Santa Cruz provinces), on Tierra del Fuego, and slopes and foothills of the Andes. In Neuquen Province it is found down to an altitude of about 700 m. In Chile, it is widespread from Cape Horn to the northern border with Peru, and on Tierra del Fuego and Isla Hoste in the Cape Horn Archipelago. It is listed in Colombian legislation, though no other reference to its presence there has been located. In Ecuador it is found in the Andean region, at least as far north as Cotopaxi in Pichincha province. In Peru, the species has been reported to be ubiquitous throughout the Andean region to at least 4500 m, also being found on the upper parts of the western Andean slopes, where it is known to descend to at least 1000 m (IUCN 1988). See Figure 3.

Population and Status.

Argentina: Estimated numbers 60,000 individuals in Santa Cruz province, 200,000 for Patagonia and 30,000 for Chubut province (F.A.C.I.F., 1987). Crespo (1986) considers this species most abundant in the south of the country. Crespo and DeCarlo (1963) noted increases in numbers in Neuquen Province between 1910 and 1915 when sheep grazing increased. In Salta Province of northern Argentina, the culpeo is believed to be rare and in danger of extirpation (Mares et al. 1981). In Patagonia, six years of data collected on population trends using scent line stations suggest that although there are annual cycles, the population of culpeo has

Figure 3. Distribution of the culpeo (*Dusicyon culpaeus*).

remained essentially constant (Bellati pers. comm.). During the colonization of Patagonia, both sheep and European hares were introduced. Bellati believes that this increase in food led to an increase in culpeo populations earlier in this century.

Chile: Generally scarce. In Torres del Paine National Park, Magallanes, 45 zorros were sighted in a 424 km strip census yielding a density of 1.3 individuals/km^2 (Rau pers. comm.; Abello 1979).

Peru: Abundant in the highlands of south Peru (de Macedo, pers. comm.; Grimwood 1969). Known on the eastern side of the Andes, and is abundant in the deserts (Grimwood 1969), but does not descend into the coastal forest. Present in the Pampas Galeras National Reserve.

Commercial Use. Extensively trapped and hunted for its pelt.

Threats

1. International trade: The true situation concerning legal and illegal trade combined is far from clear. Considering only CITES recorded trade, IUCN (1988) concluded that international trade is currently not a significant threat to the species, and that its present level does not have a deleterious effect on the Argentine population. Cattan (pers. comm.) however considers illegal hunting to be undoubtedly the most important threat to the species. Strict enforcement of wildlife legislation in most Latin American countries is unlikely to occur in the near future. Domestic enforcement of legislation is minimal and biological resources are too readily converted into hard currency for depressed economies (Mares and Ojeda 1984).
2. Land use changes: Overall consequences for this species unclear. It has been suggested that burning, forest clearing in Chilean Patagonia, and converting forests to sheep pastures has benefited *Dusicyon griseus* to the detriment of *Dusicyon culpaeus* (Duran et al. 1985).
3. Predation on lambs by the culpeo results in strong local pressure for predator control measures (Bellati pers. comm.).

Current Research Programmes. J. Bellati is running two long-term research projects in northwestern Rio Negro, Patagonia, Argentina. The first aims to monitor the diet and relative population density of the culpeo and its main prey. The second project addresses questions related to the impact of zorro populations on sheep farming.

Conservation Measures Taken

Argentina: Classified as Endangered as by the Argentine Wildlife Board (Direccion Nacional de Fauna Silvestre).

Peru: Not protected.

Chile: Protected since 1980, although hunting for scientific purposes may be authorized by the Bureau of Livestock and Agriculture (SAG). Illegal hunting is very difficult to control (Cattan, pers. comm.). Legal exports have been halted. The quality of enforcement is unknown, but suspected to be poor in both Chile and Argentina.

Bolivia: Not individually protected, although a blanket ban on wildlife exports was in force until 31 July 1986.

Reviewers. P. Cattan; J. Bellati.

Grey zorro (*Dusicyon griseus*)

English: South American grey fox. Spanish: Zorro chilla, zorro chico, zorro gris (Chile), zorro gris chico (Argentina). Araucano: Nuru, N'rú. Puelche: Yeshgai.

Description. The coat is brindled grey, the underparts paler grey, the head a rust colour flecked with white. Large ears. Tail long and bushy. A black spot occurs on the chin (Fuentes and Jaksic 1979). Head-and-body length: 42-68 cm, decreasing as latitude increases from 33°S to 54°S. Tail length: 30-36 cm. Shoulder height: 40-45 cm. Weight 4.4 kg.

Grey zorro (Dusicyon griseus). (Photo by J. R. Malcolm)

Reproduction. Time of mating: Aug.-Sept. Gestation: 53-58 days. Litter size: 2-4, but may be variable (Jaksic pers. comm.). 3-6 (Cattan pers. comm.). Lactation: unknown. Age at sexual maturity: 1 year, but uncertain (Jaksic, Cattan pers. comm.). Longevity: unknown.

Social Behaviour. Little known.

Diet. In central Chile, rodents comprised 87-98% of prey items in faeces examined. In autumn, however, 39% of all scats examined contained berries, mostly of *Cryptocarya alba* and *Lithraea caustica* (Jaksic et al., 1980). Rabbits (*Oryctolagus cuniculus*) and birds each comprised only 3 % of animal prey. In Chilean Tierra del Fuego, the main dietary components were: insects, berries of *Berberis buxifolia*, and small mammals (Jaksic et al. 1983; Yanez and Jaksic 1978). In northern Chile (Simonetti et al. 1984), rodents appeared to be the preferred vertebrate prey. The extent to which sheep are taken is unclear: Atalah et al. (1980) found sheep carrion a part of the zorro diet; other work has found sheep predation to be minimal (Duran et al. 1987—culpeo faeces may have polluted sample; Jaksic pers. comm.). Zorro predation is exerting control over endemic rodents e.g. *Octodon degus* and *Abrocoma bennetti* (Yanez and Jaksic 1978; Jaksic et al. 1980). Variability in diet is summarized in Medel and Jaksic (1988).

Habitat. Plains, pampas, deserts, and low mountains.

Distribution. See Figure 4. In Argentina, *D. griseus* is widespread throughout Patagonia from the straits of Magellan to Chubut province and northwards, apparently in a relatively narrow strip (Crespo 1975) in the lowlands of western Argentina, as far as Santiago del Estero and Catamarca (approximately 26-28°S, and possibly in Salta province (IUCN 1988)). It was introduced to Tierra del Fuego in 1951 to control the European rabbit (Jaksic and Yanez, 1983). On the Malvinas/ Falkland Islands, it is found on several small islands (Weddell, Statts, Beaver, Tea, River, and Split) off the west coast of west Falkland (Leaver 1985 in IUCN 1988). A disjunct northern population may be present (stipled area, Figure 4). In Chile, it is widespread from the straits of Magellan northwards as far as the southern half of the II Administrative Region (ex-Atacama Province, 23°-24°S), mainly in lowlands and foothills of coastal mountain ranges. *D. griseus* was introduced to Tierra del Fuego. It is found in southern Peru, and is believed to exist in central Peru, but this requires confirmation (de Macedo pers. comm.; Jaksic pers. comm.).

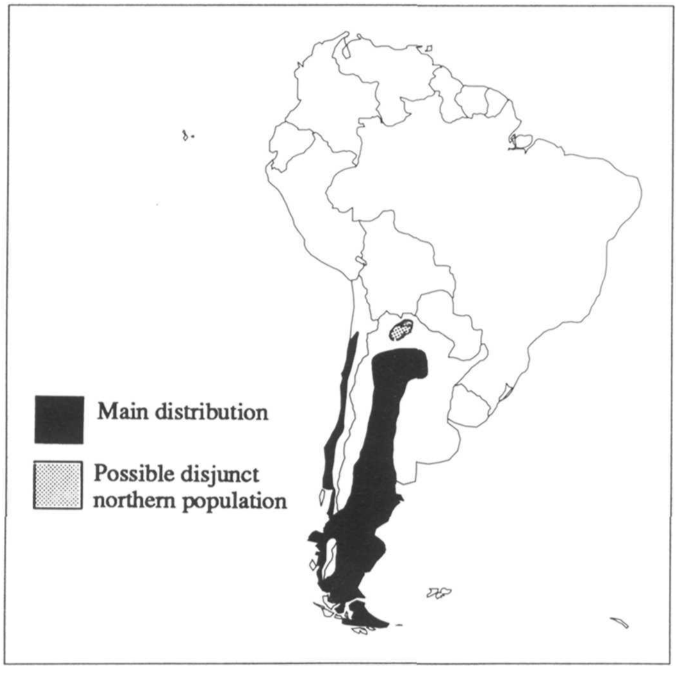


Figure 4. Distribution of the grey zorro (*Dusicyon griseus*).

Population and Status

Argentina: Crespo (1986) considered the grey zorro "generally scarce" but Olrog and Lucero (1980) state that it is "locally common". An introduced population is apparently thriving on Tierra del Fuego. Bellati (pers. comm.) reports that in Rio Negro, Patagonia, population levels have been stable since 1983, despite heavy culling for furs. Heavy snowfall can temporarily depress population levels, but recovery in the following year is swift.

Chile: Duran et al. (1985) estimated 37,250-65,837 individuals for Magallanes (XII) region (28,000 km^2), southern Chile. These estimates are extremely suspect (Jaksic pers. comm.). Suggestions that these data may be used to extrapolate population densities in other areas (IUCN 1988) should be reconsidered. Various methodological errors may have been made in collecting data for this survey, for example samples were made with spot-lights on roads, then extrapolated to roadless areas. The species is known to concentrate along roads to scavenge for road kills (Jaksic pers. comm.). The study, funded by a Magallanes' hunters association, resulted in the ban on hunting of grey zorro being lifted and hunting licenses being issued. Hunting became uneconomical (due to scarcity) after a very small proportion of estimated populations were removed, suggesting an overestimate of standing densities. Highest densities were found on Riesco Island. There is little recent information for the northern parts of the range, but it is thought to be generally scarce except in southern parts of the country.

Commercial Use. Considerable trade, most of which originates in Argentina, or is the result of skins trans-shipped to Argentina. The number of skins exported according to CITES for the years 1980 to 1983 was 381,000, 98% of which were purported to have originated in Argentina. Over 7,000 skins were recorded as being exported from Chile, despite the species being protected in that country. Most exports were made to West Germany (72%), Switzerland (7.2%), and Italy (4.4%) (IUCN 1988; see Chapter 9).

Threats

1. Persecution as a livestock and poultry predator in Chile. There is little hard evidence for such predation.
2. Clearing and burning of forest/bush in Chile may increase the available habitat for this species, but may also bring the animal in contact with domestic stock, thus creating a potential conflict.
3. Expansion of the culpeo's range may have reduced population numbers in many areas of Argentina (Bellati pers. comm.).

Current Research Programmes. Studies on the population dynamics of prey and grey zorro populations have been conducted since 1983 by Dr. J. Bellati.

Conservation Measures Taken. Protected by law in Chile (Iriate and Jaksic 1986), but enforcement is lax. No hunting or commercialization has been permitted since 1929. The Argentine Wildlife Board (Direccion Nacional de Fauna Silvestre) has classified the species as endangered (en peligro). Hunting is banned year-round in the following provinces: Catamarca, Neuquen, Salta, Entre Rios, Tucuman, and La Rioja. In Rio Negro and Tierra del Fuego, the species is considered an economically important species (pelt exports), while in Ninguna Province, the grey zorro is considered a pest species (IUCN 1988).

Reviewers. M. Beccaceci; J. Bellati; F. Jaksic.

Azara's zorro (*Dusicyon gymnocercus*)

English: Azara's fox. Spanish: Zorro gris de las pampas (Argentina); zorro de campo (Uruguay).

Description. Similar in colour, but somewhat larger than *D. griseus.* The back is brindled grey and underparts a paler grey. The head is reddish, the ears are large. Tail is long and bushy. Head-and-body length: 62 cm. Tail length: 34 cm. Shoulder height: unknown. Weight: 4.2-6.5 kg., males 10% heavier than females.

Reproduction. Time of mating: Jul.-Oct. Gestation: 55-60 days. Average number in a litter: 3-5. Duration of lactation: unknown. Age at sexual maturity: unknown. Longevity: 13.6 years.

Social Behaviour. Monogamous pairs. Male provisions pups and females at den. Young at den for first three months, after which they hunt with parents. Occur at densities of approximately 1.04/km^2 (Crespo 1971).

Figure 5. Distribution of Azara's zorro.

Diet. Omnivorous, but relatively carnivorous with 75% of the diet comprised of equal percentages of rodents, lagomorphs, and birds (Crespo 1971).

Habitat. Found in the pampas, hills, and deserts, occasionally forest. Prefers plains to mountains and fields with tall grass (Rabinovitch pers. comm.), grasslands, heath, ridges ("sierras"), small narrow woods, and areas along streams.

Distribution. In Argentina, it is found in the following northern provinces: Salta, Formosa, Chaco, Santiago del Estero, Catamarca, San Juan, La Rioja, Mendoza, San Luis, Cordoba, Santa Fe, Corrientes, Entre Rios, Buenos Aires, and north of Neuguern and Rio Negro (Rabinovitch pers. comm.). Also found in Uruguay, Paraguay, and southeast Brazil. See Figure 5.

Population and Status. In Argentina, 100,000 to 150,000 individuals in la Pampa province. Status unknown elsewhere.

Commercial Use. Heavily hunted and trapped for fur in several countries (Uruguay, Paraguay, Argentina). Captured most often with leg-hold traps, but also caught using bowls, box traps, and dogs. Commercial hunting has been suspended in Uruguay, but it is still killed in areas which conflict with human use. In Brazil, where the species enjoys complete protection, there is no market for fur. In Paraguay, the species is protected, but enforcement is lax. In a single year, up to an estimated 30,000 skins may have been trans-shipped from Paraguay to Uruguay for processing (Rabinovich 1987). As the species has not, to date, been included in CITES, little concrete information is available on total numbers killed for fur each year.

Threats. Although Azara's zorro is protected in Paraguay, Uruguay, and Brazil, controlled hunting continues in Paraguay and Uruguay. Regulation varies across Argentina by province, but commercial hunting is permitted in most regions. The Argentine Wildlife Board (Direccion Nacional de Fauna Silvestre) has classified the species as not in danger (no amenazada). In Paraguay, hunting is permitted under decree 273/974 when proof is submitted of predation on lambs by zorros. Inspection of suspected zorro kills is rarely, if ever, made. Enforcement is lax in Paraguay, good elsewhere. Brazilian skins appear to be smuggled to Uruguay, where they are more easily sold. Furthermore, skins from Uruguay and Argentina may be illegally exported to Paraguay, then legally re-imported to their country of origin as Paraguayan skins. A summary of the literature on Azara's and the crab-eating zorros, provided by I. Verdier, notes that control against predation on lambs using poisoned bait is common. However, no evidence has been collected that these zorros hunt lambs; rather, they may well be scavenging dead carcasses. Nonetheless, persecution persists and represents a real threat, particularly if populations become over-hunted.

Current Research Programmes. None known.

Conservation Measures Taken. None known

Reviewer. M. Beccaceci

Small-eared zorro (*Dusicyon microtis*)

Spanish: Zorro negro, Perro de Monte.

Description. Dorsal side dark grey to black, ventral side rufous mixed with black, white, and grey. Very thick hair on black tail. Ears rounded and relatively short. Head-and-body length: 72-100 cm. Tail length: 25-35 cm. Shoulder height: 35.5 cm. Weight: 9-10 kg.

Reproduction. Nothing known.

Social Behaviour. Little is known, however, indigenous people report seeing only solitary individuals (J. Palton pers. comm). Primarily nocturnal.

Diet. Little known, some records of herbivory.

Habitat. Tropical forest, up to an altitude of 1,000 m (Hershkovitz 1961).

Distribution. The Amazon basin, in Brazil, Peru, Ecuador, and Colombia (Orinoco basin), possibly Venezuela. Specimens were collected by Palton and Gardener (Dietz pers. comm.) in southeast Peru, Lorelto Department, the village of Balta, Rio Curanja; less common in north Peru, Amazonas Department, at the junction of Rio Santiago and Rio Seneppajust, just south of the border with Ecuador. In Ecuador, *D. microtys* is found only around the base of Mt. Sumaco, Napo Province. Grimwood (1969) reports specimens collected at the Rio Inuya and the Rio Curanja at approximately 71°50' W, 10° 20' S, in the Manu basin (now Manu National Park), and near Pucallpa on the Rio Ucayali. However, despite 15 years of intensive field work in Manu National Park, the small-eared zorro has never been observed at the Cocha Cashu field station (Terborgh, pers. comm.). See Figure 6.

Population and Status. Nothing recent is known. The small-eared zorro is considered rare throughout its range by Grimwood (1969). It may be present in Manu National Park, Peru, however, it has not been observed at the Cocha Cashu Field Station (Terborgh pers. comm.). One sighting in Tambopata reserve zone was reported in 1986 (Stewart pers. comm.).

Commercial Use. None known.

Threats. Habitat loss. As so little is known about the distribution and abundance of this species, the quantitative effect of habitat loss is difficult to assess.

Current Research Programmes. None known.

Conservation Measures Taken. Protected in Peru and Brazil; on the Brazilian list of endangered species.

Reviewers. P. Stewart; J. Terborgh.

Sechuran zorro (*Dusicyon sechurae*)

English: Sechuran fox.

Description. A pure, pale agouti in colour with a black-tipped **tail.** Head-and-body length: 53-59 cm. Tail length: 25 cm. Shoulder height: unknown. Weight: 4 to 5 kg.

Reproduction. Nothing known.

Social Behaviour. Nothing known.

Diet. Nothing known.

Habitat. Low open grasslands in the sandy coastal semi-desert.

Distribution. Northern Peru and southern Ecuador. Southern limits are unknown, but at least 12.00° S (Grimwood 1969). See Figure 7.

Population and Status. Nothing known.

Commercial Use. None known.

Figure 6. Distribution of the small-eared zorro.

Figure 7. Distribution of the Sechuran zorro.

Threats. None known.

Current Research Programmes. None known.

Conservation Measures Taken. None known.

Reviewers. None.

Figure 8. Distribution of the hoary zorro.

Hoary zorro (*Dusicyon vetulus*)

English: Hoary fox, small toothed dog.

Description. A small *Dusicyon* zorro with a short muzzle, small teeth, and a dark stripe on the dorsal surface of the black-tipped tail. The upper parts of the body are grey, the underside of the body cream or fawn, with the ears and outside of the legs being rufous. Head-and-body length: 60 cm. Tail length: 30 cm. Shoulder height: unknown. Weight: 2.7 to 4 kg.

Reproduction. Nothing known.

Social Behaviour. Nothing known.

Diet. Possibly a termite specialist.

Habitat. Upland mountain areas in open woodland and bush-land.

Distribution. South-central Brazil in Minas Gerais and Matto Grosso. See Figure 8.

Population and Status. Little known. Dietz (pers. comm.) reports that in the Serra da Canastra population numbers appear to have varied during the late 1970s and 1980s. Sightings initially were rare in 1978, but increased in number towards the end of the year. No sightings were made in 1983 or 1985. The role of the species in the transmission of leishmanias was investigated in Ceará by Deane and Deane (1954). M.A. Drumond, State Forestry Institute of Minas Gerais, reports that in Minas Gerais, the hoary zorro has been sighted at Fazenda Jardim, Município de Varzea da Palma; Fazenda Jaragua, Município de Buritizeiros; Fazenda São Francisco, Municipio de Lassance; Fazenda Três Barras, Município de São Gonçal do Abaeté; and at Fazenda Triângulo, Município de Buritizeiros. Hoary zorro sightings have also been reported at Chapada dos Guimares, Mato Grosso, and Pirapora, Corinto.

Commercial Use. None known.

Threats. Changing agricultural practices may result in habitat loss.

Current Research Programmes. Proposed cooperative research project between the University of Belo Horizonte and the Oxford Wildlife Conservation Research Unit to study the maned wolf, hoary zorro, and crab-eating zorro in Minais Gerais.

Conservation Measures Taken. None known.

Reviewer. A. Rylands.

Bush dog (*Speothos venaticus*)

English: vinegar dog. Spanish: Zorro/Perro vinagre, perro de agua, perro de monte (Venezuela).

Description. A very unusual canid, reminiscent of a viverrid or mustelid. It is stocky and broad-faced with small ears, a short bushy tail, and very short legs. Head and neck are reddish-tan or tawny becoming darker (nearly black) towards the tail. The underside is also dark, and sometimes has lighter throat patch. The feet are webbed. Head-and-body length: 57-75 cm. Tail length: 12.5-15 cm. Shoulder height: 25-30 cm. Weight: 5-7 kg.

Reproduction. Time of mating: Unknown, may show two estrous cycles in captivity (Kleiman 1972) but more probably oestrus is aseasonal and influenced by social factors (Porton et al. 1987). Gestation: 67 days. Litter size: 1 to 6, mean 3.8. Lactation: approximately 8 weeks. Age at sexual maturity: 1 year. Longevity: 10 years.

Social Behaviour. The bush dog is the most social of the small canids, living in groups of up to 10 individuals. Data from Porton et al. indicate that these may be family groups which exhibit social suppression of estrus, as in other social canids. They den in burrows or hollow tree trunks. Mainly diurnal, they spend the night at the den. Males will bring food to nursing females in the den.

Diet. Prefers larger rodents including *Agouti* and *Dasyprocta* species (Deutsch 1983). May take prey considerably larger than its own body size, such as capybaras (45 kg) and rheas (25 kg), by hunting in packs (Defler 1986). Will eat smaller prey.

Habitat. Forest and wet savanna areas.

Bush dog (*Speothos venaticus*). (Photo by M. Lyster/WWF)

Distribution. From Central America (Panama) south through Colombia, Venezuela, the Guyanas, Brazil, Paraguay, northeastern Argentina, eastern Bolivia, and eastern Peru. As far west as Madre de Dios, bordering on Cuzco Province. See Figure 9.

Population and Status. Little is known, but the bush dog is rare throughout its range. Definitely found in the Farallones National Park, Colombia (Velasco pers. comm.) at low densities. In Ecuador, the species is found both east and west of the Andes including Manabi Province, Rio Santiago in Esmeraldas Province, and the Intag region. It is also known to occur in the Missiones District of northeastern Argentina (Beccaceci pers. comm.). Grimwood (1969) suggests that the bush dog is a rare species in the Manu National Park, but Terborgh (pers. comm.) reports never having seen the species. The bush dog has been sighted in southeastern Peru (Madre de Dios) in the Tambopata reserve zone (1986), where it may be locally abundant (P. Stewart pers. comm.). In Venezuela, the known distribution is discontinuous: the North Coast Range, the Guayana Highlands, the Amazonas lowlands (Territorio Federal Amazonas), Bolivar State, and the Cordillera de la Costa (Bisbal 1987).

Commercial Use. None known.

Threats. None known, perhaps habitat encroachment.

Current Research Programmes. A captivity study recently initiated as a collaboration between the Oxford Wildlife Conservation Research Unit and Kilverston Wildlife Park (U.K.), alongside preliminary fieldwork in Brazil (D.W. Macdonald and D.O. Courtenay, sponsored by the PTES and The Iris Darnton Trust).

Conservation Measures Taken. Declared vulnerable in Argentina in 1983 (Beccaceci pers. comm.).

Reviewers. D. Kleiman; M. Rodden.

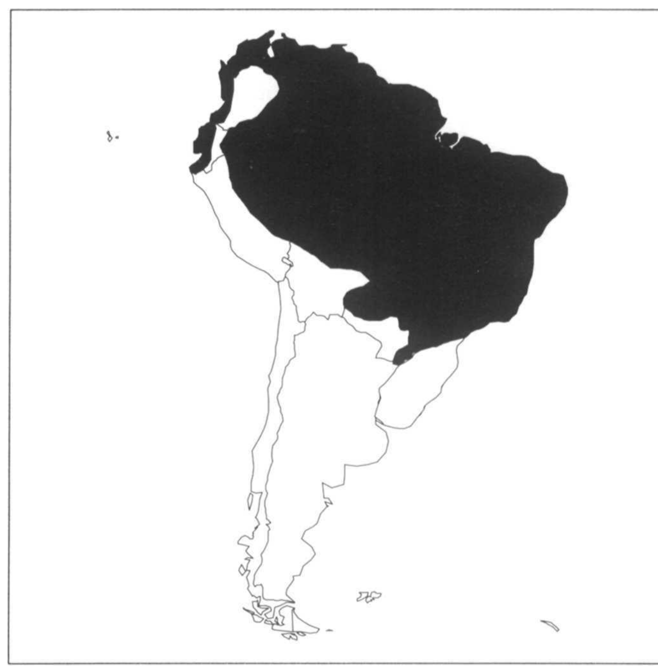


Figure 9. Distribution of the bush dog (*Speothos venaticus*).

6. Holarctic

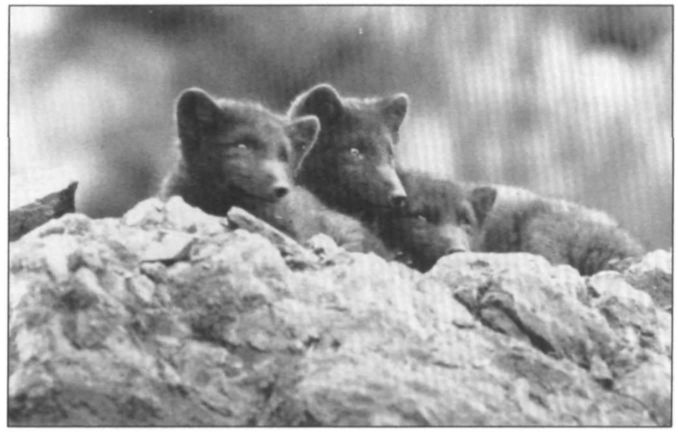
Introduction

That a single chapter of this action plan should encompass a geographic area including the greater part of three continents at first may seem absurd. Yet, the boundaries we have drawn for this chapter are too small to encompass the range of three of the nine species included herein! The grey wolf (*Canis lupus*) inhabits areas of India and the Middle East. The red fox (*Vulpes vulpes*) has a distribution which is nearly cosmopolitan, and the grey fox (*Urocyon cinereoargenteus*) is found in parts of South America.

Other species included in this chapter occur in more limited geographical areas. The arctic fox (*Alopex lagopus*) is found in all three continents discussed, while the the raccoon dog (*Nyctereutes procyonoides*) occurs "only" in Asia and Europe. The four remaining species inhabit "only" North America. The coyote (*Canis latrans*) has a large and expanding distribution covering much of North America. The red wolf (*Canis rufus*), now virtually extinct in the wild, was formerly found in the southern United States. The kit or swift fox (*Vulpes velox*) lives in the dryer areas of western North America. Only one species, the island grey fox (*Urocyon littoralis*) can be considered endemic, being found only on islands off the coast of southern California.

Current Status of Species

Given the extreme differences in the distribution of these species, it is somewhat surprising that with the exception of the two wolf species, all of the canids in this region are thriving. Even the grey wolf, extinct or nearly so in much of its range, has a secure footing in much of northern Canada. By its very nature as a restricted endemic, the island grey fox lives precariously. Nonetheless, unlike most endemics, the greater part of its range is protected in one way or another. With the exception of the two wolf species, the important questions concerning the management of the species found in this geographic region are not those concerned with how to prevent extinction. Rather, managers must address problems concerned with preserving biodiversity by protecting subspecies and local sub-populations.



Arctic fox (blue morph), *Alopex lagopus*. (Photo by N. Ovsyanikov)

Species Accounts

Arctic fox (*Alopex lagopus*)

French: Reynard polaire, isatis. German: Polarfuchs.

Description. Smaller, more rounded ears than red fox; brain-case more rounded and muzzle slightly shorter and broader than *Vulpes vulpes* (Clutton-Brock et al. 1976). Occurs in two distinct colour morphs, "blue" and "white". Each colour phase also changes seasonally: "blue" moults from chocolate brown in summer to lighter brown tinged with blue sheen in winter. In winter, "white" is almost pure white, while in summer it is grey to brownish-grey dorsally, and light grey to white below. Colour morphs are determined genetically at a single locus, white being recessive. The "blue" morph comprises less than 1 % of the population through most of its continental range, but this proportion increases westwards in Alaska, and on islands. Head-and-body length: 55 cm (male); 53 cm (female). Tail length: 31 cm (male); 30 cm (female). Shoulder height: 25-30 cm. Weight: 3.8 kg. (male); 3.1 kg (female).

Reproduction. Time of mating: Mar.-Apr. Gestation: 51-54 days. Litter size: 6-16, mean 5.3 in Iceland, 10.5 Canada (Hersteinsson pers. comm.). In good lemming years on Wrangel

Island, there may be up to 19pupsperlitter(mean 11.4,0vsyanikov pers. comm.). Lactation: 8-10 weeks. Age at sexual maturity: 10 months. Longevity: animals seldom live more than a few years in the wild. Oldest recorded is 11 years (Hersteinsson, unpubl. data).

Social Behaviour. Flexible social system with resident individuals maintaining a territory that may include more than a single breeding pair. In Iceland, monogamy is the rule, but non-breeding helpers may occur; several sub-dominant females, probably yearlings from the previous litter, have been observed helping at dens. Supernumerary females emigrate when pups attain independence of the den at 8-10 weeks (Hersteinsson and Macdonald 1982). The den is used for both shelter and rearing young. Den sites are large with complex burrow systems. The life span of one den has been estimated at 300 years (Macpherson in Garrot et al., 1983). Some are used repeatedly year after year, others infrequently. Sites are limited to areas where permafrost is sufficiently deep and soil characteristics allow burrowing (Eberhardt et al. 1982). Home ranges of group members in an Icelandic study (8.6-18.5 km^2) overlapped widely with each other, and very little if at all with those of neighbouring groups. These group ranges contributed territories from which occupants rarely strayed (Hersteinsson and Macdonald 1982). In Alaska, seasonal migrations are reported: individuals leave breeding grounds in autumn, travel to the coast, and return in late winter or early spring. Large-scale emigrations have been recorded in Canada, Fennoscandia, and the Soviet Union. These may result from drastic reductions in food supplies, such as a population crash in lemmings. On Wrangel Island, communal breeding (2 pairs of adults) was observed in 1982(Ovsyanikov 1985, in litt.). Pairs may remain together on the same territory for up to five years (Ovsyanikov 1985). Temporary groups of non-breeding individuals are also formed (Ovsyanikov 1985, 1988).

Diet. An opportunistic scavenger and predator. In coastal Iceland: carrion, particularly seabirds (*Uria aalge, U. lomuia*) in late winter and summer and seal carcasses; seabird eggs and chicks; marine invertebrates. Inland, ptarmigan (*Lagopus mutus*) and migrant waders in the summer are common prey. Elsewhere, lemmings (*Lemmus* sp. and *Dicrostanyx* sp.), garbage (Eberhardt et al. 1982), and some vegetable matter are dominant in the diet

Habitat. Tundra and coastal areas. The white morph is generally associated with true tundra habitat, the blue more with coastal habitat

Distribution. Circumpolar, inhabiting arctic tundra and most arctic islands (breeds from northern Greenland at 88°N to southern tip of Hudson Bay, Canada, 53°N), but only some islands in the Bering Straits. See Figure 1.

Population and Status. Throughout much of its range, the arctic fox is abundant. Details of population cycles appear to differ among regions.

North America, Greenland, and Siberia: Arctic fox populations fluctuate with the lemming populations, which are their main prey. Bunnell (pers. comm.) suggests that the Canadian population is at least stable. In North America and Siberia, the species' range contracted in early part of this century with its southern limit moving northwards. The heavier red fox increased in numbers and extended its range northwards as a result of improved conditions for red foxes (amelioration in climate and thus improved prey base (Hersteinsson and Macdonald 1982)). The red fox appears to have a competitive advantage over the arctic fox once food availability has allowed its colonization of more northerly areas. Sterilized red foxes have been introduced to the Aleutian Islands (Alaska), as biological control agents in an attempt to eliminate the arctic fox here by competitive

Figure 1. Distribution of the arctic fox.

exclusion. The results so far have been inconclusive (West and Rudd 1983 pers. comm.). On Arakamchechen island (Bering straits), arctic and red foxes coexist using similar resources (Ovsyanikov and Menushina 1987), which suggests that competitive exclusion may not be a viable form of biological control.

Norway, Sweden, and Finland: The arctic fox was common in these areas in the late 19th century. A dramatic fall in numbers between 1911 and 1925 led to the species becoming completely protected by law. Recent attempts to assess the status of arctic fox populations in Sweden have shown that populations have not increased significantly since complete protection was provided 50 years ago. The lack of response to protection may be the result of competition from red fox; many arctic fox earths have been occupied by red fox (Hersteinsson 1982).

Iceland: Hersteinsson (1987a) summarizes the status of arctic fox in Iceland. Because of their suspected preference for eating lambs and sheep, legislation in Iceland has encouraged persecution of *Alopex* since 1295. Population levels have fluctuated since 1855 with possible causes of decline being distemper, strychnine poisoning, or changes in climate and perhaps prey availability (Hersteinsson 1987b). Recent evidence suggests that the protozoan parasite, *Encephalitozoon cuniculi* may regulate population numbers (Hersteinsson pers. comm.). Where the parasite is common (40% infected), population levels remain low or decline; where the parasite is nearly absent (2% infected), population levels increase. From 1958 to 1981, population levels declined near towns and in densely populated rural areas. The species was hunted by various methods, many of which were aided by the use of snowmobiles. State-subsidized hunting encouraged continued persecution: despite an increase in hunting effort, offtake dropped from 1,590 individuals in 1958 to 456 individuals in 1978. The entire population was estimated at 700 to 800 in 1982. By 1985, the population appeared to have increased to 1,780 ± 70 individuals.

Commercial Use. Used extensively for fur. In North America, 37,000 arctic foxes were taken for skins between 1977-1978 (Macdonald and Carr 1981). In Iceland, government-sponsored hunting is used to control population levels. In the past few years, an average of 900 foxes have been killed per year from a population of approximately 2,000 adults. Pelts are of poor quality and are unmarketable; the program costs approximately $200,000 per annum. In Iceland, a law was passed in 1957 stipulating that the state would pay two-thirds of all costs of an extermination campaign on the arctic fox. This law is currently under review (Hersteinsson, 1987a). In Norway, Greenland, Canada, the Soviet Union, and Alaska, trapping is limited to licensed trappers operating in a set trapping season. The enforcement of these laws appears to be uniformly good.

Threats. Large areas of fox habitat in northern Alaska have recently experienced intensive petroleum exploration and development activities. The impact on arctic fox denning habits is poorly understood (Garrot et al. 1983). At Prudoe Bay oil development area, northern Alaska activities did not appear to have an immediate deleterious effect on resident arctic fox populations. However, dependence on garbage sites increases contact between foxes. Such increased contact may lead to greater transmission of disease, particularly rabies (Eberhardt, 1982).

Ovsyanikov (1988) reports that a subspecies of the arctic fox (*Alopex lagopus semenovi*) is found only on Mednij Island, one of the Commander Islands in the northeast U.S.S.R. An intensive fur farming operation took place on the island from 1920-1950: between 1,100-1,200 foxes lived wild on the island, and about half this number were trapped annually. In 1965, trapping stopped, but numbers remained high for the next few years. A steep decline in fox numbers took place from 1972 onwards. In 1979, no individuals were seen alive during annual surveys of the island. The present population is estimated at 100 ±20.

The apparent cause of this rapid decline in numbers of this subspecies is mange. There are no villages on the island, but people working on ships occasionally visit it with their dogs, which chase and kill foxes, and could easily transmit disease. The Mednij Island blue arctic fox is currently listed in the Russian Red Data Book but not in the Red Book of the U.S.S.R. This means it currently has legal protection against trapping, a situation which greatly displeases local people who are keen to begin trapping again. Against this background, a nature reserve is planned for Mednij Island. In any event, it is essential that domestic dogs be prohibited from the island.

At the time of the Russian-American Company (around 1866), arctic fox from the Commander Islands (*A. lagopus semenovi*) were introduced into the Aleutian Islands. Investigation might determine whether any individuals still occur there today. A second subspecies, *Alopex lagopus beringensis*, has a stable population of several hundred individuals. Trapping, however, is intensive (300/year) (Ovsyanikov 1988).

Current Research Programmes

1. Experiments on the effectiveness of electric fencing in preventing damage by foxes in eider colonies are being conducted in western Iceland (Hersteinsson 1987a).
2. A census of the Icelandic population is conducted annually by the Icelandic Wildlife Management Unit.

Conservation Measures Taken. The laws in Iceland relating to the subsidy of *Alopex* extermination campaigns are under review (Hersteinsson 1987a).

Reviewers. P. Hersteinsson; N. Ovsyanikov

Coyote (*Canis latrans*)

English: Coyote; brush wolf, prairie wolf.

Description. Adults have a grizzled buff grey coat with the outer ears, forelegs, and feet brownish or yellow. The throat and belly are light grey to white; a grey-black band, sometimes very faint, runs down the mid-back. A shoulder saddle of black-tipped hairs is typical. The tip of the tail is black. Head-and-body length: 70-97 cm. Tail length: 30-38 cm. Shoulder height: 45-53 cm. Weight: 9-16 kg, females 20% smaller than males.

Specimens in northeast United States are somewhat larger (Berg, pers. comm.).

Reproduction. Time of mating: Jan-March. Gestation: 63 days. Average number in a litter: 6-18. Duration of lactation: 5-7 weeks. Age at sexual maturity: 1 year, (10 months only in southwest U.S.A., Berg, pers. comm.). Longevity: unknown.

Social Behaviour. Usually found as breeding pairs or solitary adult females with home ranges of 4 to 143 km^2 (Andelt 1985, Springer 1982). In some areas, delayed dispersal of young may lead to pack formation with only the dominant pair (parents) breeding. Young usually disperse at 7-10 months, and may travel up to 160 km, averaging 40-50 km. Pups are bom in the den. Coyotes will take over old badger, skunk, or woodchuck burrows or dig their own dens. Social behaviour is reviewed in Bekoff (1977) and Bekoff and Wells (1986).

Diet. Opportunistic predator, will take squirrels, rabbits, birds, poultry, livestock, rodents, insects, carrion, garbage, pronghom antelope, deer, and mountain sheep.

Habitat. Wherever suitable prey exists, from tundra to grassland to forest to city (e.g. large populations found in Los Angeles, California). Established coyotes exclude fox, but are excluded by established wolves (Berg, pers. comm.).

Distribution. Widely distributed throughout all of the United States and all of southern and south-central Canada, south through Mexico into northern Central America. Northward expansion of coyotes may be the result of wolf removal, as their range is expanding in areas where wolves have been eliminated for more than a century. See Figure 2.

Population and Status. Large and increasing despite control efforts and unprotected status in most areas. No threat to the species as a whole.

Commercial Use. Trapped and hunted extensively for fur, sport, and to attempt to reduce loss of livestock and poultry.

Threats

1. In small parts of the range, interbreeding with domestic dogs and wolves may pose a threat (Kolenosky 1971; Schmitz and Kolenosky 1985a,b). However, interactions among these species are usually strongly aggressive.
2. Loss of livestock (sheep and lambs) could result in increased trapping pressure, renewal of poisoning, etc. To date, such measures have been ineffectual, and thus pose little threat (Bekoff 1977; Bekoff and Wells 1986). However, the desire amongst some ranchers to control coyotes remains. In some cases, up to 67% of all lambs and 20% of sheep in an area may be lost to coyotes. Yet, in other areas where sheep farming overlaps with the coyotes' range, no losses are reported. Mean losses may range from less than 1 % to nearly 25% depending on the area, study, and species concerned (reviewed in Andelt 1987, Chapter 12).

Conservation Measures Taken. Protected in 12 of the 50 States in the United States, but many states have seasons for trapping/hunting. Many areas have banned the use of poisons for killing animals suspected of taking livestock. Harvest data are being collected and are being used in efforts at population modelling (Berg, pers. comm.).

Reviewers. W. Andelt; M. Bekoff; W. Berg.

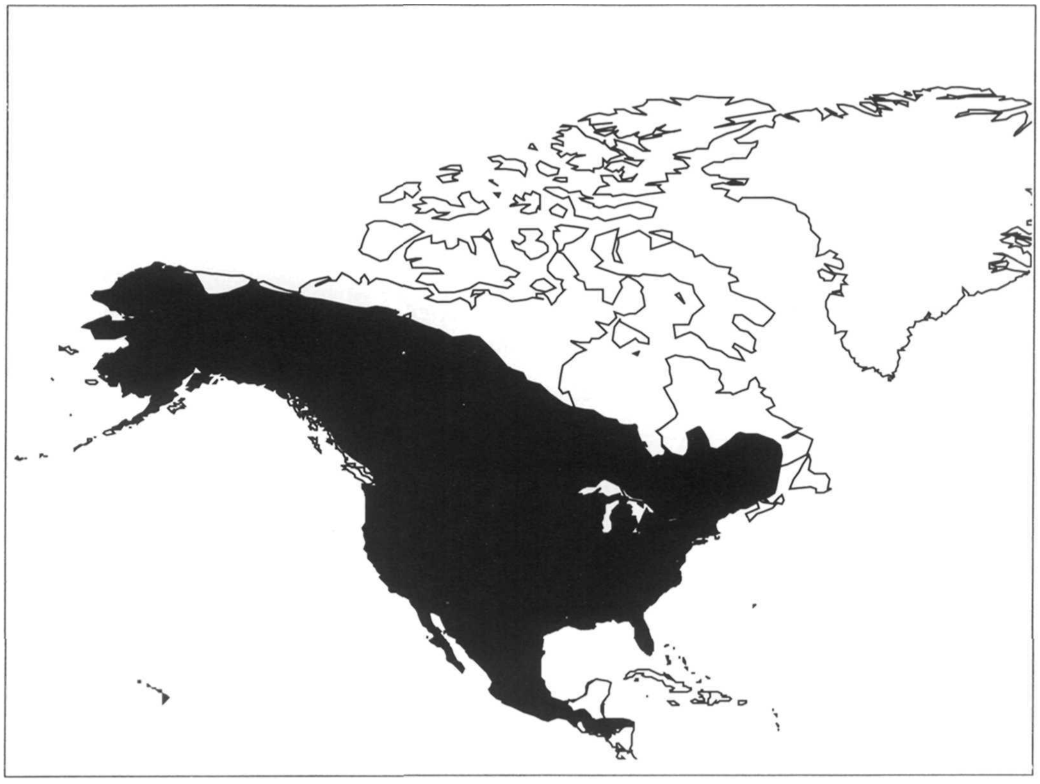


Figure 2. Coyote distribution.

Coyote (*Canis latrans*). (Photo by C. Marks)

Grey wolf (*Canis lupus*)

English: Gray wolf, timber wolf, tundra wolf, plains wolf. Spanish: Lobo. French: Loup. German: Wolf.

Description. The largest wild canid. Fur is thick and usually grey, but can vary from nearly pure white, red, or brown to black. Head-and-body length: 100-150cm. Tail length: 31-51 cm. Shoulder height: 66-81 cm. Weight: 16-60 kg, males heavier than females.

Reproduction. Time of mating: January-April. Gestation: 61-63 days. Litter size: 1-11, mean 6. Duration of lactation: 8-10 weeks. Age at sexual maturity: 22-46 months (Mech, pers. comm.), occasionally 10 months. Longevity: up to 13 years in the wild (Mech 1988), 16 years in captivity.

Distribution. The wolf originally was the world's most widely distributed mammal, living throughout the northern hemisphere north of 15° N latitude. Present distributions are much restricted; wolves occur primarily in wilderness and remote areas (Harrington and Paquet 1982). See Figure 3.

Habitat. Extremely variable, densities being highest where prey biomass is highest.

Social Behaviour. A pack- living animal with a complex social organization. Packs are primarily family groups. The dominant pair breeds, with sub-dominant females under behaviourally induced reproductive suppression (Packard et al. 1985). Packs include up to 30 individuals, but smaller sizes (8-12) are more common. An excellent review of wolf social behaviour and ecology can be found in Mech (1970).

Diet. Extremely variable, but the majority of the diet is large ungulates (moose, caribou, deer, elk). Grey wolves will also eat smaller prey items, livestock, carrion, and garbage.

Population and Status. Because of the diversity in climate, topography, vegetation, human settlement, and development, wolf populations in various parts of the original range vary from extinct to relatively pristine. In the following summary, we present data by region on subspecies present, population status, approximate numbers, percent of former range occupied at present, main prey (where available), legal status, and cause of decline.

Alaska: Subspecies: *ligoni, pambasileus, tundrarum, alc.es.* Status: fully viable, numbering approximately 6,000. Range occupied: 100%. Main prey: moose, caribou, sheep, deer, beaver, goat. Legal status: animals are hunted and trapped in limited seasons with bag limits. Some control work, enforcement active.

British Columbia, Yukon: Subspecies: *crassodon.fuscus, columbianus, pambasileus, mackenzii, occidentalis, tundrarum, ligoni, irremotus.* Status: fully viable, numbering approximately 8,000. Range occupied: 80%. Main prey: moose, caribou, sheep, deer, beaver, goat, elk. Legal status: game species, furbearer (BC), no closed season (Y).

Grey wolf (*Canis lupus*). (Photo by K. Hollett)

Northwest Territories: Subspecies: *arctos, bernardi, columbianus, griseoalbus, hudsonicus, mackenzii, nubilus, occidentalis, pambasileus.* Status: fully viable, numbering 5,000-15,000. Range occupied: 100%. Main prey: moose caribou, sheep, deer, beaver, goat. Legal status: furbearer.

Alberta: Subspecies: *occidentalis, griseoalbus, irremotus, nubilus.* Status: fully viable, numbering approximately 4,000. Range occupied: 80%. Main prey: moose, caribou, sheep, deer, beaver, goat, elk, bison. Legal status: furbearer.

Saskatchewan, Manitoba: Subspecies: *hudsonicus, griseoalbus, irremotus, nubilis.* Status: fully viable, number unknown. Range occupied: 70%. Main prey: moose, elk, deer, beaver, bison, caribou. Legal status: furbearer.

Ontario, Quebec: Subspecies: *lycaon, hudsonicus, labradorius.* Status: fully viable, number <10,000. Range occupied: 80%. Main prey: moose.deer, caribou, beaver. Legal status: furbearer.

Figure 3. Distribution of the grey wolf (*Canis lupus*).

Newfoundland (the island): Subspecies: *beothucus*, extinct since 1911.

Labrador: *labradorius.* Status: fully viable, number unknown. Range occupied: 95%. Main prey: moose, caribou, beaver, musk ox, hares. Legal status: furbearer.

Minnesota: Subspecies: *lycaon.* Status: viable, numbering approximately 1,200. Range occupied: 30%. Main prey: deer, moose, beaver. Legal status: full protection. Cause of decline: persecution, habitat destruction.

Michigan and Wisconsin: Subspecies: *lycaon.* Status: lingering, 35 individuals. Highly endangered. Range occupied: 10%. Main prey: deer, beaver, moose. Legal status: full protection. Cause of decline: persecution, habitat destruction.

Northwestern United States: Subspecies: *irremotus.* Status: slowly recolonizing, 30 individuals. Highly endangered. Range occupied: 5%. Main prey: deer, elk, moose, sheep, goats, beaver. Legal status: full protection. Cause of decline: persecution, habitat destruction.

Southwestern United States: Subspecies: *baileyi.* Status: extinct. Range occupied: nil. Main prey: deer, livestock. Legal status: full protection. Cause of decline: persecution, habitat destruction.

Mexico: Subspecies: *baileyi.* Status: lone wolves or pairs, <10 individuals. Highly endangered. Range occupied: <10%. Main prey: livestock. Legal status: unenforced full protection. Cause of decline: persecution, habitat destruction.

Sweden/Norway: Subspecies: *lupus.* Status: lone wolves or pairs, <10 individuals. Highly endangered. Range occupied: <10%. Main prey: moose, reindeer, livestock. Legal status: full protection. Cause of decline: persecution.

Finland: Subspecies: *lupus.* Status: lingering, probably only lone wolves or pairs, <100 individuals. Endangered. Range occupied: <10%. Legal status: no protection (north), game status (east), protected (south). Main Prey: moose, reindeer, white-tailed deer, livestock. Cause of decline: persecution.

Greenland: Subspecies: *orion.* Status: lingering, 50? individuals. Threatened. Range occupied: unknown. Main prey: musk-ox, caribou. Legal status: unknown. Cause of decline: persecution.

Turkey: Subspecies: *lupus, pallipes.* Status: Viable, but in decline. Unknown number of individuals. Range occupied: unknown. Main prey: livestock, unknown. Legal status: no protection.

Syria: Subspecies: *lupus, pallipes.* Status: lingering, low population density, 200-500 individuals. Highly threatened. Range occupied: 10%. Main prey: livestock, carrion, small wildlife. Legal status: no protection. Cause of decline: persecution.

Jordan: Subspecies: unknown. Status: lingering, low population density, 200? individuals. Highly threatened. Range occupied: 90%. Legal status: no protection. Main prey: unknown. Cause of decline: persecution.

Israel: Subspecies: *pallipes, arabs.* Status: lingering, low population density, 100-150 individuals. Highly threatened. Range occupied: 60%. Main prey: hares, livestock, carrion. Legal status: full protection. Cause of decline: habitat destruction, persecution.

Egypt (Sinai): Subspecies: *arabs.* Status: 30 individuals. Highly endangered. Range occupied: 90%. Main prey: hares, livestock. Legal status: no protection. Cause of decline: persecution.

Lebanon: Subspecies: unknown. Status: lone wolves or pairs, >10 individuals. Highly endangered. Range occupied: unknown. Main prey: garbage, carrion. Legal status: no protection. Cause of decline: persecution.

Arabian peninsula: Subspecies: *pallipes, arabs.* Status: in decline, <300 individuals. Range occupied: 90%. Main prey: garbage, carrion, livestock. Legal status: no protection. Cause of decline: persecution.

Iran: Subspecies: *pallipes, campestris.* Status: fully viable, numbering >1000. Range occupied: 80%. Main prey: gazelle, mountain sheep, livestock, wild boar, deer, *Capra* sp. Legal status: Game species. Cause of decline: persecution.

Iraq: Subspecies: unknown. Status: unknown. Range occupied: unknown. Main prey: unknown. Legal status: unknown. Cause of decline: unknown.

Afghanistan: Subspecies: *pallipes, chanco.* Status: viable, suspected decline, 1,000? individuals. Range occupied: 90%. Main prey: unknown. Legal status: unknown. Cause of decline: unknown.

Pakistan: Subspecies: *pallipes, campestris.* Status: unknown. Range occupied: unknown. Main prey: unknown. Legal status: unknown. Cause of decline: unknown.

Bhutan: Subspecies: *chanco.* Status: unknown. Range occupied: unknown. Main prey: unknown. Legal status: protected. Cause of decline: unknown.

Nepal: Subspecies: *chanco.* Status: unknown. Range occupied: unknown. Main prey: unknown. Legal status: unknown. Cause of decline: unknown.

India: Subspecies: *pallipes.* Status: lingering, probably only lone wolves or pairs, 1,000-2,000 individuals. Endangered. Range occupied: 20%. Main prey: livestock, hare, deer, antelope. Legal status: unenforced full protection. Cause of decline: decreasing prey, persecution.

Mongolia: Subspecies: *chanco.* Status: viable, possible decline, >10,000 individuals. Range occupied: 100%. Main prey: livestock, saiga. Legal status: extermination efforts active.

China: Subspecies: *chanco.* Status: extermination efforts active, population numbers unknown. Range occupied: 20%. Main prey: saiga, other ungulates, livestock. Legal status: unknown. Cause of decline: persecution, habitat destruction.

U.S.S.R. (Europe): Subspecies: *lupus, albus, campestris, chanco.* Status: fully viable, numbering approximately 20,000. Range occupied: 60%. Main prey: ungulates, livestock. Legal status: reduction and control even in nature reserves. Cause of decline: persecution, habitat destruction.

U.S.S.R. (Asia): Subspecies: *lupus, albus, campestris, chanco.* Status: fully viable, numbering approximately 50,000. Range occupied: 75%. Main prey: ungulates and livestock. Legal status: reduction and control even in nature reserves. Cause of decline: persecution, habitat destruction.

Poland: Subspecies: *lupus, campestris.* Status: fully viable, numbering approximately 900. Range occupied: 90%. Main prey: (moose), roe deer, red deer, wild boar, mufflon. Legal status: partial protection. Cause of decline: persecution, habitat destruction.

Czechoslovakia: Subspecies: *lupus.* Status: steep decline/ lingering, 100? individuals. Highly threatened or endangered. Range occupied: 10%. Main prey: roe deer, red deer, wild boar, mufflon. Legal status: no protection. Cause of decline: persecution, habitat destruction.

Romania: Subspecies: *lupus.* Status: decline, 2,000? individuals. Range occupied: 20%. Main prey: roe deer, red deer, wild boar, mufflon. Legal status: no protection. Cause of decline: persecution, habitat destruction.

Bulgaria: Subspecies: *lupus.* Status: lingering, low population density, 100? individuals. Highly threatened. Range occupied: unknown. Legal status: no protection. Main prey: (moose) roe deer, red deer, wild boar, mufflon. Cause of decline: persecution, habitat destruction.

Greece: Subspecies: *lupus.* Status: Viable, but in decline, >500 individuals. Range occupied: 60%. Main prey: deer, wild boar, chamois, livestock. Legal status: partial protection. Cause of decline: persecution, habitat destruction.

Yugoslavia: Subspecies: *lupus.* Status: steep decline, approximately 2,000 individuals. Rangeoccupied:55%. Main prey: deer, wild boar, chamois, livestock. Legal status: partial protection. Cause of decline: persecution, habitat destruction.

Albania: Subspecies: *lupus.* Status: unknown. Range occupied: unknown. Main prey: unknown. Legal status: unknown. Cause of decline: unknown.

Hungary: Subspecies: *lupus.* Status: Extinct Range occupied: nil. Main prey: unknown. Legal status: protected. Cause of decline: unknown.

Italy: Subspecies: *lupus.* Status: lingering, low population density, 250 individuals (Boitani 1987). Highly threatened. Range occupied: 10%. Main prey: garbage, livestock. Legal status: full protection. Cause of decline: persecution, habitat destruction, prey extermination.

Spain: Subspecies: *signatus*, (*lupus*). Status: lingering, low population density, 500-1,000 individuals. Threatened. Range occupied: 10%. Main prey: livestock, roe deer, wild boar. Legal status: partial protection. Cause of decline: persecution, habitat destruction.

Portugal: Subspecies: *signatus*, (*lupus*). Status: lingering, low population density, 150 individuals. Highly threatened. Range occupied: 20%. Main prey: livestock, roe deer, wild boar. Legal status: partial protection. Cause of decline: persecution, habitat destruction.

Central Europe: Subspecies: (*lupus*). Status: Extinct. Range occupied: nil. Main prey: livestock, red deer, roe deer, chamois, wild boar. Legal status: no protection. Cause of decline: persecution, habitat destruction.

Commercial Use. Hunted for fur in Canada, Alaska, and the Soviet Union.

Legal Status and Enforcement Variable, from complete protection, well enforced, to concerted efforts to exterminate the species.

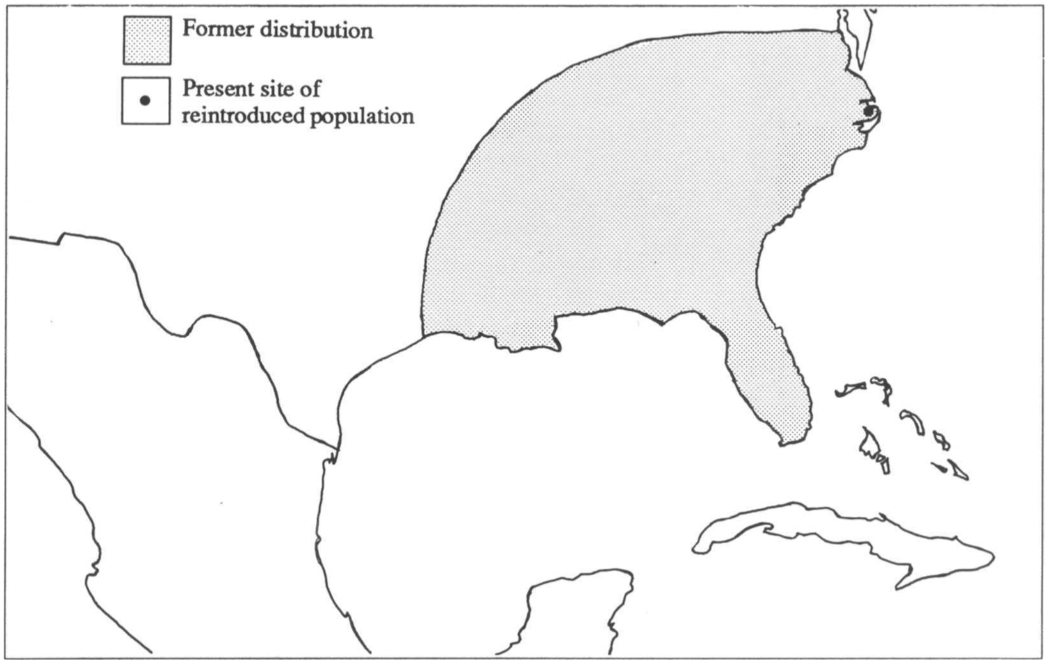


Figure 4. Distribution of the red wolf (*Canis rufus*).

Threats

1. Competition with humans for livestock.
2. Misunderstanding on the part of the public concerning the threat and danger of wolves.
3. Clearance and fragmentation of habitat, with resulting areas being too small for populations with long-term viability.
4. Hybridisation with domestic and feral dogs (*Canis familiaris*).

Current Research Programmes. Several in Europe, Canada and the United States.

Conservation Measures Taken. Protected in various National Parks and reserves in Canada and throughout the 48 contiguous United States. Extensive legal protection in many countries, however, enforcement is variable.

Red wolf (*Canis rufus*)

Description. The red wolf has a cinnamon and tawny coat with grey and black highlights, but can be black. Head-and-body length: 95-120 cm. Tail length: 25-35 cm. Shoulder height: unknown. Weight: 18-41 kg.

Reproduction. Same as grey wolf.

Habitat. Swamps, wetlands, bushlands, and forests.

Distribution. Formerly found throughout the southeastern United States from southern Florida to central Texas. Extinct in the wild, but reintroduced in 1988 into North Carolina. See Figure 4.

Social Behaviour. A pack-living animal with a complex social organization. Packs are primarily family groups.

Diet. Swamp rabbits, nutria, raccoons, and deer.

Red wolf (*Canis rufus*). (Photo by H. McCarley/WWF)

Population and Status. Reintroduced, 1988. 8 individuals. Highly endangered.

Commercial Use. None.

Threats. Genetic introgression from interbreeding with coyotes.

Current Research Programmes. Reintroduction programme in North Carolina (see Chapter 11).

Conservation Measures Taken. Full protection throughout its range; reintroduction; captive breeding.

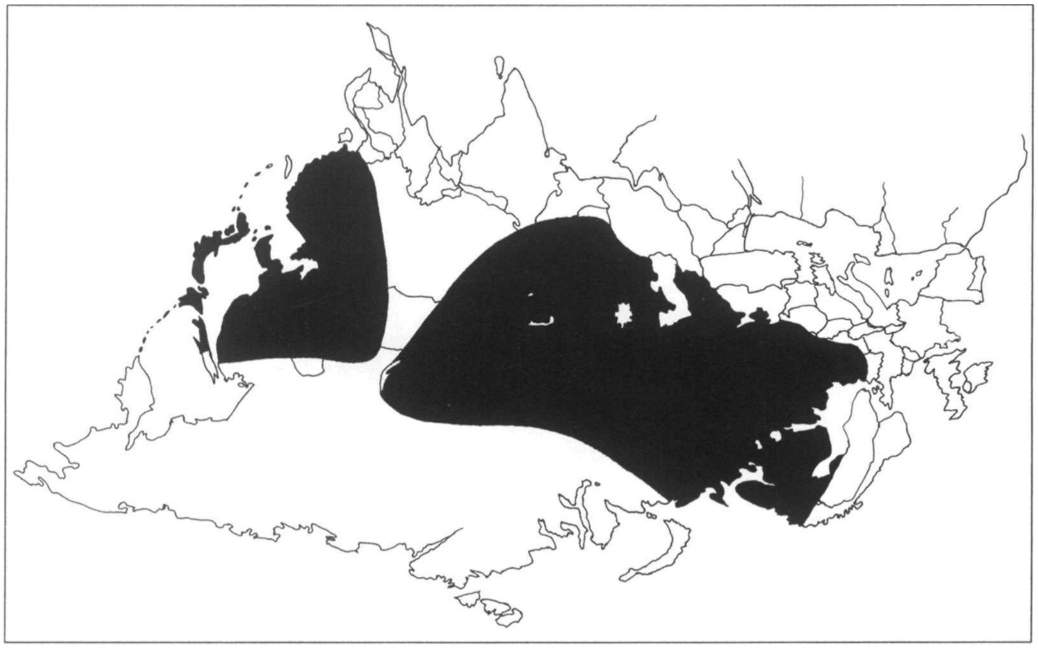


Figure 5. Racoon dog (*Nyctereutes procyonoides*) distribution.

Raccoon dog (*Nyctereutes procyonoides*)

French: Chien viverrin. German: Marderhund. Japanese: Tanuki.

Description. Long brindled black-brown body fur with black facial mask, sleek black legs, and black fur on upper side of tail. Long guard hairs up to 120 mm long, winter coat developed by Nov.-Dec; under-fur moults by Feb.-Mar. and winter coat moulted by June. Head-and-body length: 50-60 cm. Tail length: 18 cm. Shoulder height: 20 cm. Weight: 7.5 kg.

Reproduction. Time of mating: Jan.-Mar. Gestation: 60-65 days. Litter size: 4-6, but can reach 12(Ikeda 1983). Lactation: 30 days. Age at sexual maturity: 9-11 months (Ikeda pers. comm.). Longevity: 11 years in captivity, 3-4 years in the wild (Ikeda, pers. comm.).

Social Behaviour. Reported to live in pairs or temporary family groups, but no firm evidence on the ties between animals that share all or part of their home range. Apparently, raccoon dogs prefer to forage in woodland with an abundant understorey, especially of ferns. Individuals spend most of the night searching for food. They begin to forage within two hours of sunset, break about midnight, and are active again until sunrise. Communal feeding has been observed among neighbours, though they normally are seen foraging alone.

Raccoon dogs use latrine sites, and a study in Japan showed that each animal was using at least ten different latrines (Ikeda 1984, 1987a). These were distributed unevenly within the home range. Ikeda suggests these may play a role as landmarks and points of information transfer. Hibernates in semi-torpor.

Diet. Omnivorous. The diet varies with seasonal availability of food types. Fruit, invertebrates (including members of the Hemiptera, Coleoptera, Diptera, and Orthoptera), small rodents, birds, and birds' eggs are all included in the diet. Marine organisms are eaten where available, including crabs, fish, clams, and kelp.

Raccoon dog (*Nyctereutes procyonoides*). (Photo by H. Ikeda)

Habitat. Woodland and forested river valleys.

Distribution. East Asia, Far East, east Siberia, Manchuria, China and Japan, and northern Indo-Chinese Peninsula. The actual distribution and extent of range on the Asian mainland today is not well known. Introduced into Europe: 1927-1957: about 9,000 individuals introduced into the western Soviet Union for fur-farming; spread slowly to Poland, also known in East Germany, Czechoslovakia, and Romania. Occasionally caught in West Germany even near Danish and French borders. See Figure 5.

Population and Status

China: Once thought to occur widely; today it is not well known and may be in danger of local extinction.

Japan: Abundant throughout (Ikeda 1987b).

Europe: Thought to be spreading rapidly now in eastern Europe. May occur in Sweden; in Finland it is fairly common in the east, south, and central, more scattered in the southwest and in west Finland; some individuals have even been detected in northern Norway.

Commercial Use. About 70,000 individuals are hunted annually in Japan. The majority of pelts are produced in Finland (mainly from farmed animals) and the Soviet Union (mainly from wild animals). There has been some production in Denmark and central European countries. Historically, hunting began in Russia in 1928. Breeding animals were exported to Germany in the 1930s, but the population was wiped out by disease in 1973.

Threats. Rabies and rapid urbanization appear to be causing local extinction in parts of Japan. Surprisingly, despite its widespread distribution, there is a lack of interest in the raccoon dogs among Japanese people. Hence, an education campaign in Japan would be a valuable addition to conservation plans.

Current Research Programmes. None known.

Conservation Measures Taken. In Japan, a small island (7.9 km^2) has been protected for raccoon dog habitat by being designated as a Natural Monument under the Law For Protection of Cultural Properties (Ikeda pers. comm.).

Reviewer. H. Ikeda.

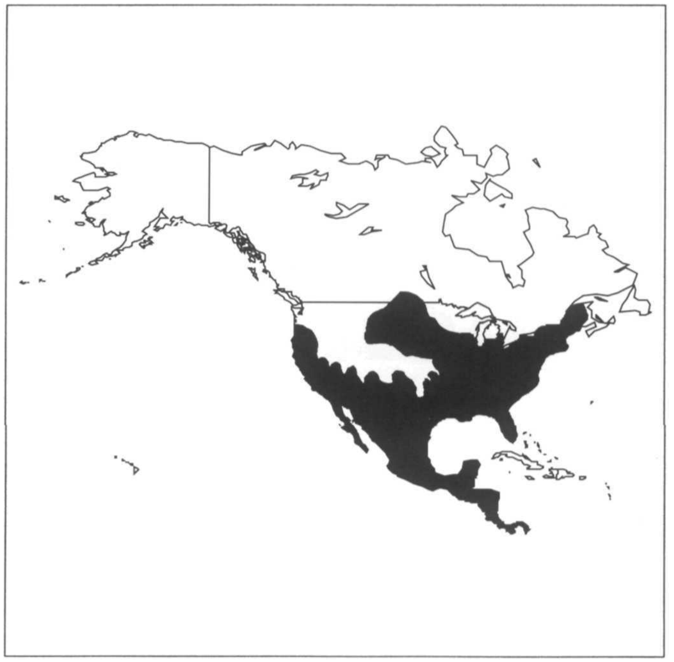


Figure 6. Grey fox distribution.

Grey fox (*Urocyon cinereoargenteus*)

Spanish: Zorro gris, zorro plateado (Venezuela).

Description. A mottled or grizzled greyish fox, the colour being derived from individual hairs banded with white, grey, and black (Fritzell and Haroldson 1982). There is a dark stripe down the back and a small black mane. Parts of the neck, flanks, and legs are rufous, the face and underbelly being white or buff. Head-and-body length: 53-81 cm. Tail length: 27-44 cm. Shoulder height unknown. Weight: 3-7 kg, females slightly lighter than males.

Reproduction. Time of mating: Jan. to Apr. depending on latitude. Gestation: 51-63 days. Litter size: mean 4, range 1-10. Lactation: 7-9 weeks. Age at sexual maturity: 10 months; females breed in the first year. Longevity: 15 years.

Social Behaviour. The usual social unit is the mated pair. Dens are located in brushy or woodland areas. The dens are rarely dug by the fox. Foxes can also use various other denning sites. The grey fox can climb trees and use hollows in standing trees, logs, buildings, rock crevices (Fritzell and Haroldson 1982). Home range size (= territory) varies from 3 to 27.6 km^2 and ranges are usually overlapping. Young disperse in first year and have been known to travel up to 84 km (Sheldon 1953). Nocturnal/crepuscular in activity.

Diet. Omnivorous. Diet includes small vertebrates, especially rabbits, insects, and carrion.

Habitat. Found in, and prefers, woodlands (Fuller 1978), but is also common in old field succession areas, preferring such habitat to cultivated or more open areas (Trapp 1978). Grey foxes can also be found in urban areas (Fritzell 1987).

Distribution. Very widespread throughout deciduous forests from northern South America (Venezuela (Bisbal 1982) and Colombia) up through most of central America and into southwestern, western, and eastern United States. Not found in the Rocky Mountains or the far northwest of the United States. The grey fox disappeared from Canada in the late 17th century concurrent with the introduction of the red fox from Europe (Trapp and Hallberg 1975). The causal relationship between these events is questionable (Follman 1973). The decline of the grey fox, and spread of the red fox, might, as much as anything else, have been the result of changing patterns of land use. Small populations have recolonized parts of southern Ontario, Manitoba, and Quebec. This colonization and range expansion through the northern United States and southern Canada may be the result of increased prey availability (*Sylvilagus* sp., Anderson 1946, Trapp and Hallberg 1975). See Figure 6.

Population and Status. Widespread healthy populations in most areas where the species occurs. Habitat availability may limit distribution (Fritzell 1987), but lack of suitable habitat does not appear to pose a great threat to the species' survival.

Commercial Use. Trapped extensively for fur. Fritzell (1987), using data compiled by G. Linscombe, showed that grey fox sales in the United States have increased dramatically in the last decade. Despite a decline in 1983-1984, sales in that year were nearly 1,000% of those in 1970-1971. This trend reflects an increased demand for long-furred species.

Threats. None known.

Current Research Programmes. None known

Conservation Measures Taken. Protected in various states of the United States and other countries as a fur-bearing species.

Reviewers. E. Fritzell; T. Fuller.

Island grey fox (*Urocyon littoralis*)

Description. Very similar to the North American grey fox, but smaller. Note especially the shorter tail. Head-and-body length: 48-50 cm. Tail length: 11-29 cm. Shoulder height: 12-15 cm. Weight: 1.3-2.8 kg.

Reproduction. See grey fox, *Urocyon cinereoargenteus.*

Social Behaviour. See grey fox, *Urocyon cinereoargenteus.* Note home range approximately 0.32 km^2 (Laughrin 1977).

Diet. Primarily fruit and insects (Laughrin 1977) but includes small mammals, birds, reptiles, and eggs (Collins and Laughrin 1979, Kovach and Dow 1981).

Habitat. Variable. Found in grassland, coastal sage/scrub, sand dune communities, and forested areas.

Distribution. Found only on the six largest Channel Islands off the coast of southern California, United States. See Figure 7. However, a recent discovery indicates that some nearby mainland populations also belong to this species (Medeal et al. 1990).

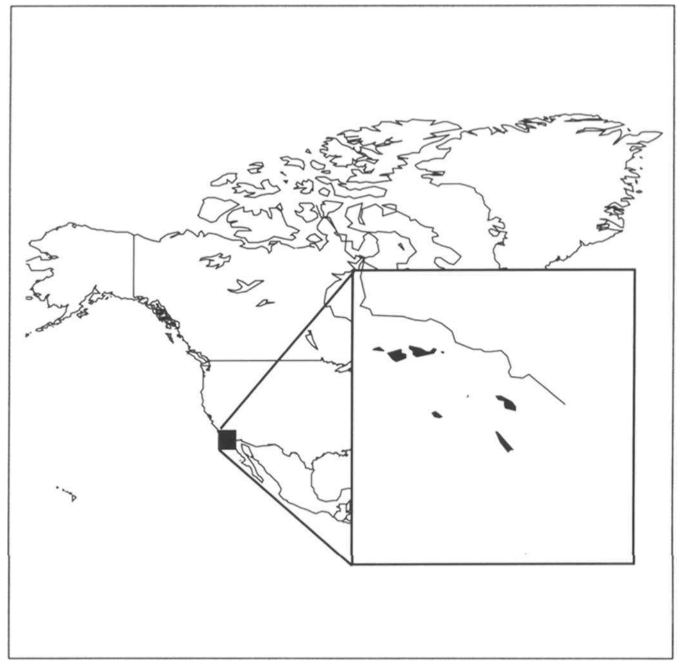


Figure 7. Island grey fox distribution.

Island grey fox (*Urocyon littoralis*). (Photo by J.R. Malcolm)

Population and Status. Populations appear to be healthy on all islands with the exception of Santa Catalina Island, which has not been extensively surveyed. Population densities range widely, from 0.3 to 8.0 individuals/km^2 (Laughrin 1973,1977; Kovach and Dow 1981). On San Clemente Island, densities based on trap grids were estimated to be 3.7 to 7.9 foxes/km^2 (Garcelon 1988).

Commercial Use. None known.

Threats

1. Habitat destruction/competition through the introduction of feral animals.
2. Possible competition on three islands with feral cats (*Felis catus*).
3. Potential of disease introductions carried by domestic dogs.

Current Research Programmes

1. Elimination of feral cats on San Clemente and San Nicolas by the U.S. Navy.
2. Population genetics and disease titres of the island grey fox are being investigated by Dr. R.Wayne, University of California, Los Angeles.
3. An 18 month research programme, running concurrently on Santa Rosa and San Miguel, has been proposed by D. Garcelon, Institute for Wildlife Studies.
4. The establishment of a captive breeding population is being considered by the Los Angeles Zoo.

Conservation Measures Taken. Protected completely throughout its range. Listed as threatened by the State of California. A candidate species for listing as threatened or endangered by the U.S. Fish and Wildlife Service. Enforcement is difficult because islands are remote. However, this isolation appears, at the moment, to be more useful in providing protection. San Nicholas and San Clemente Islands are occupied by the U.S. Navy. Two other islands, Santa Rosa and San Miguel, are administered by the U.S. Park Service. On these islands, we can assume protection and enforcement are assured.

Reviewers. E. Fritzell; T. Fuller, D. Garcelon.

Swift or kit fox (*Vulpes velox*)

English: Prairie fox. French: Renard v61oce

Description. A small fox whose coat colour varies with season, being greyish on the back, tail, head and flanks and buff-orange underneath in the winter. The upperside is somewhat redder in the summer. The black-tipped tail is moderately long and very bushy. Head-and-body length: 37-53 cm. Tail length: 22-35 cm. Shoulder height: 18-35 cm. Weight: 1.8-3 kg, slight sexual dimorphism.

Swift fox (*Vulpes velox*). **(Photo by L. Carbyn)**

Reproduction. Time of mating: December to January, somewhat later in the north of the range. Gestation: 50-60 days. Litter size: 3-6. Lactation: Six to seven weeks. Age at sexual maturity: 10 months. Longevity: 13 years in captivity, 3 to 4 years in the field.

Social Behaviour. Nocturnal/crepuscular. Monogamous pairs, males provision the young and the female during early lactation. Dens are located in sparse prairie in well-drained areas. Dens consist of approximately 4 m of tunnels 1 m deep, self-excavated. Home range area is approximately 1.5 to 5.0 km^2 (maximum 15 km^2) with overlap in areas where territories are small. In the Mojave Desert, home ranges averaged 11.2 km^2 with little or no overlap except for mated pairs (Zoellick 1985 in O'Farrell 1987) Densities range from one fox per 0.4 to 10.0 km^2 (Morrell 1972; O'Farrell 1984).

Diet. Omnivorous. Small mammals, particularly lagomorphs, insects, birds, amphibians. Small amounts of fruit are also eaten.

Habitat. Open prairie/grassland plains of west-central North America into the drier semi-deserts and true deserts of the southwest United States.

Distribution. Historically in Canada from southern Alberta, Saskatchewan, and perhaps southwestern Manitoba south into the United States. In the United States, *V. velox* has been found in eastern Montana, North and South Dakota, Wyoming, Colorado, Nebraska, Kansas, Oklahoma, and northwestern Texas. The present distribution is much reduced from the historical range having become extinct in Canada and much of the United States. With the exception of the San Joaquin kit fox (*V. v. mutica*), the subspecies formerly associated with *V. macrotis* are common in most of their their range, including northwestern Texas, New Mexico, Arizona, Utah, southern central California and Nevada. Rare in Idaho and Oregon (O'Farrell 1987). See Figure 8.

Population and Status. The species has been extirpated in Canada (although reintroduction programs have been and are being attempted). In the United States, the status of *V. velox* varies considerably throughout its range and much depends on one's interpretation of the taxonomic relationship both within *V. velox* and between *V. velox* and the species formerly referred to as *V. macrotis.* The subspecific status of *V. velox* remains debated. While what has been considered to be a northern subspecies, *V. v. hebes* was considered endangered, what some considered a southern subspecies, *V.* v. *velox,* was moderately common in much of its range. For example, after being thought extinct for 70 years in Montana, a sighting of *V.v. hebes* was reported in 1978 (Hillman and Sharps 1978). Though extinct in South Dakota for 60 years, a small and expanding population was reported in 1978. Yet, given the length of time in which no sightings were made, invasion of northern areas by the alleged southern subspecies may well account for this sighting. Given this confusion, the U.S. government delisted *V. velox hebes* as an endangered species (Carbyn 1986).

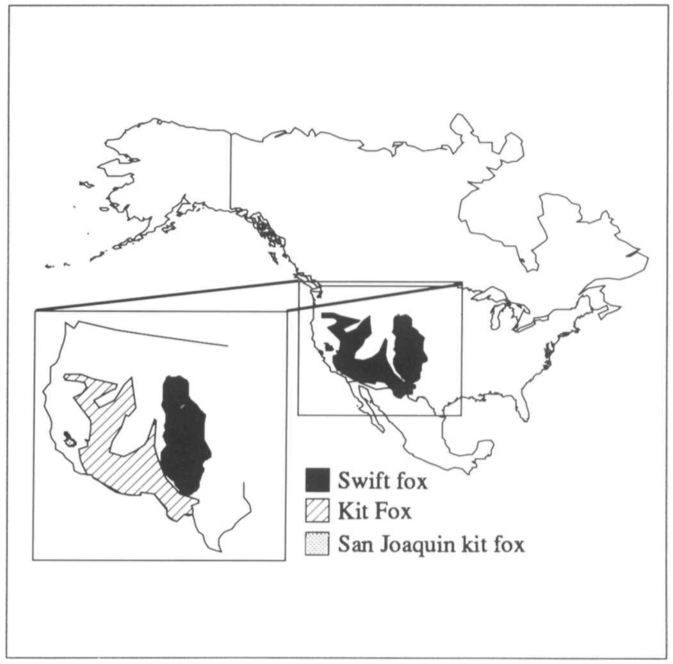


Figure 8. Swift or kit fox distribution.

Sharps (1980: cited in Scott-Brown et al. 1987) summarized the status of *V. velox hebes* in the north-central United States. However, given that the subspecies only occurred historically in an area smaller than that discussed by Sharps, we can assume that his state-by-state summary includes both subspecies. In North Dakota and Montana, no viable populations were known. In Oklahoma and Nebraska, small stable populations could be found. In Kansas, Colorado, South Dakota, and Wyoming, populations appeared to be expanding.

The status of other populations of *V. velox* in the northern United States (swift foxes) has been summarized by Scott-Brown et al. (1987). In most states, little information exists on population numbers; however, what little data there are suggest that swift fox numbers are stable or increasing (O'Farrell, pers. comm.). Harvest rates of *V. velox* subspecies are low (< 4,000/ year on average in all states combined—Scott-Brown et al. 1987); offtake of *Vulpes veloxmacrotis* subspecies is somewhat higher (4,000-7,000; O'Farrell 1987).

Six subspecies were formerly associated with *V. macrotis* and are now considered to be subspecies of *V. velox.* Of these, only the San Joaquin kit fox, *V. velox mutica,* is considered endangered by the U.S. Department of Interior (Snow 1973; O'Farrell 1987). O'Farrell (1983 in O'Farrell 1987) suggested that approximately 7,000 individuals remained in 14 counties of west central California. Road kills, habitat loss, and the inadvertent poisoning of kit foxes through rodent control programmes are the greatest threats to the survival of the subspecies.

Commercial Use. Formerly trapped very heavily for fur, and limited trapping still occurs.

Threats

1. The use of 1080 poisons, primarily aimed at coyotes (*C. latrans*) appears to have resulted in the poisoning of *V. velox* (Scott-Brown et al. 1987). However, there is some debate as to whether the use of such poisons results in a decline, or an increase in *V. velox* populations: while poisons may directly reduce fox densities if they concurrently eliminate or reduce coyote numbers, an increase in fox numbers may occur (reviewed in Carbyn 1986). O'Farrell (pers. comm.) believes that the use of 1080 has a strong, negative effect on kit foxes in California. Since banning of the substance on federal lands occurred in 1972, kit foxes have recolonized many of these areas (O'Farrell, pers. comm.). The State of California will not allow use of 1080 unless absence of San Joaquin kit foxes can be proven (O'Farrell, pers. comm.).
2. Coyotes, *C. latrans,* are the major cause of death in some fox populations (O'Farrell 1984; Scott-Brown et al. 1987). Competition with, and predation by the coyote may well have an increased negative impact on *V. velox* population levels and distribution in the future due to the coyote's large range expansion in recent years (Voigt and Berg 1987).

Current Research Programmes

1. Long-term research and conservation programs continue to be supported by the U.S. Department of Energy on the Naval Petroleum Reserves in California (O'Farrell pers. comm.). The program aims to study the life history of the San Joaquin kit fox, and the effect of petroleum production on its habitat. Reclamation of disturbed habitat is being attempted, as are studies to assess ways to minimize the impact of human activities on the fox population. This study is of particular importance as it is attempting to find ways of enabling foxes and man to coexist.
2. The National Guard and the California National guard are sponsoring research on the San Joaquin kit fox living in Camp Roberts, California (O'Farrell pers. comm.).
3. The Nature Conservancy is sponsoring research on coyote-kit fox interaction in California (O'Farrell pers. comm.).
4. The California Energy Commission is sponsoring a study of the conservation of San Joaquin kit foxes in urban areas in Kern County, California (O'Farrell pers. comm.).
5. Active reintroduction programs are being attempted in Canada (Reynolds 1983; Carbyn pers. comm.). Releases were begun in 1983 using soft release techniques (animals were initially held in pens). In confirmation of the coyote exclusion hypothesis presented above, the greatest cause of mortality in the study was found to be predation on foxes by coyotes (Scott-Brown et al. 1987).

From 1984 to 1988, 246 foxes were released at 17 sites, five in Saskatchewan and 12 in Alberta (Carbyn pers. comm.). From 1984 to 1987, soft release techniques were used, but in 1987, hard release techniques (no pen holding) were emphasized. In total, 136 foxes have been released by soft release methods, 110 by hard release. Foxes showed excellent winter survival in 1987, with a minimum of 33 pups from 7 litters surviving. Due to drought and an associated decline in food (grasshoppers), the 1988 hard releases were not as successful as those made in 1987. 34 foxes were kept back to be released in the spring of 1989. Approximately 30% of the released foxes are being monitored by radio telemetry. The releases involved a number of agencies, and were being coordinated by the Canadian Wildlife Service.

Whether southern foxes should be introduced in the northern range has been debated in the literature, with Stromberg and Boyce (1986) arguing that reintroduction may result in the mixture of distinct races, while Herrera et al. (1987) argue that such increase in genetic diversity, being the goal of captive breeding programs, should not be considered a problem.

Conservation Measures Taken

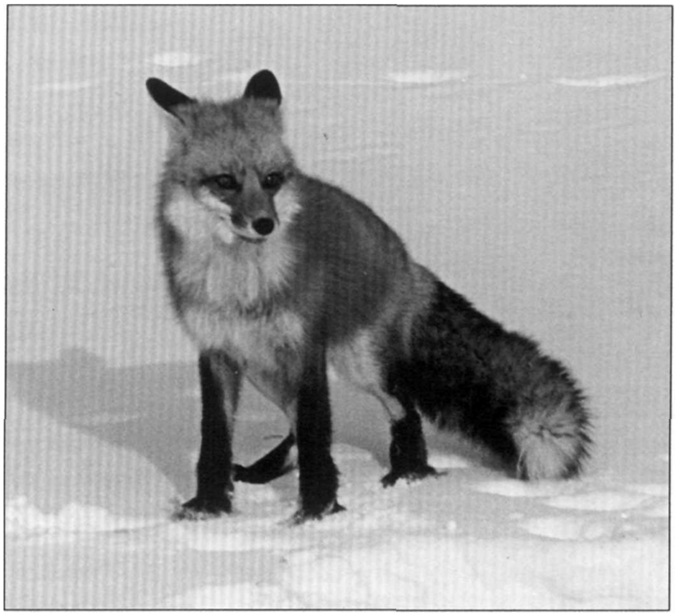
1. Protected throughout its range (Scott-Brown et al. 1987), and in most areas classified as a furbearer. The species is trapped in some areas (Texas, Kansas, Colorado, New Mexico). In Nebraska and Montana the species is listed as endangered. The San Joaquin kit fox is classified by the U.S. Federal Government as endangered and by the State of California as threatened.
2. O'Farrell (1987) summarized the status of subspecies formerly classified as kit foxes. They are classified as predators in Arizona; trapping for kit foxes occurs in Arizona, Nevada, and Utah; hunting is pursued in Arizona, Colorado, Texas, and Utah. The species is fully protected in Idaho and Oregon, where it is rare.

Reviewers. L. Carbyn; T. O'Farrell.

Red fox (*Vulpes vulpes*)

English: Silver fox and cross fox (refer to common colour morphs). French: Renard. German: Fuchs. Spanish: Zorro.

Description. A medium-sized canid, the largest fox in the genus *Vulpes.* Large bushy tail, often tipped in white. Ranges in colour from greyish and rust red to a flame red, usually reddish-brown. Black backs to ears; lower limbs often black. Enormous geographical range and corresponding wide variation in all measurements. Measures given here are ranges with selected European averages. Head-and-body length: 58-90 cm, males 67 cm, females 63 cm. Tail length: 32-49 cm, males 45 cm, females 38 cm. Shoulder height: 35-40 cm. Weight: 3-11 kg, males 6.7 kg, females 5.4 kg.



Red fox (*Vulpes vulpes*). (Photo by D. Vandel)

Reproduction. Time of mating: variable with latitude and habitat, usually in late winter/early spring. Gestation: 49-55 days, usually 51-52. Litter size: 3-12, usually 4-5 in Europe, 6-8 in Ontario (Voigt and Macdonald 1984). Lactation: 4 weeks, completely weaned at 6-8 weeks. Age at sexual maturity: 9-10 months. Longevity: 10-12 years in captivity, but generally less than 3 years in much of agricultural Europe.

Social behaviour. Variable with habitat, but generally territorial with basic social unit the monogamous pair, which may or may not be share territory with non-breeding kin. Territory sizes vary widely with habitat from less than 1 km^2 up to 10 km^2 (reviewed in Voigt and Macdonald 1986). Variation in home range size is proportional to food density and distribution, and probably affected by local mortality pressure. Reports of overlapping home ranges in some (but not all) urban environments (e.g Harris 1979) and drifting territories in other urban settings (Doncaster and Macdonald submitted). Mainly crepuscular/nocturnal, but more diurnal where undisturbed. Pups are cared for by both parents, and remain in or near the den for the firstthree months of their lives. Communal denning, with more than one litter and/or adopted pups have been reported, mainly in North America, but a single pair with pups is the most common breeding unit. The breeding pair is often associated with non-breeding family members. These are usually female and may act as helpers (Macdonald 1979). Almost all males and a variable proportion of females disperse at 6 to 10 months, however males tend to disperse earlier and move greater distances (e.g. males 30 km, females 10 km, Phillips et al. 1972). Mean dispersal distance varies widely between populations, and is positively correlated with home range size (Macdonald and Bacon 1982).

Diet. Extremely varied, including invertebrates (particularly beetles and earthworms), small mammals (rodents and lagomorphs), birds (including game species), and fruit, along with garbage and carrion. Generally caches food surplus to requirements, and has highly developed memory for locations of hoards (Macdonald 1976).

Habitat. Extremely varied in habitat requirements, from arctic tundra to city centres (including sightings in London, Paris, Stockholm etc.). Natural habitat is dry, mixed landscape, with abundant 'edge' of scrub and woodland. Also found in uplands, mountains (crosses alpine passes), deserts, sand dunes, and farmland. nourishes especially in affluent suburbs and, in many habitats, appears to be closely associated with man.

Distribution. Distributed throughout the northern hemisphere from the Arctic Circle to North Africa, Central America, and the Asiatic steppes excluding Iceland, the Arctic islands, some parts of Siberia, and extreme desert. European subspecies introduced into Eastern states (e.g. Virginia) of North America in the 17th Century, and mixed with local subspecies then moving southwards as habitat changed (forest clearance); also introduced to Australia. See Figure 9.

Population and Status. Abundant and widespread. Heavily trapped, shot, or poisoned in much of its range, but in North America, where it is considered an important resource (fur), trapping is carefully regulated. Populations are locally and periodically decimated by rabies epizootics, but recovery appears to be swift (e.g. western Europe, North America, Wandeler et al. 1974).

Commercial Use. Trapped extensively for fur, with seasons being carefully regulated in some countries, and not at all in others.

Threats. Killed in enormous numbers during rabies control schemes in both North America and Europe. Following such control, rapid recovery of numbers is typical (e.g. Wandeler et al. 1974). Current revolution in approach to this problem involves the use of an oral vaccine, already highly successful in several European countries (Kappeler et al. 1988). See page86.

Current Research Programmes

1. Studies with regard to rabies control and ecology in many countries, e.g. M. Artois in France, P. Pastoret and B.

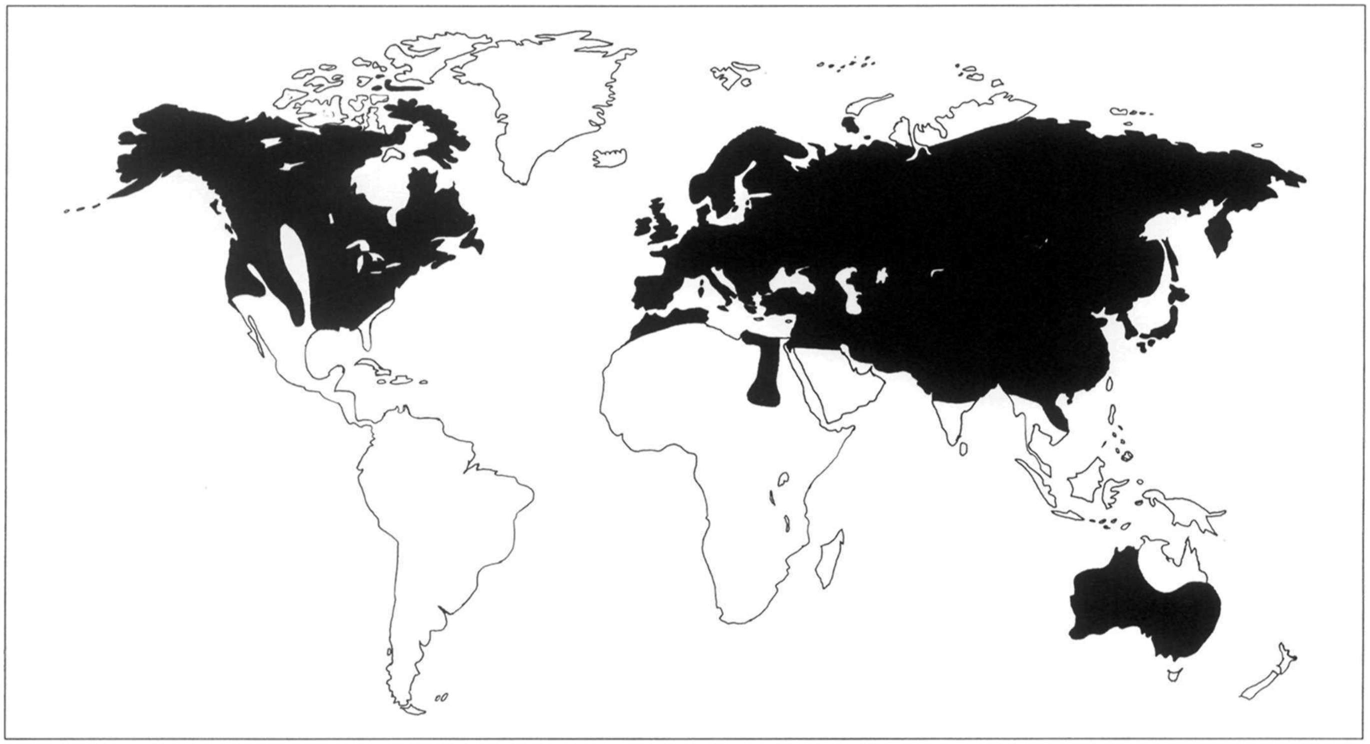


Figure 9. Red fox distribution.

Brochier in Belgium, A. Kappeler (following up studies of A. Wandeler) in Switzerland, D. Johnson, P. Bachman, and C. MacInnes (following up studies by D. Voigt) in Canada, L. Schneider in Germany, and D.W. Macdonald in Saudi Arabia.

2. Studies of impact on game birds by S. Tapper et al. (of the Game Conservancy, England), and of the use of alternative control strategies such as aversive conditioning and repellents by D.W. Macdonald of Oxford, U.K.
3. Long-term ecological studies such as those by S. Harris (in urban Bristol, U.K.) and E. and C. Lindström (in Swedish taiga), and many others in a wide variety of habitats.

Conservation Measures Taken. From a legislative point of view the red fox is widely treated as vermin, and unprotected, but in areas where it is a commercially important furbearer (North America, Scandinavia), it is conserved under harvest laws. Where it is regarded as a quarry species (e.g. by those using firearms in many European countries, and by those hunting with hounds, for example in the United Kingdom) it is protected by closed seasons. Otherwise, no conservation measures are in place. However, there are indirect benefits to the fox through the replacement of traditional killing schemes by oral vaccine in rabies control.

Reviewer. M. Artois.

7. North Africa and the Middle East

Introduction

The vast deserts and semi-deserts of North Africa and the Middle and Near East support a remarkable variety of animal life, often living in areas where the presence of any living thing seems unlikely. Among the animals found in this region are seven canid species. Four of the species indigenous to the region are, to a greater or lesser extent, desert foxes: the pale fox,Rüppell's fox, the fennec fox, and Blanford's fox. Each of these species exhibits physical characteristics typical of desert animals: large ears, small bodies and often thick fur. Two species that inhabit the region—the red fox and the golden jackal—are more closely associated with man, preferring less arid and ecologically richer areas. Details of the distribution and biology of the red fox are found in Chapter 6. The golden jackal has been discussed in Chapter 4.

Fennec fox. (Photo by M. Greer)

Current Status of Species

If one word were chosen to describe our knowledge of the current status of the four species of desert fox that word would be ignorance. Harrison (1968) and Gasperetti et al. (1985) summarize the scant information available. The ecologically richer habitats in this region appear to be dominated by the more widespread red fox and golden jackal, leaving the less hospitable areas to the smaller desert foxes. In addition, the purely nocturnal habits of these foxes make casual observations more difficulL Until such a time as we have even a vague idea about the densities at which these animals exist, and the extent of the distribution of these canids, caution is required.

A further complication in making recommendations is that none of the four species of desert fox breeds well in captivity. With the exception of Rüppell's fox, there have been few attempts to breed these species in captivity (see Chapter 11). Attempts to breed Rüppell's fox have not been very successful. Furthermore, captive populations of these foxes are limited in number.

Species Accounts

Fennec fox (*Fennecus zerda*)

French: Fennec. German: Fennek, Wüstenfuchs.

Description. The smallest fox, with distinctive large (15cm) ears and a cream-coloured coat with a black-tipped tail. The soles of the feet are furred, and dark bristles cover the anal gland. Head-and-body length: 24-41 cm. Tail length: 18-31 cm. Shoulder height: 19-21 cm. Weight: 1-1.5 kg.

Reproduction. Time of mating: Jan.-Feb., may remate later if litterislost. Gestation: 50-52days. Lactation:9-10weeks. Age at sexual maturity: 6-11 months. Longevity: 11-14 years (captivity).

Social Behaviour. Mainly nocturnal. The fennec has been observed in groups of up to 10 individuals, but the relationship of

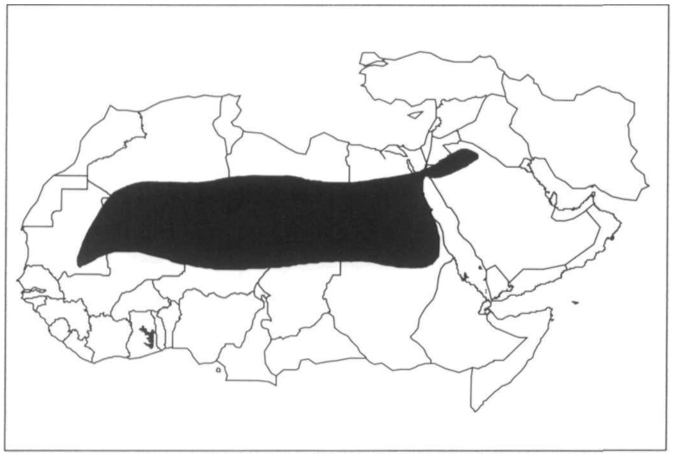


Figure 1. Fennec fox distribution.

members of these groups is unknown. Males mark territories with urine and become aggressive during the breeding season. Females defend nest site. Males do not enter den. Pups first exit den at four weeks and leave the den at three months.

Diet. Omnivorous, eating plant materials, small rodents, birds, eggs, reptiles and insects.

Habitat. Sandy desert.

Distribution. Deserts of North Africa, throughout the Sahara including Morocco, Algeria, Tunisia, Libya, Egypt, south to the Sudan to approximately 17° N. One sighting was made in the Sinai in the late 1970s. No recent sightings have been made there. See Figure 1.

Population and Status. Not known.

Commercial Use. Trapped and sold as pets and extensively hunted for pelts by indigenous people in the Sahara.

Threats. Other than potential over-exploitation, none known.

Current Research Programmes. Survey, by questionnaire, of status (N. Hackmann for Canid Specialist Group).

Conservation Measures Taken. None known.

Reviewer. N. Hackmann.

Blanford's fox (*Vulpes cana*)

English: Afghan fox. Iran: Siah rubah. Israeli: Shual tzukim.

Description. A small fox with very large ears and long tail which appears very bushy due to long dark guard hairs. Its appearance is very cat-like and its gait and demeanour are also rather feline. The colouring is variable, usually blotchy black, grey and white. The tail often has a dark tip, but is sometimes white. Some skins examined in the British Museum have white tips (Yom-Tov pers. comm.) as do specimens in the wild (Geffen 1990). It has an almost black mid-dorsal line; the hind legs may be dark and the underparts are almost white. In Israel, colouring is light brown, grey, and yellow, and mid-dorsal line is sometimes absent. Head-and-body length: 42 cm. Tail length: 30 cm. Shoulder height: 28-30 cm. Weight: 0.9-1.3 kg in Israel (these data and most of what follows, are based on Geffen 1990).

Reproduction. Time of mating: Dec-Jan. Gestation: 50-60 days. Litter size: 1-3 pups. Lactation: 60 days. Age at sexual maturity: 8-12 months. Longevity: 4-5 years. All data on reproduction is for animals from Israel.

Social Behaviour. Monogamous, solitary hunter. Strictly nocturnal.

Diet. Reportedly more frugivorous than other foxes. When eating domestic crops, the fox appears to prefer ripe melons, seedless grapes, and Russian chives. It has also been observed eating insects, including locusts. In Israel, the fox is mainly insectivorous and frugivorous.

Habitat. Blanford's fox is usually found in mountainous regions and prefers cliffs. In southwest Turkestan and Iran the species is known from barren mountain steppes and rocky hills bordering low valleys, cultivation and plains. The species is found to an altitude of approximately 2,000 m. Originally, Blanford's fox was thought to avoids hot lowlands. In Israel, however, it is found near the Dead Sea (the lowest valley in the world), an area that reaches extreme summertime temperatures.

Distribution. Until recently, Blanford's fox was thought only to be found in in Afghanistan, southwest Soviet Union, Turkestan, northeast Iran, and Baluchistan. In recent years it has been found in Israel. Blanford's fox was also trapped in Dhofar, Oman in 1984. It is probable, therefore, that the range of this species extends throughout Arabia (Oman, Yemen, Jordan, and west Saudi Arabia). See Figure 2.

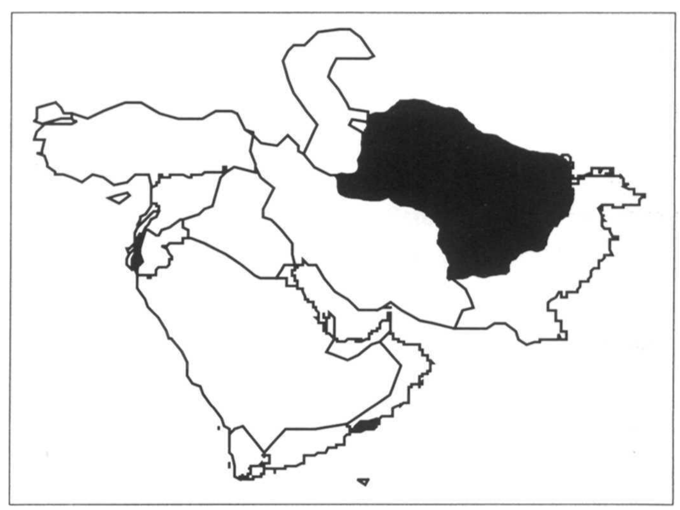


Figure 2. Distribution of Blanford's fox.

Population and Status. Believed rare in most localities; locally abundant in parts of Israel (Mendelssohn et al. 1987).

Commercial Use. Its skin is valuable in commerce and, in its range, the species is heavily hunted. Figures for domestic trade are unknown.

Threats. As the animal is not at all trap-shy, trapping is easy and can decimate a population in a month (Geffen pers. comm.).

Current Research Programmes. E. Geffen and R. Hefner are currently studying the distribution and ecology of the Blanford's fox in Israel. This work is funded by the Nature Reserve Authority of Israel and the Flora and Fauna Preservation Society.

Conservation Measures Taken. Completely protected throughout Israel. Blanford's fox is known to occur in the following protected areas in Israel: Ein Gedi National Park (2.0 individuals/km^2); Elat Mountains National Park (0.5 individuals/km^2). Geffen (pers. comm.) estimates a total population in the Negev desert of approximately 1,000 individuals.

Reviewers. Y. Yom-Tov; E. Geffen.

Pale fox (*Vulpes pallida*)

French: Renard pâlé German: Blassfuchs.

Description. Similar in body structure to the red fox, but smaller with longer legs and ears. A pale fawn colour on body and ears; the tail is reddish brown with a black tip. The legs, and sometimes the back, are rufous. The underside, inside of the ears and face are whitish. Head-and-body length: 38-45 cm. Tail length: 23-29 cm. Shoulder height: 25 cm. Weight: 2-3.6 kg.

Reproduction. Time of mating: unknown. Gestation: unknown. Litter size: 3-4. Lactation: unknown. Age at sexual maturity: unknown. Longevity: unknown.

Social Behaviour. The pale fox has been observed in what are presumed to be mated pairs and small family parties. Dens are self-constructed, 2-3 m deep and up to 15 m long. Chambers within the den are lined with grass. Nocturnal/crepuscular.

Diet. Essentially herbivorous, eating mainly berries and fruit, but sometimes birds, small rodents, and small reptiles.

Habitat. Sandy and stony savanna, semi-deserts into marginal deserts.

Distribution. The Sahel from Senegambia to Kordofan, also the Sudan, east of the Nile to the Red Sea. See Figure 3.

Population and Status. Unknown.

Commercial Use. None known.

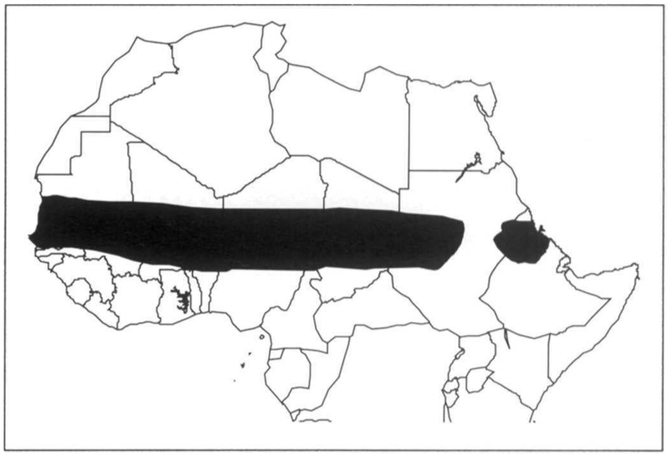


Figure 3. Pale fox distribution.

Threats. None known.

Current Research Programmes. None known.

Conservation Measures Taken. None known.

Reviewers. None.

Rüppell's fox (*Vulpes rueppelli*)

English: Sand fox. French: Renard famélique. German: Sandfuchs, Rüppellfuchs. Also locally referred to as "le fennec" in confusion with the fennec fox.

Description. A pale sandy coloured coat with black patches on the face. The tip of the tail tip is conspicuously white. The fur is soft and dense, and the animal's frame is slighter than the red fox with short legs and broad ears. Head-and-body length: 40-52cm. Tail length: 25-39 cm. Shoulder height: 30 cm. Weight: 1.2-3.6 kg.

Reproduction. Time of mating: unknown. Gestation: unknown. Litter size: 2-3. Lactation: unknown. Age at sexual maturity: unknown. Longevity: 6.5 years in captivity.

Social Behaviour. Again, little is known, but reports indicate that the species may be gregarious, having been sighted in groups of 3-15 (Linn pers. comm.). These may represent extended family groups. However, in Oman they appeared to live as territorial pairs occupying ranges of c. 50 km^2 (Lindsay and Macdonald 1986). Grouping may be incidental, caused by close aggregation of dens in the few areas where denning sites are available. *V. reuppelli* is crepuscular/nocturnal.

Diet. Reports suggest an omnivorous diet with a substantial insectivorous component (Lindsay and Macdonald 1986).

Habitat. Desert, either stony or sandy.

Distribution. Morocco to Afghanistan. Scattered populations in the mid- and eastern Sahara, Hoggar to Air through Tibesti to Libyan, Nubian, and Arabian deserts. Also found in the Sinai, north to the Dead Sea and Iraq, through Iran and western Afghanistan. Probably found in most of the Arabian Peninsula (Linn pers. comm.). See Figure 4.

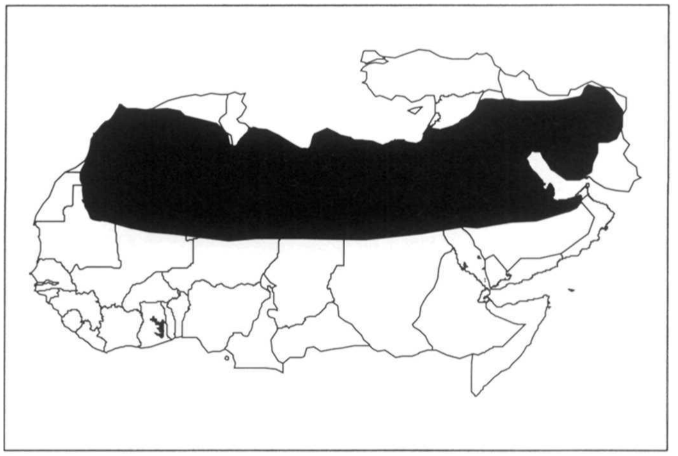


Figure 4. Distribution of Rüppell's fox.

Population and Status. Unknown.

Commercial Use. May be occasionally killed for food by bedouin.

Threats

1. In Saudi Arabia, the red fox is well adapted to living in areas of the desert, particularly those colonized by man. Hence, Rüppell's fox may only be able to compete in the harshest desert areas.
2. Gasperetti et al. (1985) note that poisoned baits are used indiscriminately to control predators in Saudi Arabia.

Current Research Programmes

1. A pilot study is in progress conducted by D. W. Macdonald in association with King Khalid Wildlife Research Centre in Saudi Arabia.
2. Further research in Oman (Linn pers. comm.).
3. Research proposals in need of funding have been prepared by Ms. J. Bakker (Oxford Wildlife Conservation Research Unit) for field work in Israel.

Conservation Measures Taken. None known.

Reviewer. I. Linn.

8. South and Southeast Asia and Australia

Introduction

Other than the nearly ubiquitous red fox (Chapter 6), the widely distributed golden jackal (Chapter 4), and the wolf (Chapter 9), four canid species are found in south Asia: the dhole, the Bengal fox, the corsac fox, and the Tibetan fox. In southeast Asia, canids are represented by a mere three species: the dhole, the golden jackal, and the dingo. This lack of species diversity is somewhat surprising given the broad range of habitats available: tropical forest and coast, desert, semi-tropical and temperate hills, and alpine tundra.

Two canid species, the dingo (*Canis familiaris dingo*) and the red fox (*Vulpes vulpes*) are found in Australia. Both these species have been introduced to the island-continent, the red fox being introduced more recently (late 19th Century) than the dingo (approximately 3,500-4,000 years before present). Basic information on the biology of the red fox can be found in Chapter 6. As elsewhere, the red fox is a common and successful species throughout much of Australia.

The dingo has become part of the ecological landscape of Australia. Until recently, the dingo was thought to be unique to Australia, with origins in the Indian sub-continent (Gollan 1980). Recently, however, Corbett (1985) has argued that dingo-like canids found throughout Southeast Asia are more closely related to the Australian dingo than to the domestic dog. Following Corbett's classification, we have included Southeast Asian dingoes in this survey.

Dingo (*Canis familiaris dingo*). (Photo courtesy of Australian News and Information Bureau/IUCN)

Current Status of Species

Of the five species indigenous to this region, the biology and the present distribution of three species are essentially unknown. Our knowledge of the dhole is somewhat better but extends only to areas in the Indian sub-continent. In those areas traditionally associated with the dingo, Australia and the larger islands of the South Pacific, the species is often in conflict with, and persecuted by, man. Throughout its range, the dingo is being swamped by genetic introgression from varieties of the conspecific domestic dog, *Canis familiaris.*

Species Accounts

Dingo (*Canis familiaris dingo*)

Aboriginal: Warrigal, Warang (northern Australia).

Description. The coat is usually ginger, but varies from a light, sandy colour to a deep red-ginger. Irregular white markings are found on the feet, chest, and the tip of the tail. The tail is long and bushy. Dingoes can be distinguished from the domestic dog (*Canis familiaris familiaris*) and dingo-dog hybrids by their larger canines and carnassial teeth, differences in skull bones, and the pattern of breeding (Corbett 1985 and pers. comm.). Also, while domestic dogs show no seasonal pattern of breeding, dingoes breed only once a year. Head-and-body length: 72-111 cm. Taillength:21-36cm. Shoulder height: 40-65 cm. Weight: 8.6-21.5 kg (males); 8.3-17.0 kg (females). (Measurements are from central Australia.) Dingoes in eastern Australia are somewhat larger (Harden and Robertshaw pers. comm.). Dingoes in Asia are smaller than Australian specimens (Corbett pers. comm.).

Reproduction. Time of mating: Mar.-Apr. (autumn to early winter in Australia); Aug.-Sept. (Thailand and probably the rest of Asia). Gestation: 63 days. Average number in a litter: 1-10, mean 5.4 (Australia). Duration of lactation: 2 months, pups independent at 6-8 months. Age at sexual maturity: 1 year in captivity, most females do not breed until two years of age (Corbett pers. comm.).

Social Behaviour. Very flexible, but often pack-living (up to 10 individuals), similar to that of the wolf (*Canis lupus*) and the African wild dog (*Lycaon pictus*) (Corbett 1988b). Young males are usually nomadic. Dingoes use cooperative breeding and hunting, but there is great flexibility in hunting strategies depending on prey species (Robertshaw and Harden 1986; Newsome et al. 1973). Within the pack, the dominant female kills the young of sub-dominant females. Mean home range areas for adults are 27 km^2 in New South Wales (Harden 1985) and up to 320 km^2 in the arid Northern Territory of Australia (Corbett pers. comm.).

Diet. Australia: Macropod marsupials are the most common element of diet in all studies (Robertshaw and Harden 1985, 1986—54%; Newsome et al. 1983a, 1983b-43%; Whitehouse 1977—69%; Newsome et al. 1983a,b—57%). In arid central Australia, it concentrates on lizards, rabbits, and rodents. In tropical northern Australia, magpie geese, rats, and small wallabies are preferred. The dingo will switch prey when availability of primary prey changes (Corbett and Newsome 1987). Can subsist on fruits and xerophilous plants (Meggitt, 1965). In Asia, dingoes eat mainly rice and other food scavenged from humans, but also small lizards, rodents, and insects.

Habitat. Australia: Can be found from desert to deep forest. Sometimes favours forest edges, heath, or grassland. Population density is a function of prey availability (Harden and Robertshaw pers. comm.).

Distribution. Found throughout mainland Australia except where excluded from sheep grazing areas by a dingo fence in the east and the west. Also found in the islands and mainland of southern and southeast Asia including Papua New Guinea (formerly *C. hallstromi),* Indonesia, Malaysia, the Philippines, Burma, Thailand and southern China. See Figure 1.

Population and Status

Australia: Large and widespread population except in the settled areas of the southeast and southwest. Populations have vastly increased since European settlement despite heavy persecution in grazing areas due to episodic losses of livestock.

Asia: Populations viable despite heavy predation by indigenous peoples for food and some mortality during rabies control programmes.

Commercial Use. Australia: Bounties (Aus. $2-6) for skin and scalps. Asia: major source of protein for indigenous peoples. Canine teeth are used as decoration in Indonesia and the Pacific islands.

Threats

1. Interbreeding with more recently introduced subspecies of domestic dog, *Canis familiaris familiaris. C. f. familiaris* was first introduced in Australia in 1788, earlier in most of Asia. In southeastern Australia, approximately 34% of the wild population are hybrids (Newsome and Corbett 1985).
2. Australia: Classified as a pest species everywhere except the Northern Territory. Government sponsored dingo control using bounties, poisoning, etc., especially in sheep grazing areas (Harden and Robertshaw 1987).

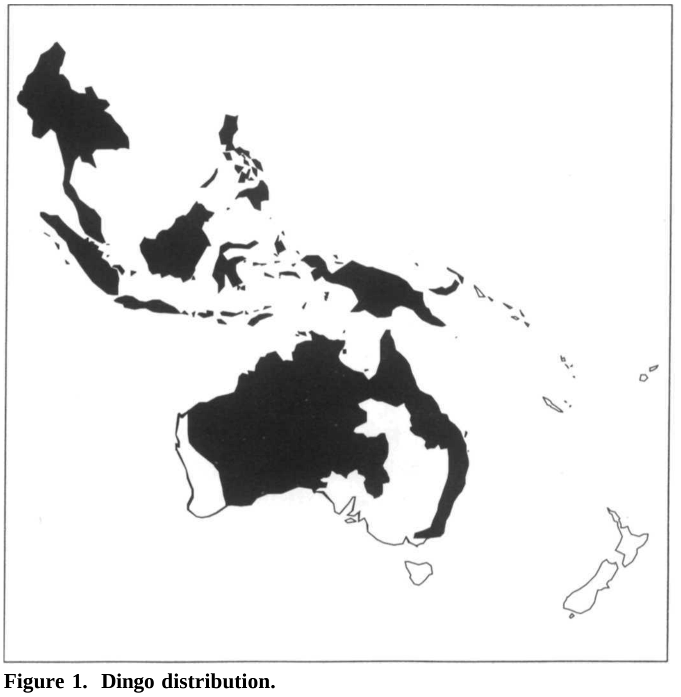


Figure 1. Dingo distribution.

Dhole (*Cuon alpinus*). (Photo by A.J.T. Johnsingh)

Current Research Programmes

1. In Australia, the government funds research on dingo ecology in various regions. Of particular interest is the interaction between dingoes and livestock.
2. Private societies (e.g. Australia Native Dog Training Society of New South Wales) promote recognition of the dingo and are attempting to change its legal status.
3. Research in Western Australia (Harden and Robertshaw pers. comm.).
4. In Asia, research by the Australian government is being undertaken to investigate the origins, ancestry, and present distribution of the dingo.

Conservation Measures Taken. None.

Reviewers. J. Clutton-Brock; L.K. Corbett; B. Harden; J. Robertshaw. The authors would like to thank particularly Dr. Corbett for his extensive comments and revisions of our original draft and Dr. L. Brisbin for additional material.

Dhole (*Cuon alpinus*)

English: Red dog, Asiatic wild dog. Assamese: Kuang-kukur, rang-kukur. Bengali: Ban Kutta, Ban-kukur. Bhutanese: Phara. Burmese: Tan-kwe. Canarese: Ken-nai, chen-nai. Chenchu: Reis-kukul. Chinese: Nyar. Gujiarati: Earam-naiko. Gurkhali: Ban-kukur. Hindi: Adivi-kuta, son-kuta, sona-kuta, rasa-kuta. Hindustani: Jungli-kuta,ram-kuta,ban-kuta. Kachin: Kyi-kwa-lam. Kashmiri: Jungli-kuta, ram-hun, ban-kuta, bhansa. Korku: Bun-seeta. Lepcha: sa-tun. Malay: Sirgala, Arjing-kutar. Malayalam: Hahmasai-kuta,kolsun,kolsa,kolarsi. Nepali: Bwaso. Tibetan: Phara. Tamil: Chen-nai. Telegu: Vanna-kooka. (all from Burton 1940). Thai: Maa Paa.

Description. A fairly large, doglike canid, with rounded ears and a long, moderately bushy tail. Legs are rather short, and the pelage is evenly tawny or dark red with a slightly darker tail and lighter underparts. Head-and-body length: 90 cm (Soviet Union populations some 20% longer). Tail length: 40-45 cm. Shoulder height: 50 cm. Weight: 15-20 kg; female 10-13 kg.

Reproduction. Time of mating: Sept.-Feb. in central and northern India, Sept.-Dec. in southern India (Johnsingh 1982). Gestation: 60-62 days. Litter size: 8-9, but 3-4 common. Lactation: At least 8 weeks. Age at sexual maturity: 1 year. Longevity: 10 years, up to 16 years in captivity.

Social Behaviour. Dholes live in packs which are an extended family unit of usually 5-12 animals with aggregations of up to 25 animals occasionally noted (Johnsingh 1985; Cohen 1977). Packs are territorial. In **a** study in Bandipur, southern India, more than three adults took part in feeding both the lactating mother and the pups. Pack continues to care for pups after they leave the den, by regurgitating meat and allowing them access at kills (Johnsingh 1985).

Diet. The primary component of the diet is other vertebrates, particularly medium-sized ungulates. The dhole will also include berries and reptiles in its diet. Cohen et al. (1978) found vegetable matter in only 25% of scats; Johnsingh (1982) found grass to be a major component in 7% of scats analyzed. In Bandibur, India prey importance (by biomass used) was: chital (*Axis axis* -73%); sambar (*Cervus unicolor* -17%); rodents 5%;

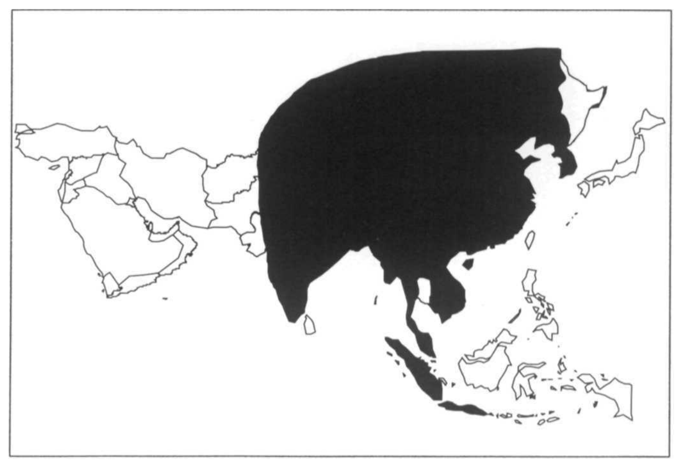


Figure 2. Dhole distribution.

lagomorphs 2.5% (Johnsingh 1982). The small size of rodents meant that they represented 90% of individuals killed. In the Soviet Union, Sosnovski (1967) reports that main prey include reindeer (*Rangifer rangifer*), wild sheep (*Ovis* sp.), wild goats (*Capra* sp.), and badgers (*Meles meles*).

Habitat. In the Soviet Union, the dhole inhabits alpine areas and dense forests; in India, dense forest and thick scrub jungle up to 2,100 m; in Thailand, dense montane forest up to 3,000 m. Observations in India suggest five factors determine the quality of the habitat for dholes: prey abundance; water availability; presence of scrub interspersed with open lands with short grass; absence of human disturbance; and rock crevices, porcupine burrows, or hyaena dens as den-sites.

Distribution. The dhole has historically occurred in the forest areas of the Indian peninsula, though it was seldom reported in north-western provinces. Its range also included Malaysia, Java, Sumatra, Burma, and northwards into Korea, China, and eastern Soviet Union. In the Soviet Union, the dhole has been found at 54°N in the Pamir region, but it is believed extirpated in these northern regions. See Figure 2.

Population and Status

South Asia: The dhole is very rare in Bangladesh, now only found in the hill districts of Chittagong and Sylhet. In eastern India, the dhole is rare or extinct in Mizoram, Tripura, Nagaland, Meghalaya, and Assam. About 10 years ago, a pack was seen in Goalpara district near the Bhutan-Assam boundary. In 1953, a pack was reportedly seen by forest labourers in Garampani Wildlife Sanctuary, Assam. The dhole is still widespread in the Garo hills of Meghalaya. In the forests of Arunachal Pradesh, dholes are frequently sighted in Nandhapa Tiger Reserve, but are rare in other areas. The dhole is extinct or extremely rare in the hill tracts of Nagaland (Bombay Natural History Society has not received skins from Nagaland since 1931). In West Bengal, dholes are occasionally seen in the Mahanadi Wildlife Sanctuary, the Jhalda-Baghmundi Matha zone of the Purulia forest division, and the Cooch Behar forest division. They have not been reported in the Sundarbans Tiger Reserve. The status of the dhole in the Himalayas is much more precarious. The last skin from Sikkim was collected in 1931. In recent years, the dhole has not been recorded in Himachal Pradesh. In 1977, a pack was seen in the forests around Dudhwa, Uttar Pradesh. Dholes are probably extinct in other parts of Uttar Pradesh. Dholes are rarely seen in Chitwan, Nepal, and Langtang National Parks. The status of the dhole within India has been reviewed recently by Johnsingh (1987). The dhole is extinct in the Punjab, Haryana, and Gujarat. There is no reliable information from Kashmir. The dhole is nearly extinct in Ladakh, a pack of four individuals in Rumbak valley in Hemis High Altitude National Park being the only recent sighting (Johnsingh pers. comm.). In southern India, dholes have been sighted in forest ares of Adilabad, East Godawari, Khamman, Kurnool, Mahabudnagar, Srikakulam, Vishakhapatnam, and Warangal districts. The dhole is a common predator in the Bandipur and Nagarhole Wildlife Sanctuaries in Karnataka. In Kerala, occasionally seen in the Wynad Sanctuary, the Nilambur Valley, Silent Valley, the Elical mountain range, the Siruvani mountain range, the Nelliampathi hills, and in parts of the Nettar Wildlife Sanctuary. Dholes are frequently seen in the Periyar Tiger Reserve. In Tamil Nadu, dholes are seen in the Kalakadu-Mundanthurai Wildlife Sanctuaries, the Anaimalai Wildlife Sanctuary, the Nilgiri Tahr Sanctuary, and the Mudumalai-Sigur area.

Burma: Still believed to be widespread in the forested tracts of Burma, but the geographical boundaries of the subspecies are unknown (Johnsingh 1987). Known in the following Burmese divisions: Bhama, Nawlaik, Thayetmyo, Myitkyina, Katha, Monya, Minbu, Pyinmana, Toungoo, Pegu, Thaton, Pa-an, Tavoy, Shwebo, Maymyo, Pakokku, Prome, and Zigon.

Soviet Union: Very rare. Occasional sightings in the following regions: southwestern Primorje; Priamurje; far southeast Russia; Amur river region; and in Tian-Shan. Dramatic decline in records in Primorje after 1920. No reliable information is available on the situation at Tuva, Altai, or in Kazakhstan in last 25 years. There is no indication that breeding populations remain and sightings are, most probably, of migratory animals (Ovsyanikov pers. comm.).

Thailand: Present in Thailand, including Khao Yai National Park (Lekagul and McNeeley 1977) but status is unknown. Despite frequent visits to the north of Thailand, and bordering Burma, Corbett (pers. comm.) never observed dholes, nor was he convinced that they still existed in much of this region.

China: Occurs very sparsely in the forested mountains of western Sichuan, southern Gansu, eastern Qinghai, and in eastern Tibet (Schaller pers. comm.).

Commercial Use. Fur, but no international market.

Threats

1. In India, disease appears to be important in population regulation. In *C.a. primaevus,* virulent distemper, rabies, or both are thought to kill dholes periodically in Chitawan and Corbett. The prey base in these areas suggests that these should be among the best dhole habitats in this subspecies' range. Their rarity in this region may be due to natural causes, or may be the result of increased human contact (and contact with domestic dogs) leading to frequent disease introductions.
2. *C. a. dukhunensis:* Two forms of disturbance within reserves by local people: stealing of kills; and disturbance at den sites during the breeding season leading to den shifting and possible pup mortality. Threats in outside reserves include poisoning, resulting from conflicts with cattle grazers and depletion of natural prey (*Axis axis, Cervus unicolor*) by poachers (Johnsingh 1986).
3. Declines in populations for "unexplained" reasons have been documented in Kanha and the Soviet Union. In the Soviet Union, reasons for decline after 1920 are uniformly uncertain. The decline cannot be attributed to population or development pressures, or persecution. Ovsyanikov (pers. comm.) suggests that poison bait programmes aimed at elimination of wolves, *Canis lupus,* may have inadvertently eliminated dholes in areas in which the two species overlap.

Current Research Programmes. None known.

Conservation Measures Taken. Hunting has been prohibited since 1971 in the Soviet Union. In India, it is protected under Schedule 1 of the Wildlife Act of 1972 (permission required to kill any individual unless in self defense or if a man killer). In India and Nepal, Israel and Sinclair (1987) report the following populations in protected areas: Periyar (777 km^2) fairly common, approximately 50 packs; Mudumalai, Bandipur, and Nagarhole complex (1805 km^2) fairly common, but the number of packs is unknown. This was the site of research by both Fox

(1984) and Johnsingh (1979 and following); Kanha (940 km^2) moderately common, habituated to vehicles; Bandhavgarh (450 km^2) only one pack known to exist in the park; Chitawan (967 km^2)—recent reports are that the dhole, once formerly abundant in this park, is now rare. The creation of tiger reserves in the south of India has provided some protection for remnant populations of the *dukhunensis* subspecies (Johnsingh pers. comm.). The dhole is also reported to be common in two protected areas in Burma (Maymyo and Shwe-u-daung) but sightings in these areas have not been confirmed. A population is thought to be protected in Khao Yai National Park, Thailand; the size of this population is unknown.

Reviewers. A. Johnsingh; N. Ovsyanikov; G. Schaller, P. Stewart.

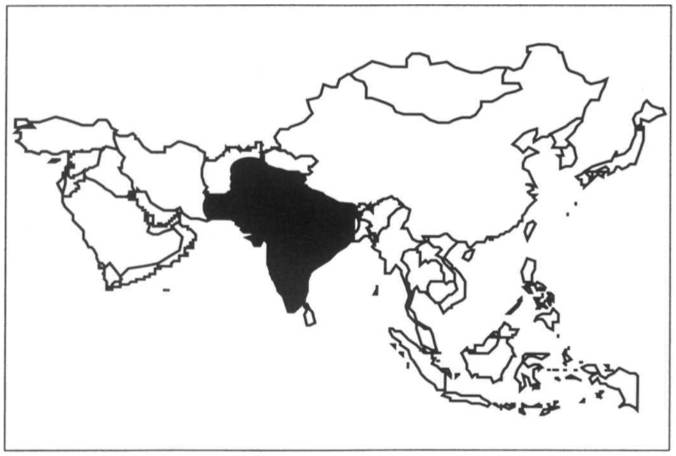


Figure 3. Bengal fox distribution.

Bengal fox (*Vulpes bengalensis*)

Description. Sandy-orange coat with black-tipped tail. Skull typically foxlike with long sharply pointed canines and well-developed molar teeth. Head-and-body length: 45-60 cm. Tail length: 25-35 cm. Shoulder height: unknown. Weight: 1.8-3.2 kg.

Reproduction. Time of mating: unknown. Gestation: 53 days, equivalent to average for vulpine foxes. Litter size: 2-4. Lactation: unknown. Age at sexual maturity: unknown. Longevity: unknown.

Social Behaviour. The Bengal fox is believed to live in long-term monogamous pairs, but this is based on little evidence. The fox hunts solitarily, probably as a result of the prey it favours. Usually crepuscular and nocturnal, in mild temperatures hunting may be pursued during the day. This behaviour is especially common following rain and in cloudy weather. Two types of dens have been described: simple short dens with two openings used for brief periods of rest, and complex cavernous dens with many entrances used. The entrances to dens are littered with droppings.

Diet. The Bengal fox feeds opportunistically on insects, ground nesting birds, and smaller mammals. When in season, melons, shoots, and pods of *Cicer arietum* are eaten. *V. bengalensis* also eats winged termites, grasshoppers, crabs, and rodents.

Habitat. Open country, thorny scrub or semi-desert, up to 1,350 m.

Distribution. India, Pakistan, and Nepal. See Figure 3.

Population and Status.

India: Most common fox of Indian plains (Johnsingh 1986). Eliminated by non-commercial killing from most of plains where not protected. No significant population can be found within a protected area in India. Animals are patchily distributed with a density of approximately one animal per 10 km^2. In open plains, the fox has been mostly eliminated, although small populations appear to persit in areas where rocky outcroppings provide denning sites. In areas under agricultural development, the fox, usually a diurnal forager, only forages in late evening (Johnsingh, pers. comm).

Nepal: There is little current information, but Chesmore (1970) noted its presence in the following areas: open farmlands of Terai, Birganj forest, Rapti valley, and in extreme western Nepal.

Pakistan: No information.

Commercial Use. None known.

Threats

1. The major threat is killing for sport and for the alleged medicinal properties of its flesh (Johnsingh 1986 pers. comm.). The great majority of foxes are killed for sport and not because they pose any threat to domestic livestock. In Tirunelveli District, Tamil Nadu, nomadic people use nets to kill foxes for flesh, teeth, claws, and skin; they also kill with hand-made animal-fat covered bombs. Local hunters readily shoot foxes, attempt to kill them with dogs, or jam den entrances with stones.
2. Rapidly expanding human exploitation of habitable areas suggests reduced chance of survival in open parts of the country; rugged terrain may continue to provide refuge.

Current Research Programmes. None known.

Conservation Measures Taken. The establishment of reserves for the Indian great bustard, a project directed by Asad Rahmani of the Bombay Natural History Society, may also result in inclusion of the Bengal fox in protected areas (Johnsingh pers. comm.) Bustard sanctuaries have been, or will be established in Karnataka, Andhra Pradesh, Madhya Pradesh, Maharashta, Ragasthan, and Gujarat. Surveys of these bustard reserves should be made to assess fox occurence and population densities.

Reviewers. G. Schaller, A. Johnsingh.

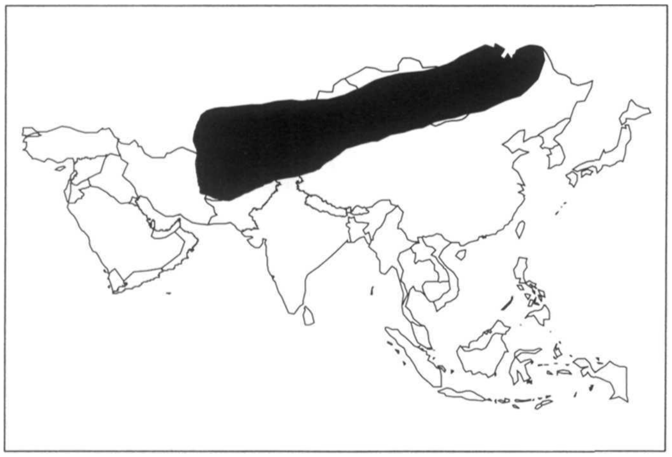


Figure 4. Corsac fox distribution.

Corsac fox (*Vulpes corsac*)

Description. A grey to red-grey fox with a white chin. Similar to *V. vulpes* but with relatively larger legs and ears. Head-and-body length: 50-60 cm. Tail length: 22-35 cm. Shoulder height: unknown. Weight: unknown.

Reproduction. Time of mating: Jan.-Mar. Gestation: 50-60 days. Litter size: 2-11. Lactation: unknown. Age at sexual maturity: unknown. Longevity: unknown.

Social Behaviour. Little is known about the social behaviour of this species. It lives in a burrow and several individuals may share dens. The corsac fox is suspected to be more social than most fox species as it has been seen hunting in small packs. However, these may be adults and older young. Usually uses dens excavated by other mammals.

Diet. Omnivorous, showing a preference for small mammals but also eating birds, reptiles, insects, and plant material.

Habitat. Steppes and semi-desert. Avoids areas used for agricultural purposes.

Distribution. Southeast Soviet Union, Soviet and Chinese Turkestan, Afghanistan, Mongolia, Transbaikalia, and northern Manchuria. See Figure 4.

Population and Status. Unknown.

Commercial Use. None known.

Threats. None known.

Current Research Programmes. None known.

Conservation Measures Taken. None known.

Reviewers. N. Ovsyanikov.

Tibetan or Tibetan sand fox (*Vulpes ferrilaia*)

Description. Back tan to rusty, sides and rump grey, tip of tail white. Canines elongate. Head-and-body length: 50-70 cm, 51.5 cm (1 specimen, Schaller pers. comm.). Tail length: 2940 cm, 27 cm (1 specimen, Schaller pers. comm.). Shoulder Height: Unknown. Weight: 3-4 kg. (Feng et al. 1986) 3.25 kg. (1 specimen, Schaller pers. comm.).

Reproduction. Time of mating: late Feb-Mar. Gestation: 50-60 days (?). Litter size: 2-5. Lactation: Unknown. Age at sexual maturity: Unknown.

Social Behaviour. Little known. The Tibetan fox dens in the crevices of boulder piles or in burrows under rock ledges.

Diet. Rodents, lagomorphs, and ground birds. The fox shows a particular preference for black-lipped pika (Schaller pers. comm.).

Habitat. High mountain steppe to a maximum altitude of about 5,300 m.

Distribution. Tibetan plateau of India, China, and Nepal.

Population and Status. Widespread. Generally at low population densities in areas with people, but moderately common elsewhere. See Figure 5.

Commercial Use. Commonly trapped. Skins used by Tibetans for hats in some areas.

Threats. None known.

Current Research Programmes. G. Schaller, Wildlife Conservation International, is collecting incidental information on the species.

Conservation Measures Taken. None known.

Reviewers. G. Schaller.

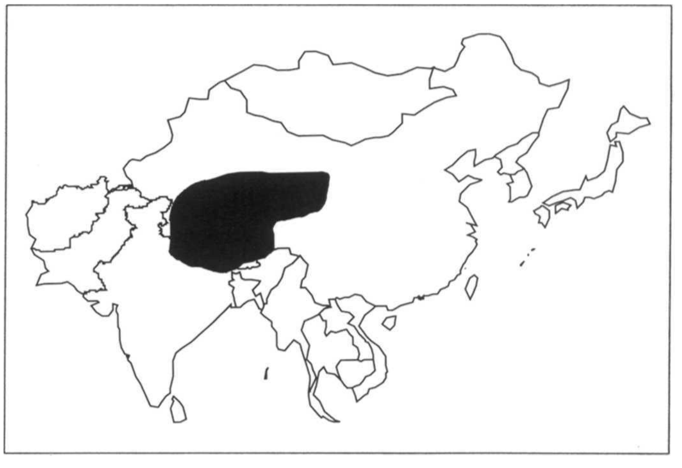


Figure 5. Distribution of Tibetan fox.

9. International Trade in CITES Listed Canids

Introduction

For centuries, canids have been treated both as pests and as products. As pests, they are blamed for destroying poultry, livestock and valuable wildlife (Chapter 11), and infecting man and his animals with disease (Chapter 12). As products, canids are killed and their flesh and fur used for a variety of purposes (Table 1). Of the 34 species of wild canid, at least 20 are killed by man for their fur.

The international trade in canid fur can be divided into two categories: furs which are farmed and furs which are derived from trapping or shooting wild canids. Both methods of acquiring pelts for market are hotly debated. On the one hand, many people oppose what they understand of the conditions in which farmed animals are bred; on the other hand, many oppose the methods of capture used in the killing of wild animals (Nilsson 1980). Yet, as long as a market for these pelts exists, canids will be killed for their pelts. Although we recognize the need for a scientific discussion of the advantages and disadvantages of the various methods of fur production, this topic lies outside the confines of this discussion.

Our focus in this chapter will be an examination of the effect of the international fur trade on the conservation of wild canids. We begin with a brief evaluation of the extent of fur farming and its potential effects on wild canids. This is followed by a discussion of the extent of trapping of wild furs in North America, the continent for which the best data are available.

The bulk of this chapter is devoted to an examination of data generated by reports collected under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The history, structure, and implementation of CITES are discussed in detail by Brautigam (1989). Those countries which are Parties to CITES are required to provide information on the importation and exportation of CITES listed species (Article VIII, paragraph 7). A brief description of the Convention is presented below.

Table 1. Use of canids in trade (data from various sources)

Use	Species
None known	Small eared zorro, Sechuran zorro, bush dog, island grey fox, pale fox, Bengal fox, corsac fox, Tibetan fox, golden jackal, simien jackal, African wild dog, hoary zorro
Hunted for trade	Red fox, arctic fox, coyote, grey wolf, racoon dog, grey fox, black-backed jackal, culpeo, grey zorro, Azara's zorro, Blanford's fox, dhole, red wolf (formerly), swift or kit fox
Killed for control	Red fox, arctic fox, coyote, grey wolf, grey fox, black-backed jackal, culpeo, grey zorro, Azara's zorro
Hunted by indigenous peoples	Bat-eared fox, cape fox, fennec, culpeo, grey zorro, grey wolf
Hunted, pelt valueless	Maned wolf, crab eating zorro

Fur Farming and Conservation

The trade in canid fur is both national and international; countries in every continent are both producers and consumers of canid-derived fur products. Much of this trade involves the farming of once wild species—the arctic fox and the raccoon dog are intensively farmed in many countries (Table 2). In fact, the majority of canid furs used in commerce come from farmed animals. Finland is the main exporting producer of farmed foxes. Poland is also a producer, and the product is an important item in the country's economy. East Asian countries (such as South Korea) have dabbled, but the figures speak for themselves. Of the total blue fox figure of 3.3 million (1988/1989), 2.6 million were produced in Scandinavia and 500,000 in Poland.

Although the practice of fur farming is intensely debated (Hochswender 1989), fur farming in and of itself poses little direct threat to wild canids. The indirect effects of fur farming on wild furbearer populations are ambiguous. On the one hand, the availability of cheaply produced, fanned furs of high quality should reduce the price (and hence trapping pressures) of wild-living conspecifics; on the other hand, increases in fur farming might prime the pump of public demand. This may have two separate effects. In some cases, the production of farmed fur may be insufficient to meet demand, thus putting pressure on wild populations. A second result may be that wild-caught pelts may increase in value just because they are different from their more common farmed brethren. One of the more bizarre manifestations of recent movements which stress "natural" living is that wild-caught furs have increased appeal (Bräutigam pers. comm.).

Patterns of trapping for two North American canids illustrate these points. In the 1920s, arctic fox skins accounted for 37% of the trade in wild-caught foxes. By the 1980s, the arctic fox accounted for only a tiny proportion of foxes trapped in North America (3%). This change in relative levels of fox trapping also is reflected in the absolute numbers of arctic fox trapped. Arctic fox harvests have declined from their 1930s peak of 69,000 pelts per year to 22,000 in the early 1980s. This decline is correlated with a large increase in fanning of the arctic fox (Obbard et al. 1987). It would appear that fur farming has, to a great extent, replaced the trapping of arctic foxes.

A completely contradictory pattern can be seen if we examine the data on trapping and farming of red fox. In the 1930s, approximately 240,000 red fox pelts were harvested annually; by the 1980s, the red fox "bag" had increased to well over 500,000 animals per annum (Obbard et al. 1987). While the advent of widespread fur fanning appears to have reduced demand for wild arctic fox, the wild red fox has not been so lucky.

Finally, with an increasing demand for fur products in general (Obbard et al. 1987), it can only be a matter of time before people become bored with the common and create a demand for the rare: people may prefer the exotic, or merely that harvested in the wild. The forces that generate markets for fur, wild-caught or farmed, are as complex as the human mind. Fashion is truly unpredictable. Although the cost of rare furs may initially be prohibitive for all but a wealthy few, it is just these wealthy few who set the fashions and generate the demand for "luxury" goods. An oft-quoted example of such an effect is the increased demand for leopard skins in the early 1960s which occurred after the American president's wife, Mrs. Kennedy, was seen wearing a leopard coat. Perhaps this is a spurious correlation, but given the power individuals can wield over fashion, one suspects it is not.

Table 2. Trade in farmed and wild canid fur (data from the International Fur Trade Federation)

Species	Origin	Production
Arctic fox (ranched "blue")	Scandinavia (especially Finland), United States, Canada, Soviet Union, Poland, Belgium, West Germany, Netherlands, Iceland, United Kingdom	3,300,000* (1988/89)
Arctic fox (wild "white")	—	18,456 (1987/88)
Red fox (mainly wild "red")	Worldwide	1,543,995 (1985/86)
Red fox (ranched "silver")	Finland, Soviet Union, United States, Canada, Japan, Poland, West Germany, Netherlands	700,000* (1988/89)
Grey fox (wild)	Canada, United States	450,000 (1985/86)
Raccoon dog (ranched)	Finland	80,000 (1986/87)
Raccoon dog (wild)	Japan	3,000 (1986/87)

*Excludes internal consumption in Soviet Union

Trapping and Conservation

Wild canids are trapped and killed, and in places trapped and killed heavily, for their pelts. Many of the species killed for their fur are in no danger of extinction. The red fox, grey fox, coyote, and arctic fox are all widespread and abundant. Although total figures of trapping "bags" are not published, some idea of the extent of trapping can be seen by examining the data in Table 3. In all of North America, just under 1.5 million wild canids were killed for their pelts in the 1982/1983 trapping season. These rates of harvest appear not to threaten wild populations (papers in Novak et al. 1987). The great majority of these pelts were harvested from species that are common throughout their ranges (foxes, coyotes). In fact, despite these levels of harvesting, the coyote has shown a range expansion in the last decade.

The grey wolf, although common in Canada, Alaska, and the Soviet Union is threatened or endangered elsewhere in the world. This species accounts for less than one half of one percent of the wild canid pelts harvested in North America, both in absolute numbers and in terms of income gained from sales of the pelts. There is little doubt that harvests of grey wolves in Canada, the Soviet Union, and Alaska pose little threat to those populations; the effects of a legal trade on other less stable populations, however, are not well understood.

CITES Trade in Canids

When the international trade in animal products threatens a species' survival, or the survival of a geographical population of a species, the species is listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). CITES provides a mechanism for either regulating, or in the case of those species threatened with extinction, prohibiting international trade. The three Appendicies to the treaty, also known as species lists, are amended periodically by the signatory Parties in response to changes in the conservation status of a species or of one of its populations. The level of protection afforded to a species is a function of the Appendix on which it is listed. Specifically, the treaty provides for the following species to be included in each of the three Appendicies:

Appendix I. All species threatened with extinction which are or may be affected by trade. Trade authorized only in exceptional circumstances.

Table 3. Trade and value of trade in wild-caught canids in North America, 1982-1983.

Species	Average pelt price (1983 U.S.$)	North American Production 1982/83	Value of Production (% Total)
Red fox	$42.50	534,430	$22,713,275 (45%)
Arctic fox	$23.20	15,707	$364,402 (0.7%)
Grey fox	$34.46	315,456	$10,870,614 (22%)
Coyote	$26.06	612,446	$15,960,343 (32%)
Grey wolf	$50.59	4,133	$209,088 (0.4%)
Total		1,482,172	$50,117,722

Data from Shieff and Baker 1987. Prices have risen since 1983, e.g. a grey wolf skin now has a value of $100-$300 in Canada (Mech pers. comm.)

Appendix II. (a) All species which may become threatened with extinction unless strict regulation is enforced; (b) other species which must be subject to regulation so that trade in endangered or potentially endangered species can be brought under control.

Appendix III. All species which any Party to CITES identifies as being subject to regulation within its jurisdiction for the purpose of preventing or restricting exploitation, and as needing the cooperation of other Parties in the control of trade.

There are strict guidelines established to govern the addition or deletion of a species from one of the appendicies, or the transfer of a species between appendicies. These rules, known as the Berne criteria, are discussed in full in BrSutigam (1989). An example of the rules is the requirements for inclusion in Appendix I: a species must be threatened with extinction; the species should be threatened, or potentially threatened, by international trade; and there must be evidence to prove these facts.

Trade in an Appendix I or II CITES listed species may only occur if a Party's Scientific Authority finds that trade will not be detrimental to the survival of the species in question. If such a "non-detrimental" finding is made, a Party's Management Authority may authorize trade. Such a "non-detrimental" finding should provide a measure of scientific rigour to CITES classifications and operation. Unfortunately, due to a variety of factors, the "non-detrimental" finding requirement is not applied as rigourously as it should be (Brautigam, pers. comm.).

Many species which are threatened, but are not traded, are not listed in CITES. CITES, as its name states, deals only with trade and not with other causes of extinction, although factors such as habitat loss, ecology, and reproductive biology are, of course, taken into account when trying to determine the levels of trade a species can sustain. Furthermore, not all species listed on Appendix II are threatened by trade; CITES may include on its appendicies common species that the Parties deem to be traded at a sufficient level to warrant monitoring and a degree of regulation (Brautigam 1989).

Although CITES does provide a mechanism by which extremely rare, but not immediately threatened, species may be included in Appendix I (Resolution Conf. 2.19), many species which are threatened are not, and probably should not be included in the species lists. Only three threatened canid species fall into this category: the African wild dog; the Simien jackal; and the island grey fox.

In theory, all CITES trade should be reported by both exporting and importing countries; hence, when exports and imports are compared, the totals in these categories should match. They rarely do. Several problems exist, the most basic being that CITES statistics make it virtually impossible to give definitive assessments as to the level of trade in any given species from any given country (Brautigam pers. comm.). These difficulties are discussed in Broad et al. (1987) and include, but are not limited to, the following:

1. Not all countries are Party to CITES.
2. The accuracy and frequency of Annual Reports, and the effectiveness of implementation of CITES, varies from country to country.
3. Products exported in one year may arrive in the importing country in the next year.
4. Commodities are identified differently by importing and exporting countries (e.g. kg of skins vs. pelt or plate numbers).
5. CITES deals only with the effect of *international* trade in threatened species. Data on *domestic* trade of endangered or threatened species do not need to be provided by those nations which are Party to CITES.
6. Illegal trade is not reported through CITES.

The data we present cover all available CITES information from 1980 to 1986. These data are derived from the Annual Reports of Parties to the Convention and were supplied by the World Conservation Monitoring Centre. Our analyses complement a review recently released by Broad et al. (1988) of significant trade in the culpeo and the grey zorro from 1980-1985. Our analyses of the data, however, differ in one significant way from that of Broad et al. 1988. If skins have been transformed into saleable products before export, the number of skins used is not reported. Categories such as "garments," "plates" (a panel of skins sewn together), or "kilos of skins scraps" may represent two or two hundred skins. Broad et al. 1988 chose to exclude these items except in "exceptional circumstances." Their estimates are therefore minimum estimates.

Table 4. Conversion factors for CITES-listed trade other than unworked skins.

Species	Body Weight (kg)	Item	Conversion Factor
Blanford's fox	1	Plate	25
Blanford's fox	1	Garments	10
Grey zorro	5	Garments	8
Grey zorro	5	Kg garments	1.25 kg/skin
Grey zorro	5	Plate	10
Culpeo	8	Garments	5
Culpeo	8	Kg garments	2 kg /skin
Culpeo	8	Plate	8
Grey wolf	50	Garments	2
Grey wolf	50	Kg scraps	12.5 kg/skin
Grey wolf	50	Plate	2

In all species studied, the great majority of pelts appear to be traded as skins. Yet, to be conservative in our analyses, our figures include many categories of worked products. The conversions we used to estimate the number of skins in a garment, plate or kilo of "scraps" are listed in Table 4. Our figures are based on the size of the animal in question. Although arbitrary, they are a rough attempt to account for the trade in worked products.

When citing figures on exports, where known, we have listed the country of origin. In some cases, the country of origin may not be listed in the CITES summary data; such errors are most apparent when a country reports exports of a species that is not found within its borders.

CITES Trade in Grey Wolves

In terms of monitoring trade, wolves pose a particularly difficult problem. While common in some countries, even abundant to the point of being a pest, wolves are becoming extinct in most parts of the world (see Chapter 6). Because each sub-population appears to face a separate threat, those wolf populations in danger of extinction are placed on Appendix I. Those which are not in danger of immediate extinction, including those which are growing and healthy, are placed on Appendix II so that trade can be monitored and regulated if need be.

In any particular year, exports and imports of wolf skins are rather unequal; however, there is no statistically significant difference in the numbers of skins reported for export and import in the years studied (paired student's t-test, $P<0.30$). Net trade in wolf skins has hovered around 6,000-7,000 skins per annum since 1981. In 1983 to 1985, exports (and to a lesser extent imports) appeared to show a sharp increase. This increase, however, does not appear to have been sustained. Further data from 1987 and 1988 may clarify this pattern.

Various wolf products appear to be exported. All parts of the body, ranging from feet to teeth, claws to flesh, are exported for one purpose or another. The great majority of wolf exports, however, are skins exported in an unfinished form (Figure 1).

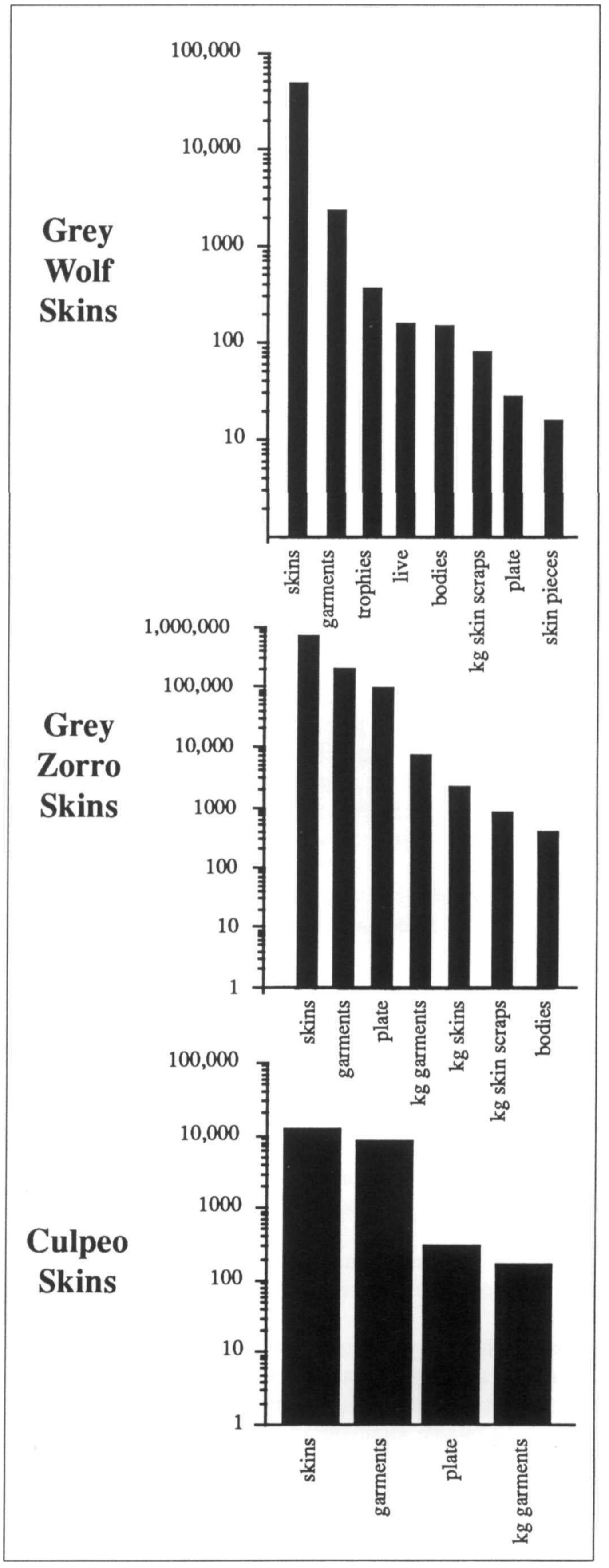


Figure 1. Types of canid specimens reported to CITES, 1980-1986.

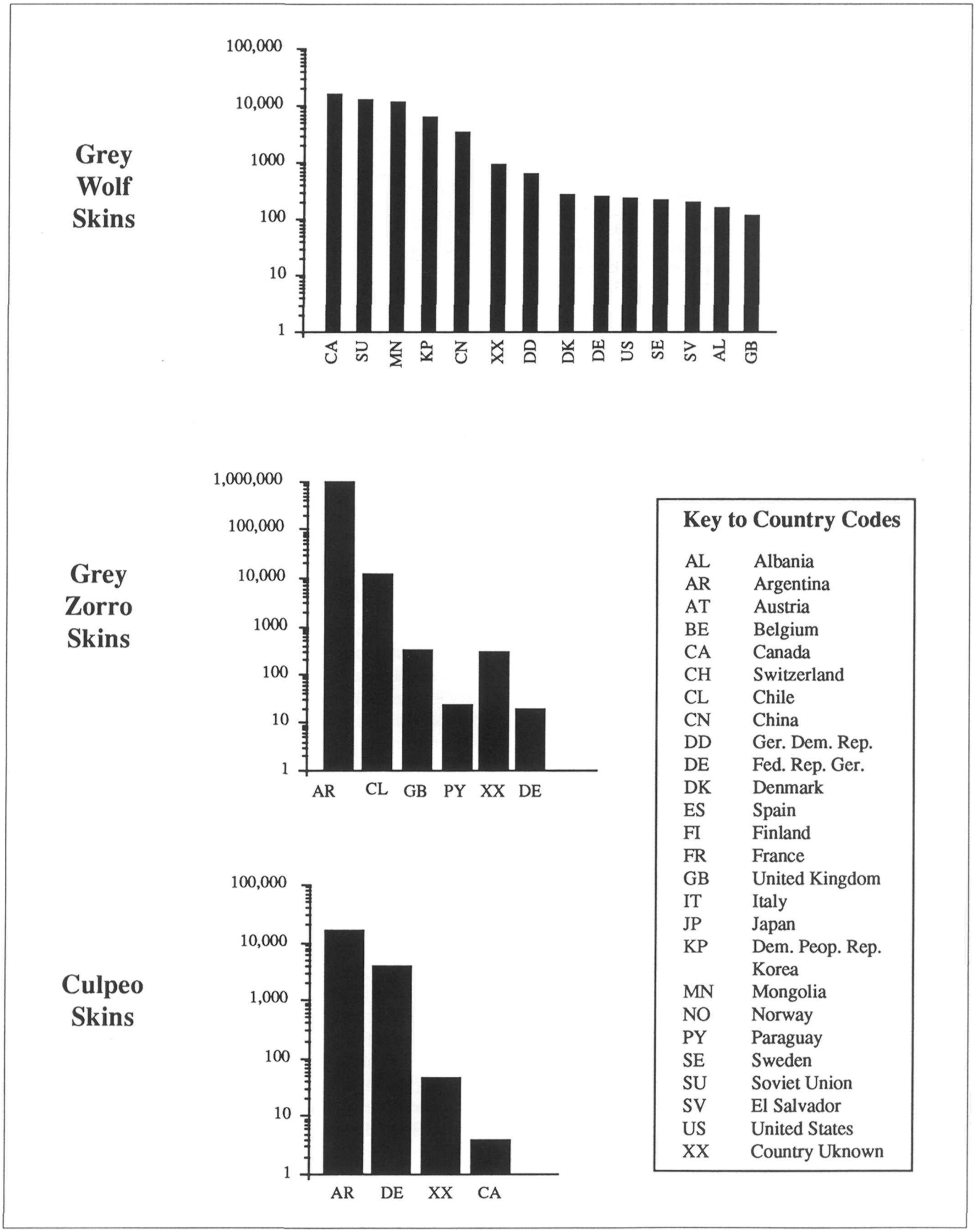


Figure 2. CITES trade in canid skins by exporting country for three dominant species, 1980-1986 (includes some transhipments).

Most of these come from countries or regions which support relatively healthy wolf populations (Figure 2): Canada, the Soviet Union, Mongolia, China, and the United States. The export of skins from Korea and Albania may present problems as the status of wolf populations in these countries is unknown. These may represent re-export of skins originating in the Soviet Union (Bräutigam, pers comm.). Several countries which have recorded significant exports of wolf skins under Appendix II (Fig. 2) have no native wolf populations, or a population insufficient to produce the exports. These countries are: Sweden, Great Britain, El Salvador, the Federal Republic of Germany, German Democratic Republic, and Denmark. We must assume that these exports are the result of trans-shipment or re-export. Since 1984, all trade within the EEC is considered "internal," hence exports from Denmark or the Federal Republic of Germany, for instance, are almost definitely transhipments or re-exports which were imported through another EEC country.

Wolf skins are imported by a variety of countries. However, most of the skins find their way to the United States and Great Britain (Fig. 3). Nine other countries imported more than 1,000 wolf skins in the period 1980-1986, while a further three countries recorded imports of more than 100 skins in that period.

At present levels, the trade in wolf skins is sustainable if all the wolf skins traded originated in those countries with healthy wolf populations. However, with many thousands of wolf skins traded annually, trade may present a hazard to a great majority of wolf populations. Most wolf populations number in the hundreds, and many support less than one hundred individuals. Fortunately, we have no evidence that wolf skins from these populations are entering the market place.

CITES Trade in Grey Zorros

There is a large international trade in the grey zorro (Fig. 2). Broad et al. (1988) believe that the species can support this level of trade. To support the contention that the species can withstand considerable harvest, Broad et al. (1988) cite population densities from southern Chile of 1.3 to 2.5 individuals per km^2 (Duran et al. 1985). These estimates are suspect (Jaksic pers. comm.). Various methodological errors were made in collecting data for this survey. For example, samples were made with spotlights on roads, then extrapolated to roadless areas. The species is known to concentrate along roads to scavenge for road kills (Jaksic pers. comm.). The study, funded by a Magallanes hunters association, resulted in the ban on hunting of *D. griseus* being lifted and licenses being issued to hunt. Hunting became uneconomical (due to scarcity) after a very small proportion of estimated populations were removed, suggesting an overestimate of standing densities (Jaksic pers. comm.).

Examining the CITES data through 1985, trade in grey zorros appeared to be declining (Fig. 4). However, trade levels increased again in 1986 with imports reported exceeding 1983 levels. Although this variation in trade, in and of itself, says little about the status of the grey zorro, the rapid fluctuations in trade levels require explanation. One explanation may be that a decline in demand reduced demand in 1984-1985. Two factors suggest this did not occur. The first is that trade in other species of wild fox-like animals increased in this period (Obbard et al. 1987); in the United States, the fur trade has shown remarkable growth in the late 1980s (Hochswender 1989). A second, purely speculative explanation is that over-harvesting in the early 1980s led to a precipitous population decline and, therefore, to smaller harvests. If this were the case, the increased harvest in 1986 would indicate either some population recovery or more effective methods of harvest.

The levels of trade in grey zorro are the highest for any CITES-listed canid. Most of these exports go to the Federal Republic of Germany (Fig. 3) and are exported from Argentina (Fig. 2) as unworked skins and garments (Fig. 1). A small proportion of the trade originates in Chile, despite hunting being illegal there.

CITES TVade in Culpeo

The international trade in the culpeo is small when compared to that of the closely related grey zorro. Annual exports peaked in the early 1980s at 1,000 skins and have declined to a consistent export of only a few hundred skins (Fig. 4). Despite a wide-ranging distribution, from Ecuador to Patagonia, in the seven years covered in this study, the vast majority of the exports recorded originated in Argentina (Fig. 2). The second largest reported exporter of culpeo skins is the Federal Republic of Germany, a country in which the culpeo does not occur. We must assume that these reports represent re-exports of skins originating in South America. That the Federal Republic of Germany is also the largest importer of culpeo skins (Fig. 3) suggests that this is a reasonable assumption.

CITES Trade in Other Species

Seven other species of canids are listed under CITES. Two species, the red wolf and the bush dog, are listed on Appendix I. The dhole, Blanford's fox, the maned wolf, Azara's zorro, and the fennec are listed on Appendix II. Azara's zorro was added to Appendix II in 1987, hence no data are yet available on trade in this species.

During the period surveyed, no trade was recorded for the red wolf, a fact which is not surprising given that under 100 animals are known to exist.

From 1980 to 1986, total trade in the bush dog was 14 animals. The trade in the bush dog is limited to live specimens, presumably brought to zoos to establish populations for captive breeding. Captive breeding programmes should be encouraged, although earlier efforts have been largely unsuccessful (see Chapter 10). Trade in Blanford's fox varies widely from year to year (Fig. 5). In fact, no trade was recorded for 1983, 1985, or 1986, despite relatively high levels of trade in 1984 (estimated at 519 skins). The great majority of skins were exported from Canada, a country well outside the range of the Blanford's fox. In fact, the only country which exported skins and may contain a population of Blanford's fox is Afghani-

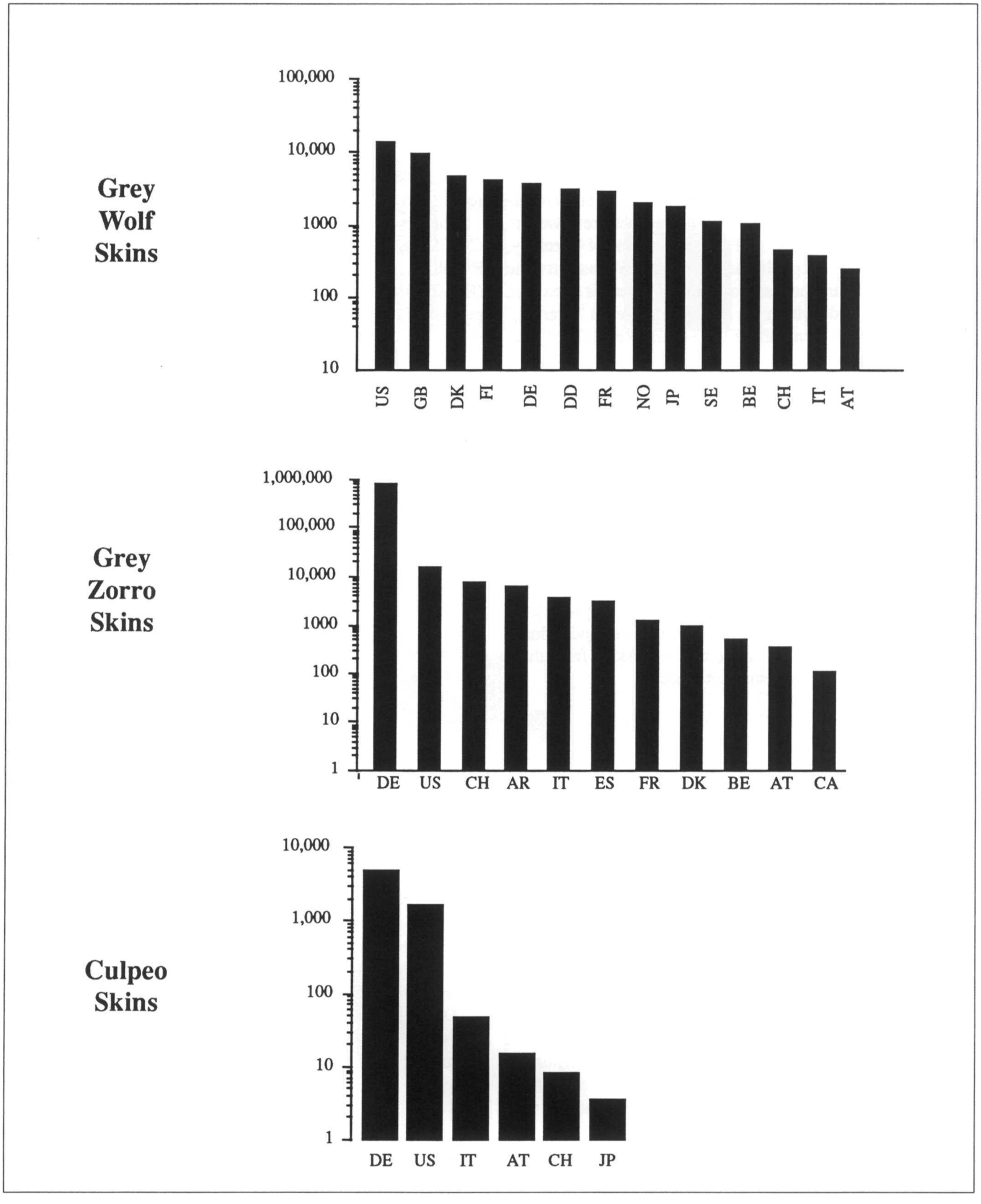


Figure 3. CITES trade in canid skins by importing country for three dominant species, 1980-1986.

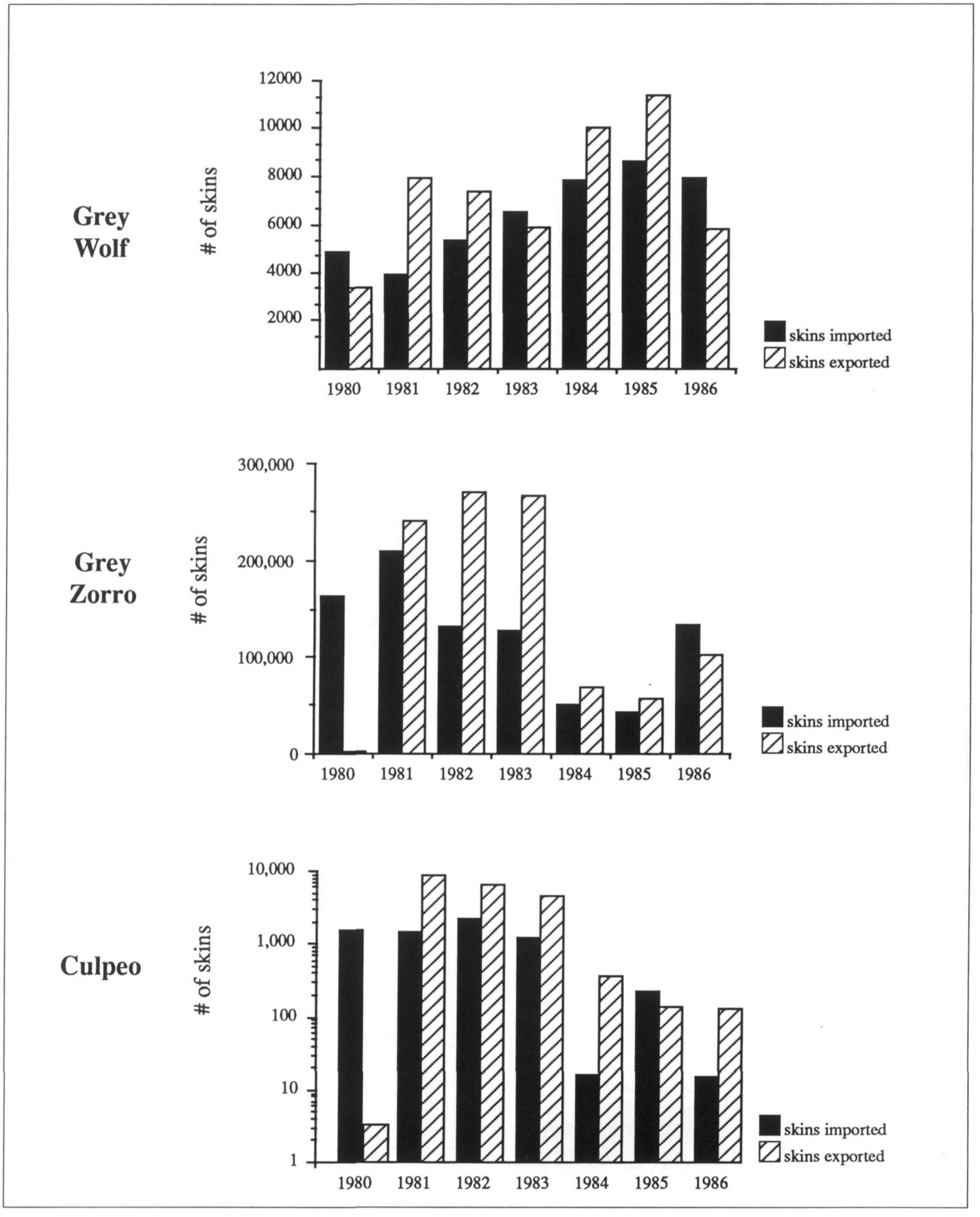


Figure 4. Annual trade in canid skins recorded by CITES for three dominant species, 1980-1986.

stan—14 skins were exported in two shipments of seven, one in 1980, one in 1982.

In 1983, 1,153 fennec skins were exported from the United States to the Federal Republic of Germany. The source of these skins is unknown, but certainly was not the United States, a country lacking fennecs. Other than this one record, trade in the fennec is limited to live specimens traded, we assume, for zoo specimens. In the seven years surveyed, approximately half of the 40 specimens traded were bred in captivity.

Argentina, a country halfway around the world from the nearest wild dhole, exported 86 dhole skin "garments" to the Federal Republic of Germany in 1983. This transaction dominates the trade in dholes. Other than this single transaction, the trade in dholes is limited to imports and exports of live specimens. Approximately 30 animals have been recorded crossing international borders, 6 of which were captive bred specimens.

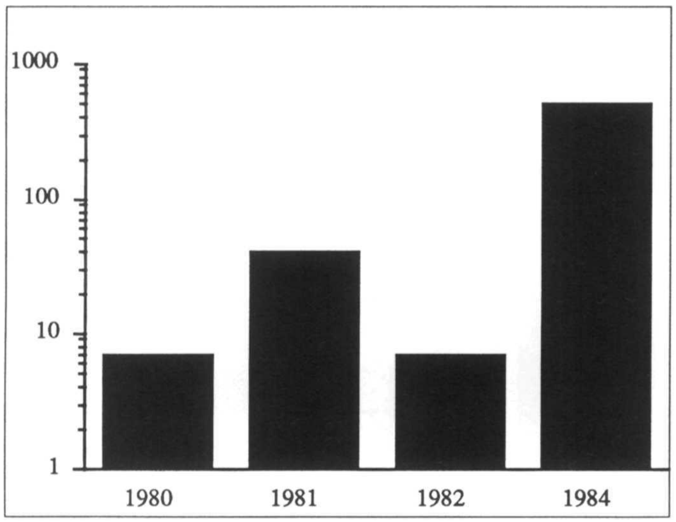


Figure S. CITES trade in Blanford's fox, 1980-1986.

Recent efforts to breed mancd wolves in captivity account for the entire trade in these animals. The level of trade is somewhat difficult to determine with any accuracy—53 animals were reported as "imports," but only 17 animals were recorded as "exports." Nonetheless, even using the import figures as a maximum estimate, the trade in these animals appears to be small and limited to live specimens.

CITES Listed Trade—Plans for Action

Data reported to CITES may be imperfect, but they are generally the best data we have on the international trade in a wide variety of wildlife taxa. Unlike most customs data, CITES reports usually list trade by species. If reasonable scientific data exist that trade may endanger a plant or animal species, there is a strong argument in favour of placing that animal on one of the CITES Appendices. The data collected by CITES also allow for review and reconsideration of these listings.

The role of CITES, however, is not to offer protection to all species, but only those affected or potentially affected by trade. As Mrosovsky (1988) clearly argues, placing a species in a CITES Appendix should not be a symbolic gesture for conservation, but a considered act. Equally so, when data collected by CITES suggests that trade is no longera threat, de-listing should be considered if the integrity of CITES is to be maintained. A balance must be struck so that those species requiring protection are listed on an Appendix, while those not requiring protection are removed from a list. Of course, removal must only be made when it can be shown that trade in a species does not pose even a potential conservation problem.

Given the information summarized above, we believe the following actions should be taken.

Red wolf

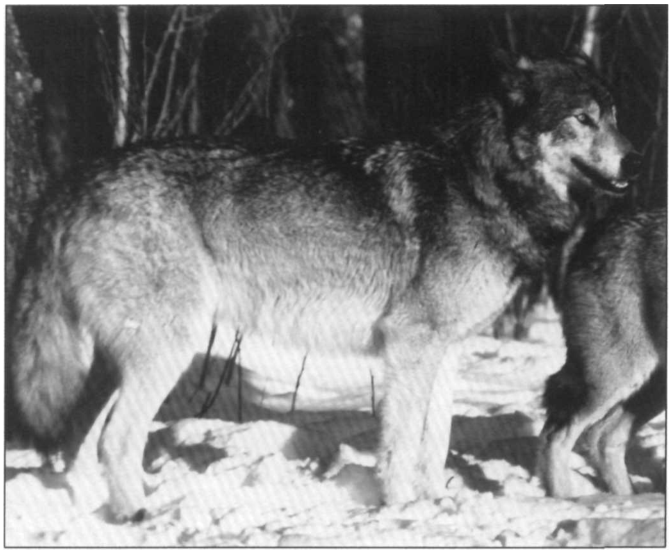
Despite being pulled back from the edge of extinction, the red wolf remains the rarest and most endangered of the world's canid species. So few animals exist that trade is all but impossible in this species. Nonetheless, given that any trade could push it to extinction, we believe that the red wolf should remain on Appendix I for the foreseeable future.

Bush dog

The CITES data reviewed offer little evidence that there is significant trade in the bush dog or that trade is a threat to this animal's survival. Despite our total ignorance of population levels of the bush dog (see Chapter 5), present levels of trade in no way endanger the bush dog. As no commercial use was recorded for the bush dog, its status should be reviewed with a view towards removing the species from CITES. The IUCN/SSC Canid Specialist Group, in conjunction with range states, hopes to implement such a review and prepare a draft proposal and supporting statement to be submitted to the CITES Secretariat.

Grey wolf

Trade in wolf skins suffers from a two-tiered system with the potential for trade in both legal and illegal skins. At the moment, few skins appear to be traded from countries with endangered wolf populations. However, given the ease with which skins can be trans-shipped, a further increase in the demand for wolf skins could lead to rapid extinction of remnant populations throughout the world. Although we do not recommend a



Grey wolf *(Canis lupus).* (Photo by F. Harrington)

change in the present classification of wolves, we do caution that the situation must be monitored. Wolves are harvested for fur in the northern countries where their populations are intact (i.e. Canada, the Soviet Union, and Alaska), not in areas where populations are precarious (e.g. Israel). Any increase in trade should, therefore, increase the take in the main harvesting countries. It is deliberate persecution, habitat destruction, lack of prey, and misunderstanding that are more likely to endanger wolves elsewhere.

Grey zorro

In their review of the trade in the grey zorro Broad et al. (1988) concluded that, having analyzed CITES data for 1980-1985, trade in this species, originating in Argentina, can be supported on a sustainable basis "at a considerable level." The implication of their conclusions is that present levels of trade are sustainable. For several reasons, we question this conclusion.

Data collected on population densities are suspect; certainly the future of this species should not be based on estimates that some experts consider inaccurate. The lack of data on the status and distribution of the grey zorro, combined with the large number of skins traded annually, is disturbing. Perhaps trade can be sustained at 100,000 pelts per year. Perhaps the population can only support 10,000 or 1,000 pelts per year. We cannot tell. If trade at the present level is a threat to populations it could force the grey zorro to extinction rapidly. Given these uncertainties, and until needed surveys are completed, we suggest that trade be limited to an annual offtake of 10,000 pelts harvested in Argentina, the only country in which hunting of the zorro is legal. Extensive population surveys must be conducted in both Chile and Argentina. These surveys should be conducted by independent bodies not likely to profit from the trade in zorro skins. Quotas should be set only after independent surveys and population estimates are made.

Culpeo

Broad et al. (1988) concluded that present levels of trade do not endanger the culpeo: we concur. The concentration of trade in Argentina may, perhaps, present problems for local populations of the culpeo if trade levels were to increase sharply. As with the grey zorro, we know little about the distribution and abundance of the culpeo in Argentina. However, population estimates of 60,000 individuals in Santa Cruz province, 200,000 for Patagonia, and 30,000 for Chubut province (F.A.C.I.F. 1987), can certainly support the present level of trade. Independent surveys of culpeo, however, should be made so that levels of harvesting can be set at scientifically established levels.

Dhole (*Cuon alpinus*). (Photo by A.J.T. Johnsingh)

Blanford's fox, Fennec, and Dhole

The status of trade in these three species follows a similar pattern. Virtually no trade was recorded with the exception of a single record for each of the three species. In each case, this transaction involved pelts which were exported by countries outside the species' range. A review of the species concerned should be initiated to determine the origin the pelts in these "exceptional" trades. Until the records are examined, monitoring of these species should continue. If, and only if, these few transactions can be explained, and if no further international market for these species can be found, we recommend that the Blanford's fox, fennec fox, and dhole be removed from Appendix II.

Maned wolf

No evidence exists that the maned wolf is endangered by international trade. Our correspondents suggest that the species is hunted, but the fur is not highly valued for commercial purposes and the pelt is unuseable. We have no doubt the species is vulnerable. But there is no evidence that the species in endangered by international trade. The status of the maned wolf should be reviewed with a view towards removing the species from CITES. The IUCN/SSC Canid Specialist Group, in conjunction with range states, hopes to implement such a review and prepare a draft proposal and supporting statement to be submitted to the CITES Secretariat

10. Captive Breeding and Reintroduction

Introduction

Mammals have been bred in captivity since humans first domesticated wild animals approximately 10,000 years ago. Since this time, with few exceptions, most of the effort put into breeding mammals in captivity has been directed at the breeding of domestic mammals (cows, sheep, goats, and pigs) for food, wool, and leather. Yet, to this day, breeding of species which have not been previously domesticated continues.

There are several reasons to breed those species which, for most purposes, are still wild. One aim of such "captive" breeding is meat production (Skinner 1989) or the production of fur; another is to provide specimens for viewing in zoos or game parks without having to capture animals in the wild and further deplete natural populations. Captive populations of wild animals can also serve as latter-day arks.

A commonly stated aim of many captive breeding programmes conducted in zoological parks is to produce founder populations for release into the wild in reintroduction programmes (Anderson 1986; Seal 1986). In the following discussion, we acknowledge that wild animals are often bred in captivity for reasons other than releasing them back into the wild. However, our discussion will focus on the potential of captive breeding as a tool in the conservation of canids, in particular, how the breeding of canids in zoos might be managed with this aim as a priority. We briefly discuss the problems of reintroduction programmes; a rigorous discussion of the various difficulties encountered in reintroduction is badly needed, but cannot be accommodated in this report.

The use of captive animals as founders of reintroduced populations has a long history. Zoos (the New York Zoological Society and the American bison), private ranches (Kenyan ranches and the black rhino), and even cloisters (Pere David's deer) can serve as arks. When extinction in the wild is imminent captive breeding offers a last option to save a species. However, captive breeding, as a conservation strategy, is a temporary measure. Even with intensive efforts to preserve genetic variation in a captive population (through the use of genetic screening and studbooks), the inevitable small size of captive populations will make it extremely difficult to preserve sufficient genetic variation such that evolution can occur (Lande 1988).

What constitutes a sufficiently large population for captive breeding depends on many factors, including global weather patterns, genetics, disease, governmental stability and commitment to conservation, and pure chance (references in Soulé 1987a; Lande 1988). We do not discuss these at length, but note that contrary to popular belief, factors other than genetics (e.g. political and economic considerations, habitat destruction, climatic change) may be the critical variables that will determine the fate of an endangered species in the next century.

Captive breeding with the aim of reintroduction is only plausible when the force driving extinction can be reversed. In principle, almost any such force is potentially reversible with biological knowledge, political will, and money. In practice, there are likely to be major difficulties. Nonetheless, potentially reversible threats of extinction include: epidemic disease threatening a sole surviving population, conversion of savanna habitat for agricultural use, extinction driven by active hunting or pest control programmes, or interbreeding with feral domestic dogs. Doubtless there are, in practice, many irreversible causes of extinction such as destruction of fragile and irreplaceable habitat where no suitable refuge exists (e.g. lowland rainforest). If habitat loss is the immediate agent of extinction, and the conservation of suitable habitat is impossible, bringing a species in from the wild may merely delay an inevitable extinction. This is not to say that such an effort is entirely worthless; times change, our understanding of ecology improves, and what appears to be an hopeless case today may not be so tomorrow. As Michael Soulé has said, "(t)here are no hopeless cases, only people without hope and expensive cases" (Soulé 1987b).

Goals and Source of Data

The following analyses aim to tackle three questions specifically with regards to canids:

1. Which species are being bred in captivity?
2. How successful are existing breeding programmes?
3. What accounts for variation in the success of captive breeding of different canid species?

The analyses are based on data extracted from captive breeding records in the International Zoo Yearbooks (IZY). We have included data from the years 1962 to 1984 inclusive, although for certain analyses some years may be excluded. Of course, not all captive breeding of canids is recorded in the IZY. For a species like the arctic fox, the great majority of captive breeding is accomplished on fur farms. The results of captive breeding for economic exploitation of a species have been known for over a century and were first elucidated by Charles Darwin (1859). The goal on a fur farm is to produce standardized, unmarked pelts. Particular traits (colour, size, fecundity) may be selected by the breeder, even if these traits are rare or non-existent in wild populations. In short, while those breeding canids in captivity for conservation aim to maximize genetic variation, the aims of fur breeders will, most probably, minimize variation. While acknowledging that fur breeders may make important contributions to improving breeding technology for rare and endangered species, the success or failure of fur breeders is essentially irrelevant to the following discussion.

The IZY data themselves are, of course, not perfect. Breeding reported in the IZY is listed by zoological collection, not by litter. In most circumstances, for a particular species, only one litter is bred in any particular zoological collection in any particular year. However, if several litters are bred in a single zoo in a single year, the data reported are the summed data of these litters. To simplify language, we refer to each report in the IZY as a "litter," recognizing that in a small number of cases the data are for several litters.

A second problem with IZY data is that, inevitably, there has been variation in reporting standards over the last two decades, both between and within zoos. These variations may distort the results we report and the conclusions we draw from them. Nonetheless, the IZY data do provide a foundation on which to build future research. Recognizing the problems with the IZY data, a similar analysis is planned for data using the ISIS (International Species Information System) database.

In our discussion we combine the information summarized in the Species Status Reports (Chapters 4-8) with the captive breeding data to devise criteria on which species might be judged as suitable for breeding in captivity. On the strength of these criteria, we make policy recommendations for future breeding projects.

Species Bred in Captivity

In the last 26 years, 32 of the 34 canid species have been bred in captivity. The two species for which there are no records of breeding in captivity are the Simien jackal and the Tibetan fox. Of the remaining 32 species bred in captivity, many have produced only a small number of litters (Fig. 1). Of the 32 species, 19 have been bred, on average, in fewer than four collections per year. The remaining 13 species account for the great majority of all captive breeding of canid species. Nearly 80% of all captive breeding can be attributed to the six species most commonly bred in captivity. In decreasing order of frequency, these species are: the grey wolf, the red fox, the raccoon dog, the golden jackal, the arctic fox, and the African wild dog (Fig. 2).

In the last two decades (1965 to 1984), a total number of approximately 4,000 canid litters has been reported in the IZY. There appears to have been a consistent effort to breed canids in captivity, with approximately 180-200 litters being reported world-wide from zoos each year (Fig. 2). Over the last two decades, one might expect that an increased interest in conservation would have led to an increased relative effort in breeding rare species. However, given that only one of the most commonly bred species is endangered (the African wild dog), this does not appear to be the case.

Success, Failure, and Breeding Canids

Someone, somewhere, has at one time or another, attempted to breed nearly every species of canid. However, that people have attempted to breed a species in captivity does not mean that all attempts have been equally successful. The question arises: how do you measure success? One could look at the number of surviving offspring, the size of litters bred in captivity versus those observed in the wild, or at some measure of how well pups survive in captivity.

In our analyses, we have equated breeding success with the percent of pups that survive in a litter. More precisely, we assume that when there is high mortality the attempts to breed a species should be considered less successful than when there is low mortality. We have used this measure for two reasons:

1. Intuitively, poor survival of pups indicates that captive breeding cannot be sustained over a long period of time.
2. The measure has been used in other studies to measure the success of captive breeding efforts (see Rails et al. 1986, 1988).

To get an idea of what the average levels of mortality are in captively bred canids, we can lump all the data into one analysis. As can be seen in Figure 3, since the late 1960s, approximately 40% of the pups in each litter have died. This pattern is remarkably consistent What might seem odd is that the earliest reports show much lower levels of mortality. In the first years of the IZY, reported mortality was extremely low, ranging from 0% (1962,1963) to well under 30% (1965-1968).

Several explanations may account for this result. First of all, in earlier years, zoos may have bred only those species that survived well in captivity. Although this may seem a logical explanation, the data we discussed earlier in the chapter suggest it is not the correct explanation: zoos have bred essentially the same mix of species for the last two decades. A second, and more likely explanation is that there was greater inconsistency in reporting during the first few years in which records were collected. To minimize the effect of potential variations in reporting, we have excluded data from the earlier years (1962-1968) from the following analyses.

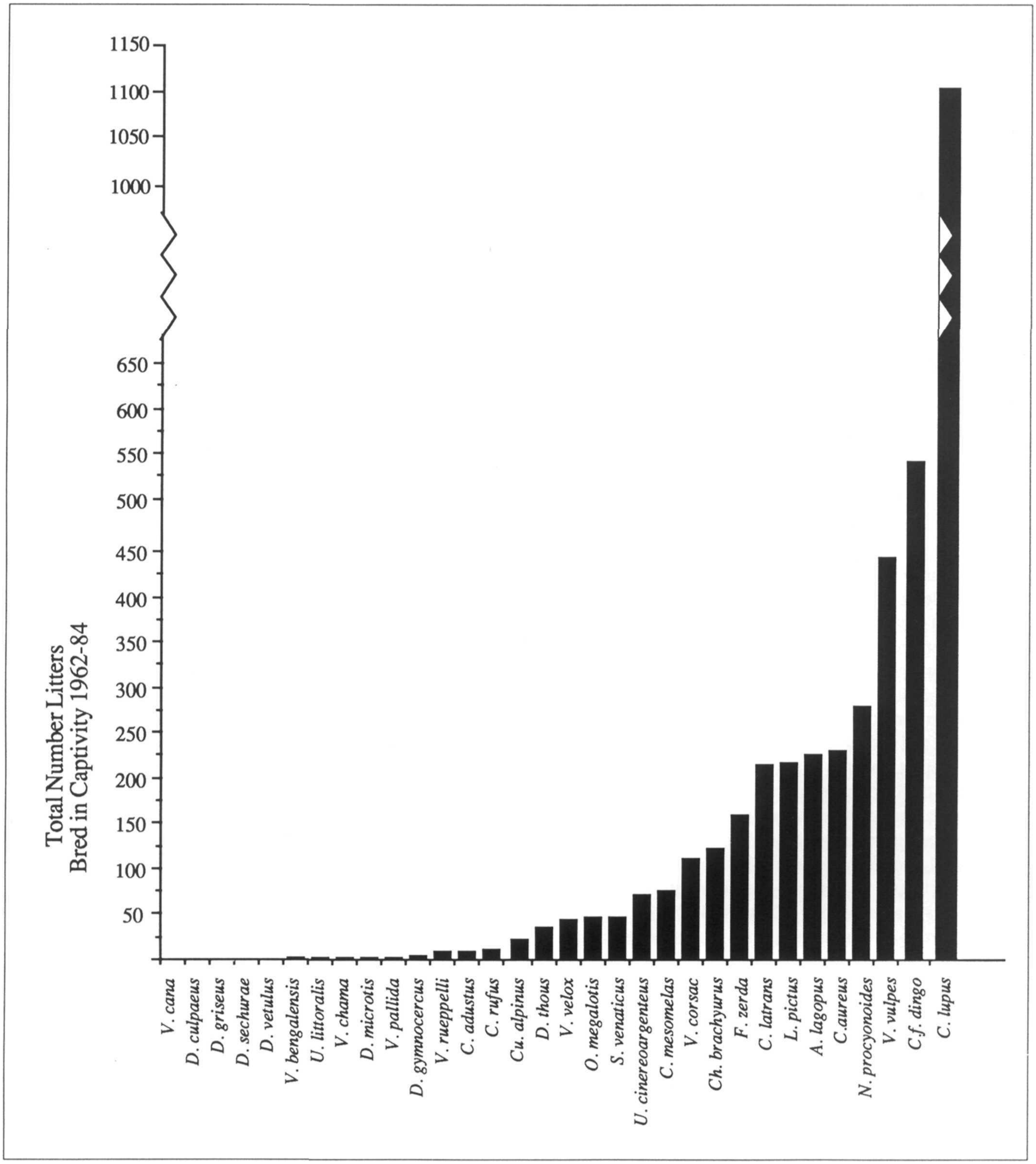


Figure 1. Number of litters bred in captivity for 32 canid species.

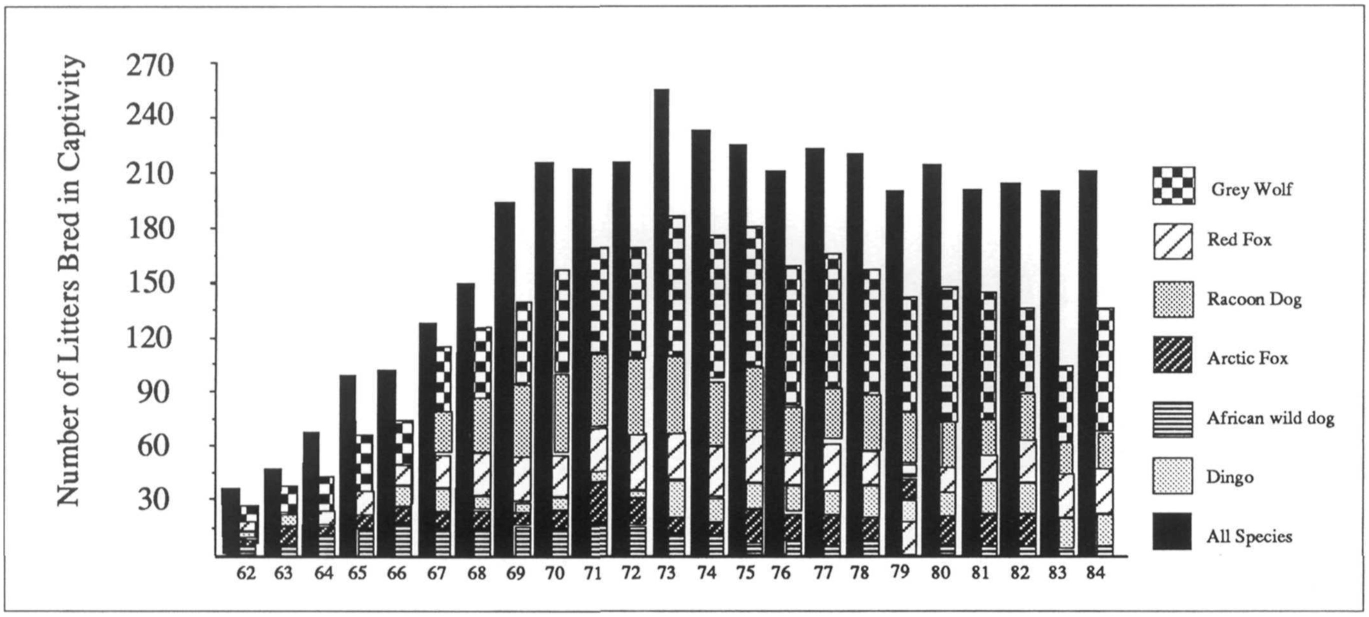


Figure 2. Canid litters bred in captivity, 1962 to 1984. All species compared to those most commonly bred.

Mean mortality across all species and across all years is approximately 41%. The level of mortality does not differ significantly from year to year[1]. There is, however, great variation in the average mortality for different species (Fig. 4). Species specific mortality ranges from a low of approximately 25% (swift fox, arctic fox) to a high of nearly 70% (bat-eared fox)[2].

What accounts for this variation in the litter mortality of captive bred canids? It appears that one important factor is the number of litters bred in captivity (Fig. 5). Practice in captive breeding, while not making things perfect, does seem to reduce mortality greatly. Pup mortality is lower for those species most often bred in captivity.[3]

Studying Figure 5, however, several further conclusions can be drawn. Several species do not fit this model; in statistical terms they are "outliers." One species, the swift fox, breeds well in captivity, despite few litters being reported. Perhaps, in this case, the great experience gained in breeding other closely related fox species (corsac fox, red fox) has made breeding the swift fox less difficult. Two species, the African wild dog and the fennec, continue to show high mortality despite having been bred in captivity relatively frequently. If these three "outlier" species are removed from the analysis, there is almost a linear decline in mortality with a logarithmic increase in the number of litters bred.[4]

The word "logarithmic" may not be familiar to all readers. The $\log_{10}$ scale allows us to compare data where there is a great range of values, in this case from 40 to 1200. Each number is translated into a power of 10. For example, $10=10^1$, $100=10^2$, $1000=10^3$. So, on the log scale, 10=1, 100=2, 1000=3. A number between 10 and 100 would have a log value of between 1 and 2. Thirty-three, for instance, is equal to $10^{1.52}$, or on the log scale, 1.52.

The use of the log scale may be convenient, both statistically and for viewing data. However, in biological and management terms, what the log scale indicates is that great increases in breeding effort are required to effect a small reduction in mortality. If 20 litters have been bred in captivity, to reduce litter mortality to any great extent we must breed not 20 more litters, but 200 more.

Many of the species most often bred in captivity are abundant in the wild (Fig. 1: red fox, arctic fox, raccoon dog, coyote) or have been abundant until very recently (grey wolf). The status of many species which are rarely bred in captivity is either Vulnerable/Endangered or Insufficiently Known (e.g Simien jackal, island grey fox, Bengal fox, Sechuran zorro). If species are grouped by their conservation status in the wild (see Species Summaries, Chapters 4-8), it is clear that those species most in danger of extinction tend to breed most poorly in captivity (Fig. 6)[5]. Species which are common in the wild have been bred most often in captivity. Hence, common species have much lower pup mortality when bred in captivity than do those which are classified as Vulnerable, Endangered, or Insufficiently Known.

[1]Effect of year on mortality ($p. > 0.15$, 1 way ANOVA).

[2]Effect of species on mortality ($p. < 0.0001$, 1 way ANOVA).

[3]Regression of mean mortality per litter, by species, as a function of log l0 of litters reported in the IZY. For 18 species species with greater than 40 litters bred in captivity, $r^2 = 0.25$, $p. < 0.05$.

[4]Regression of mean mortality per litter, by species, as a function of $\log_{10}$ of litters reported in the IZY. Excluding three outlying species, for remaining 15 species $r^2 = 0.86$, $p. < 0.001$.

[5]The grey wolf was, until recently, common throughout much of its range. It is still common in Canada and the Soviet Union. However, given that many sub-populations are endangered, the species as a whole is classified as Vulnerable. We have excluded the wolf from this analysis because of its rapidly changing status. It is the one vulnerable or endangered species that breeds well in captivity, the exception that proves the rule.

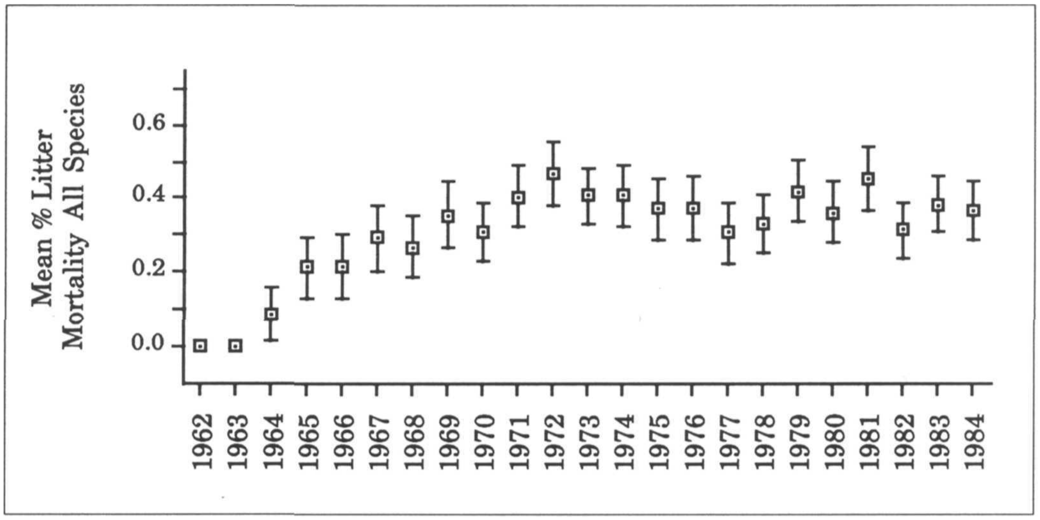


Figure 3. Mean mortality of canid pups in captively bred litters.

Conclusions and Discussion

Clearly, if captive breeding of endangered species followed by reintroduction into the wild is to be a viable conservation option, we must be able to breed endangered species in captivity. The data we have presented range from hopeful to alarming. To be optimistic, most canids have, at one time or another, been bred in captivity. The apparent importance of experience in husbandry is encouraging insofar as a species that initially was difficult to breed, such as the maned wolf, can be bred successfully.

That the number of canid litters bred in captivity annually has remained more or less constant over the last 20 years is probably nothing more than an indication that the space, time, and money for captive breeding have remained limited. That the grand mean of litter mortality for all species has not changed significantly probably reflects the fact that we have continued to breed various canid species at approximately the same ratios (Fig. 2). In fact, an initial increase in overall mean mortality would be expected if zoos were to shift their emphasis to breeding "difficult" species, those which have not been bred extensively.

Our ability to breed successfully in captivity some species of canids is encouraging. However, accumulated experience in breeding canids does not translate into an ability to breed any particular canid. The data indicate that experience must be garnered on a species by species, or perhaps genus by genus basis. There may be some exceptions; the data on the breeding success of the swift fox suggest that it may be easier to breed species with con-generic relatives which have frequently been bred in captivity. Perhaps for some rare species such as the island grey fox or the red wolf this will make captive breeding less difficult. However for many rare, vulnerable, or endangered canids there are no closely related species. The case of the bush dog is a good example. Despite great efforts at several of the world's best zoos, populations are neither self-sustaining nor are sufficient numbers of individuals kept in captivity to form a viable population (Kleiman and Rodden pers. comm.).

From the point of view of conservation, there appears to be insufficient emphasis on breeding thosecanid species which are most likely to require an ark in the near future. To change this state of affairs will be difficult. The worst problem is one of circularity: there are few specimens of the rarer species in zoos; therefore they breed less frequently and with greater litter mortality; zoo populations never become self-sustaining; hence we do not get experience at breeding these species. And so on *ad infinitum.*

We cannot afford to wait to solve this problem. Unfortunately, if we wait until a species becomes highly endangered to begin captive breeding programmes, the data suggest that such programmes may be doomed to failure. In captive breeding, practice, and lots of practice, makes perfect: mortality declines with the *log* of breeding effort.

Plans for captive breeding and implementation of these plans must begin before a species reaches an extinction crisis (as outlined in the IUCN Position Statement on Captive Breeding, adopted in 1987). To some extent, greater coordination of breeding programmes may improve the suite of affairs: if each zoo attempts to breed a single species of rare or endangered canid, and zoos breeding the same species coordinate efforts, improvement in breeding success may, perhaps, be accelerated. The establishment of studbooks for a variety of canids (*Lycaon, Speothos,Chrysocyon*), the development of AAZPA/SSP plans, and the U.S. Fish and Wildlife Service recovery plans for maned wolf, red wolf, Mexican wolf, Indian wolf, bush dog, and African wild dog all indicate that such coordination is already well underway (U.S. Seal pers. comm).

Where possible, captive breeding should be attempted in the country in which a species is found, and preferably in the region in which reintroduction will take place. The ecological imperative for such a suggestion is strong: the potential for exposure to unfamiliar diseases will be reduced; semi-natural enclosures can be constructed at a lower cost and native foods can be given to the animals; reintroduction will, most probably, be simpler. Furthermore, costs associated with such projects should be lower.

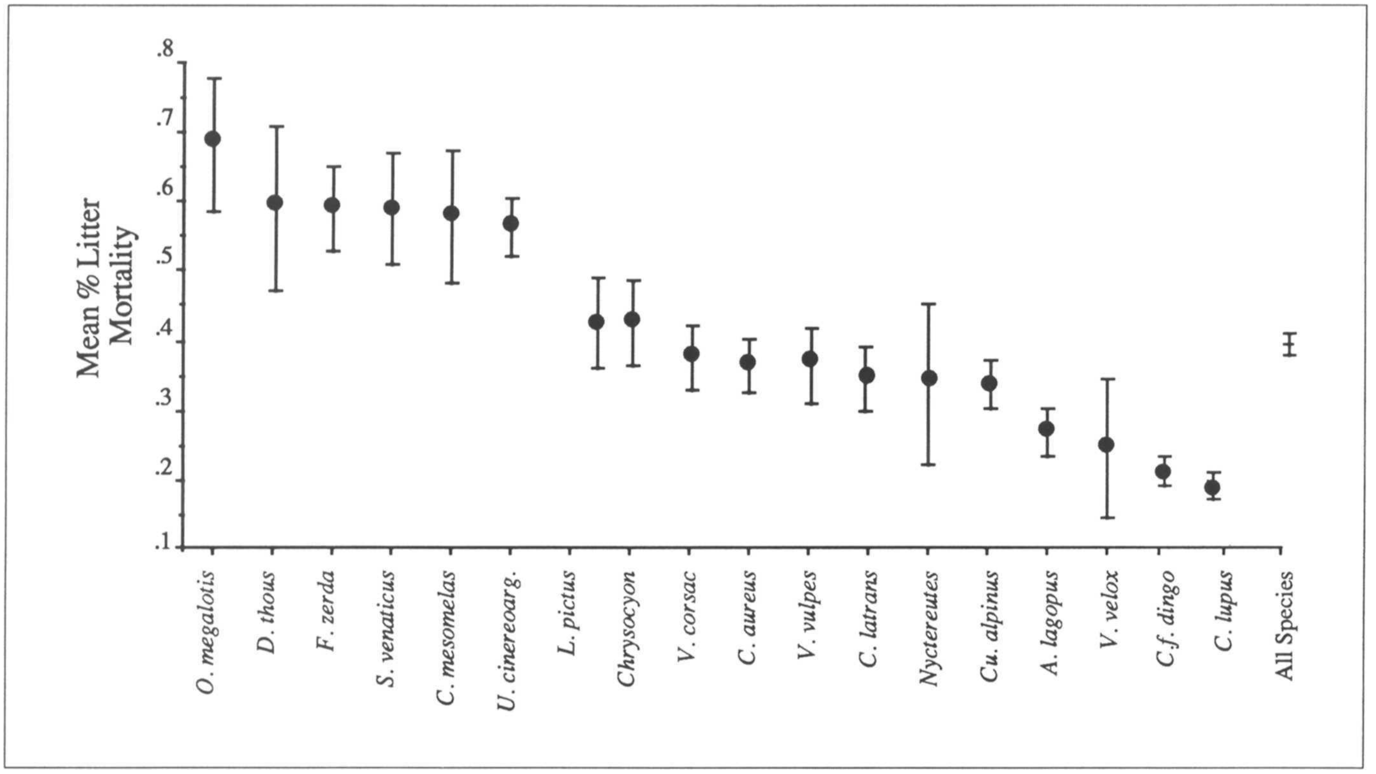


Figure 4. Mean litter mortality in all years, by species. Mean ± 2 s.e.m.

Of course, arguments can be made against such a strategy: it will limit the ability to use advanced technology (genetic screening, super-ovulation, embryo transplants, hormonal monitoring, etc.); a local epidemic could wipe out the wild and captive population; if poaching is a problem, protection may be, perhaps, more difficult. On balance, however, the potential problems can be mitigated: samples can be analyzed in laboratories away from areas in which breeding occurs and captive individuals can be isolated from wild individuals geographically or with physical barriers.

Of course, there is no single approach that will be the best approach for all species. *Ex situ* and *in situ* approaches provide different advantages and can be mutually supporting. If funds are plentiful, and there are relatively large populations still in the wild, captive breeding programmes for the vulnerable and endangered species should be started both locally and in zoological parks that have extensive experience with such programmes.

Species Recommendations

In Table 1, we list species according to their conservation status and captive breeding history. We have tried to group species that we feel present similar problems and need similar attention. Species for which we feel there is not enough information to make definite statements about their present population size, but which are not officially listed by the IUCN as "Insufficiently Known" have been included in the table. Those species that are abundant in the wild and have been shown to breed well in captivity are not included in the table.

Simien jackal

The Simien jackal is the second most endangered canid. As an endemic, population sizes have always been small but they may be declining. The present population is well under a thousand, and probably no more than 500-600. Yet no record exists of the species having bred in captivity. We recommend strongly that a captive breeding programme begin as soon as possible. The potential for reintroduction of Simien jackals to areas where they have historically occurred should be pursued so that a second and distinct wild population can be established.

Island grey fox

The island grey fox should not be difficult to breed in captivity considering its close relationship to the North American grey fox, *U. cinereoargenteus.* The population, at present, appears stable, but is inherently fragile due to its small size. We recommend that trial captive breeding be conducted to ascertain if information gathered in breeding the grey fox will enable breeding of the island grey fox to proceed easily if it were to become necessary. A captive breeding programme is being considered by the Los Angeles Zoo (Garcelon pers comm.).

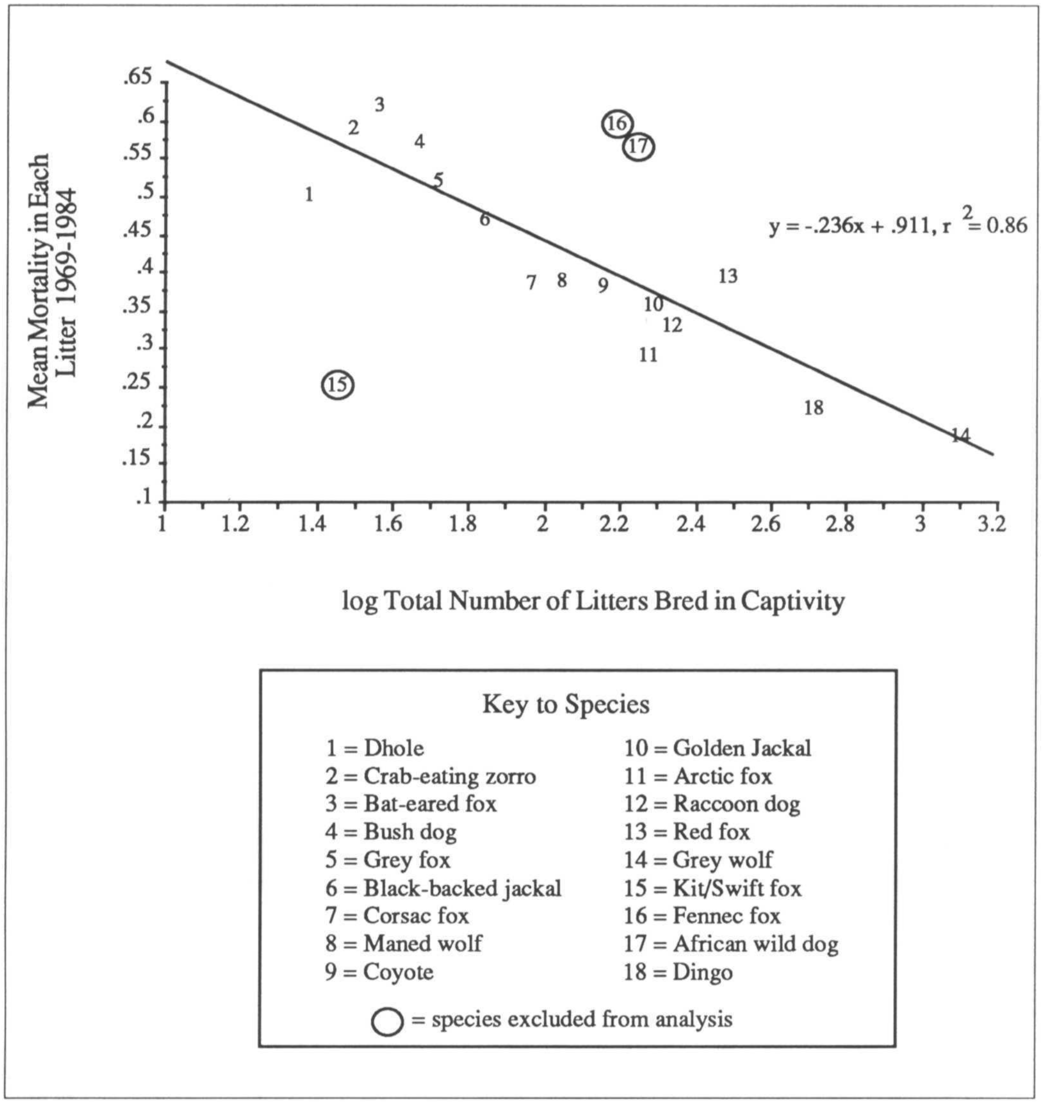


Figure 5. Mortality of pups bred in captivity declines with massive increases in the number of litters bred in captivity.

Red wolf

By 1980, the red wolf was believed to be extinct in the wild (USFWS 1984). Without a doubt, this makes the red wolf the most endangered canid. The eventual demise of wild populations was recognized early enough to allow a captive breeding population to be established at the Point Defiance Zoological Gardens in Tacoma, Washington, United States. In 1977, starting with a founder population of 14 red wolves believed to be genetically pure, a breeding programme was begun: by 1988, there were 80 red wolves in captivity at 8 locations in the United States. A reintroduction programme has begun in the 477 km^2 Alligator River National Wildlife Refuge in North Carolina and appears to be successful (all information from Phillips and Parker 1988). More reintroduction sites are needed: the U.S. Fish and Wildlife Service recovery plan specifies the need for 8 to 10 additional sites, with a total population of 200 free-ranging animals (M.K. Phillips pers. comm.). We support these goals and emphasize that without further reintroduction efforts, success cannot be assured.

African wild dog

The African wild dog, despite intensive efforts at breeding, appears to suffer from high mortality in captive breeding. A likely cause of failure is, perhaps, insufficient attention to the species' complex social structure. In the wild, first-year mortality is approximately 35%, just over half that reported in captive breeding. As persecution by humans and disease, rather than habitat destruction, are probably the major causes of population decline, reintroduction of African wild dogs should be possible (but see Childes 1988). We suggest that efforts to breed the species be supported where they already exist and that further attempts to reintroduce wild dogs be investigated. As a large number of individuals are already in captivity, perhaps lab/zoo research could be initiated to determine the cause of high reproductive failure. The South and East African populations appear to be genetically distinct; zoo populations appear to be predominantly of South African origin (R. Wayne pers. comm.). Hence, genetic screening, and the establishment of studbooks which incorporate this information will be necessary

Table 1. Summary of success in captive breeding of species of conservation concern

Species	Status	Breeding
Simien jackal	Endangered	No record of breeding in captivity
Island grey fox	Endangered	Low effort, grey fox has moderate mortality
Red wolf	Endangered	Low effort, but actively being bred in captivity
African wild dog	Vulnerable	High effort, high mortality
Bush dog	Vulnerable	Low/moderate effort, high mortality
Dhole	Vulnerable	Low/moderate effort, moderate mortality
Maned wolf	Vulnerable	Effort increasing with effect
Fennec fox	Not listed	High effort, high mortality
Small-eared zorro	Insufficiently known	Low effort, insufficient
Sechuran zorro	Not listed	data available on
Hoary zorro	Not listed	breeding success
Bengal fox	Insufficiently known	" "
Pale fox	Not listed	" "
Blanford's fox	Not listed	" "

to ensure that reintroductions using zoo-bred specimens do not mix gene pools.

A studbook for the U.S.A. is being compiled by B. Brewer, Brookfield Zoo (Brewer pers. comm.).

Bush dog

Little is known about the biology of the bush dog, and captive breeding has been fairly unsuccessful. We suggest that both a captive breeding project and a field study be pursued. However, until the ecology and the distribution of the bush dog are better known, the potential for reintroduction, or even the need, remain in doubt.

Dhole

The dhole appears to breed somewhat better in captivity than would be expected. The dhole enjoys a wide distribution despite its low numbers. Uncertainty remains about its status in many parts of its range (Soviet Union, China, Sumatra, Burma). Before embarking on further captive breeding efforts, we would recommend that information be collected from local authorities in these countries.

Maned wolf

A captive breeding programme aimed at improving captive breeding and increasing the potential stock for reintroduction is already underway. We would only suggest that given the recent decline in litter mortality, a programme of in-country breeding and reintroduction be pursued in Brazil and/or Argentina.

Fennec fox

Like the African wild dog, the fennec fox suffers from a high litter mortality when bred in captivity, despite a large number of litters having been bred in captivity. As the fennec does not appear to be in any immediate danger of extinction, captive breeding of the fennec is not a high priority.

Corsac fox

Little is known about the behaviour and ecology of the corsac fox. However, it is commonly bred in captivity, suffers low litter mortality, and should population levels prove to be low, captive breeding would not pose any problems.

Zorros and Other Fox Species

These nine species share little in common, other than that we know little about their biology and none of them is commonly bred in captivity. We would strongly encourage local governments and research institutions to conduct surveys of the distribution and abundance of these species. Where economically possible, captive breeding and captive populations might provide at least basic biological information which, at present, does not exist

A Final Note on Reintroduction

Carnivores, particularly large carnivores that range over huge areas and live at low densities, are especially vulnerable to extinction. Activeefforts to remove predators from agricultural areas may often hasten the demise of a species (red wolf, African wild dog, grey wolf). Nonetheless, many carnivores breed well in captivity and, given the generally flexible nature of many canid societies (Macdonald 1983), reintroduction may well prove easier in many canid species that it has been for other taxa.

Several reintroduction programmes, while still in their initial stages, appear to be successful. The swift fox has been recently reintroduced to Canada. Populations are growing and captive-bred animals appear to be adjusting to living in the wild

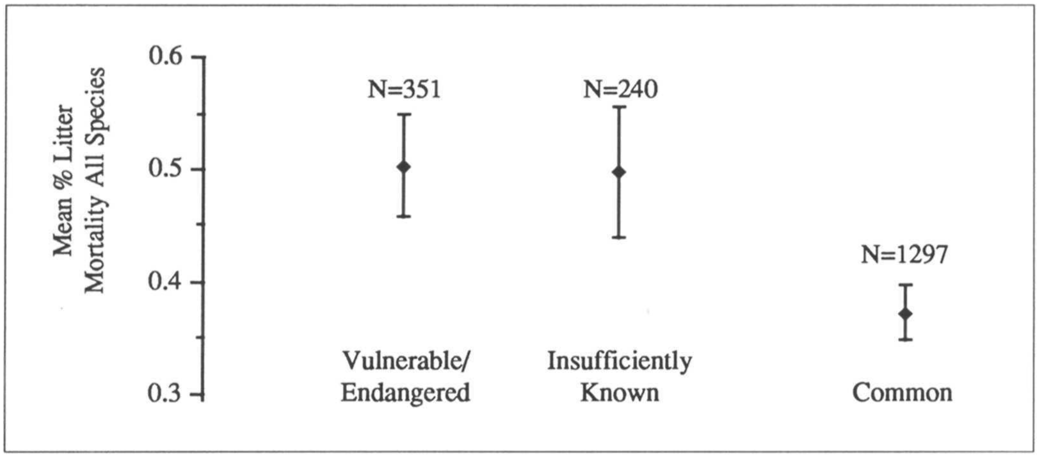


Figure 6. Those species most in danger of extinction breed least well in captivity.

(see Chapter 6, swift fox, *Current Research*). The red wolf reintroduction programme also appears to be a success (see above). However, due to the potential conflict of wolves and humans, the project was nearly abandoned (Phillips and Parker 1988; Wilcove 1987). Not until an isolated reserve was found could reintroduction begin.

The conflict between canids and people makes any reintroduction difficult. Every time a reintroduction of grey wolves has been suggested, controversy has erupted (Wilcove 1987). Even in areas where wolves occur naturally, but are near extinction, efforts to preserve remnant populations meet strong resistance (e.g. Italy, Boitani pers. comm.). Similar problems are voiced concerning the African wild dog. In Zimbabwe, where fewer than 500 wild dogs remain, the mere suggestion of further protection of the wild dog, or reintroduction and captive breeding, evokes a furious response from local ranchers—ironically, one of the most vociferous lobbies against reintroduction of the wild dog in Zimbabwe is game ranchers (Townsend 1988).

As a last resort, captive breeding and reintroduction are useful tools for species conservation. If local and regional objections to reintroduction can be overcome, the success of such projects appears to be good. Captive breeding, in addition to providing a temporary safe haven from persecution or disease can also allow isolation of wild canids from genetic dilution by cross breeding with coyotes (e.g. the red wolf, Phillips and Parker 1988). However, we do not believe a species should or can be preserved in zoos *ad infinitum* as the living equivalent of a stuffed dodo or thylacine. The aim of captive breeding, when pursued for conservation purposes, should be to provide a temporary safe haven for a species. For this purpose, zoos have, and should continue to serve as arks, not museums.

11. Predation and Predator Control

Introduction

The Carnivora, as the name implies, are generally predatory, and to a greater or lesser extent, all canids live by killing prey. This fact raises three related questions in the context of conserving and managing wild canids. First, to what extent are the populations of canids limited by their prey, and to what extent do they limit the numbers of their prey? Second, and with respect to valuable prey, is the impact of predation by canids disadvantageous to people? Third, where predation by canids throws them into conflict with people, how might such conflict best be resolved?

Problems are likely to arise with predation on three categories of prey: domestic stock, wild game, and endangered species. Clearly the delineation of these three categories is indistinct; for example, the management of incubator and pen-reared game birds such as pheasants has more in common with the domestic stock than it does with wild game such as woodcock or snipe.

Nearly every species of wild canid, from the abundant and successful coyote (Andelt 1987) to the endemic and highly endangered Simien jackal (Sillero-Zubiri and Gottelli pers. comm.) has been implicated in livestock damage. Of the 34 species discussed in the previous chapters, 21 have been reported to kill livestock or poultry at least occasionally. However, only a handful of canids are sufficiently numerous and find themselves in circumstances under which their predation is economically significant (e.g. wolves, coyotes, some foxes). Even for these, it is often a moot point as to whether they regulate the populations of their prey.

When a farmer sees a dead lamb being eaten by a jackal, or a deer stalker sees a pack of wolves gathered at the carcass of a moose, they commonly feel a wrath born of competition: both farmer and hunter had wanted the prey for themselves (albeit for different purposes). But underlying such anger is the assumption, rather than the proof, of competition. If the lamb or deer had, for example, been eaten as carrion, then it would already have been valueless. Equally, if the predators had singled out sickly individuals that were destined to perish then the measure of competition with people would be greatly devalued.

Predation does not necessarily affect long term measures of prey numbers. This paradox arises because, in prey populations which are limited by food, killing prey does not necessarily mean there are fewer of them, except in a very short-term sense! If some prey animals are destined to die from starvation, and a predator's feasting is confined to the proportion destined to die, then it acts merely as executioner. Only if predation eats into the breeding stock that could have been supported by the food supply (or some other limiting factor) could predation be said to be limiting a natural population. This point makes it vital to distinguish whether predators are taking only a "doomed surplus" or more.

Equally vital, people have to be clear whether they are competing with canids for the breeding stock or the doomed surplus. The quarry of hunters is often the doomed surplus of game, so whether or not foxes, for example, regulate the population of pheasants is displaced by the question of whether foxes eat any pheasants which the hunter might otherwise have shot: if they do, they are in direct competition with humans for pheasants.

These considerations direct attention to one salient point: evidence that predators eat a given prey is not evidence that by doing so they are a pest. To evaluate pest status much must be known of the circumstances, including both biological and economic information. Furthermore, having ascertained the magnitude of the problem, then the costs and benefits of proposed solutions also require careful assessment. Obviously, such an assessment hangs in the perspective of local economies: predation by maned wolves upon chickens may be trivial in the economics of Brazilian poultry farming, but a peasant losing his poultry flock may nonetheless be suffering a greater loss than his European counterpart losing the same number of chickens to a red fox.

Thus, in evaluating the damage done by canid through predation the following categories of information are helpful:

1. A measure of competition: this involves measuring the frequency of relevant prey deaths. So, if the concern is over live prey, then the measurement must exclude those that were eaten as carrion. Similarly, if predators take sickly individuals, the cost of their predation must be devalued by what it would have cost to nurture the ailing prey. If concern is over the breeding stock of prey, then measurement of the competition would exclude predation upon that proportion of the population doomed to die for other reasons.

2. A measure of the loss: this involves assessment of the costs of predation. Unfortunately, this may involve measuring costs in different currencies, for example, the deer stalker who is usurped by a wolf may lose both the commercial value of the carcass he might have sold, and he loses the enjoyment he anticipated in the hunt. Economic assessments must be made in appropriate contexts, particularly distinguishing the individual and the state. For example, it is relevant to know how the loss affects the micro-economic position of the individuals that bear it, and how it affects wider economics.

3. The consequences of action: if action is taken to remedy the losses due to predation, then the benefits of that action should outweigh the costs. The costs have many and varied components. One might calculate the cost of time and effort expended by hill sheep farmers in the U.K. when they hunt red foxes with hounds and terriers, and ask whether that cost either exceeds any diminution in losses resulting from their actions (or even whether it exceeds the magnitude of the losses altogether) (Macdonald 1987). However, such an estimation of costs would, to be complete, have to account for the recreational value that the hunters put on fox control. Equally, the costs of an irate farmer in Montana killing a coyote are different to those of an irate Ethiopian killing a Simien jackal for just the same misdemeanour. Logically, it should be simple to evaluate the consequences of predator control: simply compare, in a scientific manner, places where control is, or is not, conducted. If the improvement is less than the cost, then the control is a waste. Even if the cost is taken in its simplest form, such comparisons are very rarely made. A more common approach is to assume that one less predator results in a proportionate improvement in the circumstances of prey; that assumption is seriously flawed.

Here, we focus on a few of the best studied species, with a view to illustrating the nature of the problems.

Canid Predation on Livestock

One might reasonably assume that canid predation on livestock must be a common event: the fox in the chicken coop and the wolf in sheep's clothing have been enshrined in English as metaphors for negligence and cunning. But the strength of these images may belie the frequency with which the actual events occur. Amidst the flying feathers, how many chickens or turkeys are actually eaten by canids?

Every British city-dweller 'knows', whether or not he has ever seen either fox or chicken, that red foxes are the scourge of the chicken-run; the power of ideas learnt on the parental knee may not take account of the fact that free-range poultry are an economic irrelevance to the British poultry business.

In a survey by Macdonald and Doncaster (1985) of red foxes killing urban pets, many of those questioned in one district responded with details of a child's guinea pig being killed—it turned out that all these accounts referred to the same guinea pig. In the same survey missing cats were often said to have been killed by foxes, despite the fact that this is a demonstrably rare event and that cats are very often killed in road traffic accidents. Similarly, a horrendous report of a surplus kill of lambs by a red fox, vividly related by an elderly hill farmer, turned out to have been the misfortune of his father many years before. These points are not to deny the importance of predation, but merely to highlight the difficulty in quantifying it.

Only in the last few decades have data been systematically collected to assess the extent, and costs, of livestock losses to carnivores in general, and to canids in particular (Andelt 1987).

It is exceedingly difficult to answer a relatively simple question: how does one measure the magnitude of livestock losses which are caused by canids? Most field studies of canid feeding ecology are made from the perspective of the predator, not the prey. They give some indication of the proportion of livestock in an animal's diet From this, if one knows the population density of the carnivore being studied, an estimate can be made of the numbers of sheep, chickens, or cattle which might be lost to any particular species of canid. However, when measuring the impact of foxes, wolves, or jackals on livestock production, the question we need to answer is not "what percent of the diet is composed of livestock?" or even "how many sheep are eaten by canids?" but "what effect does canid predation have on total livestock production?"

To answer this question, two statistics are needed as a starting point: the number of viable domestic animals killed by the carnivore in question, and the total production of domestic animals in that region. In Table 1, we have summarized data from several studies on the impact of canid predation on livestock production.

Assessing the Extent of Canid Induced Losses

The data in Table 1 show clearly that the percentage loss of domestic livestock to canid predation is, for the most part, small. Of the 15 studies cited, mean losses in excess of 2% occur in very few cases. In some cases, such as wolves in Norway (Naess and Mysterud 1987), theextremely small losses (0.02%) reflect extremely small wolf populations (4-10 individuals). Nonetheless, even in areas where healthy canid populations persist (e.g. coyotes in the western United States), livestock losses as a percentage of total production are relatively small.

Even an estimate of 2% loss may exaggerate the losses which can be directly blamed on canids. Most of the known biases happen to inflate (but rarely deflate) estimates of canid predation on livestock. Pearson (1986 loc. cit. Andelt 1987), notes that many of the studies he reviewed in his manuscript have been conducted in areas where predation is known to be a problem. This is not surprising; there is little need, and little demand, to study the effects of predation in areas where predators are either uncommon or where predators do not disturb livestock. However, in many areas, the great majority of ranchers are rarely affected by predation by wild canids. In Minnesota, over 99% of all livestock producers were unaffected by wolves (Fritts 1982). In the western United States,

Table 1. Levels of Canid Predation on Livestock

Predator	Prey		% Crop Lost	Region	Source
Coyote	Ewes		1.0-2.5%	Western U.S.A.	USFWS 1978 loc cit. Andelt 1987
			1.9%	Western U.S.A.	Pearson 1986 loc cit. Andelt 1987
			1.4%	Alberta, Canada	Dorrance and Roy 1976
Coyote	Lambs		4-8%	Western U.S.A.	USFWS 1978 loc cit. Andelt 1987
			7.0%	Western U.S.A.	Pearson 1986 loc cit. Andelt 1987
			2.4%	Alberta, Canada	Dorrance and Roy 1976
Coyote	Beef Calves		0-0.4%	Western U.S.A.	USFWS 1978 loc cit. Andelt 1987
			0.61%	U.S.A.	Gee 1978 loc cit. Andelt 1987
Coyote	Turkeys		0.8%	Nebraska, U.S.A.	Andelt and Gipson 1979
Coyote	Goats	(Adults)	18.1%	Texas, U.S.A.	Pearson 1986 loc cit. Andelt 1987
		(Kids)	33.9%	Texas, U.S.A.	Pearson 1986 loc cit. Andelt 1987
Wolves	Beef Cattle		0.2%-3.1%	Alberta, Canada	Fritts 1982
Wolves	Sheep		0.12%	Alberta, Canada	Fritts 1982
			0.02%	Norway	Naess and Mysterud 1987
Arctic Fox	Lambs		3-4%	Iceland	Hersteinsson unpublished data

most sheep ranchers suffer no loss or only minor losses to predators (Andelt 1987).

In management terms, this suggests that the figures presented below may represent the worst case. If a study is undertaken in an area with perceived coyote problems and determines that livestock losses are approximately two percent, the average loss of livestock in all areas, those with and without perceived coyote problems, is apt to be much lower.

Of course, there is a corollary to this point: if most ranchers and farmers are unaffected by canid predation, then the few that are will suffer heavier losses. This may, in turn, result in those producers most affected taking drastic measures in an attempt to reduce loss. For example, in South Africa, one of the last surviving populations of approximately 300 African wild dogs is found in Kruger National Park. In a single year (1987), one farmer bordering the park is known to have shot 20 dogs (M.G. Mills, pers. comm.). Although livestock losses to African wild dogs in South Africa must be measured in the hundredths of a percent, the farmer bordering the park obviously found his personal losses intolerable. A second problem common to many studies is that losses reported are frequently based on reports made by ranchers. Fritts (1982) notes that this type of data collection may introduce many biases. The first such problem is verification that animals reported as being killed by canids were actually killed by canids (Macdonald and Doncaster 1985, Macdonald 1987).

In his study on wolf predation in Minnesota, Fritts extracted data from reports made to the state by ranchers seeking compensation. Many of the reports of wolf predation were completely unverified: the carcasses of 76% of the cattle, and 73% of the calves reported missing were never found, and wolf involvement in the death of these animals could not be verified. In an area of northwest Minnesota where wolves were recently protected, there was only one confirmed report of wolf predation in 5 years; only 1% of scats examined had remains of cattle suspected to have been killed by wolves (Fritts and Mech 1981).

In surveys where a large proportion of "kills" are unverified, a great majority of animals "killed" by predators may have died from other causes. The magnitude of the error introduced by unverified reporting can be seen in the results of a study on wolves and cattle in Alberta, Canada (cited by Fritts 1982). In 121 cases where the cause of death of the animal could be determined, only 19 deaths (16%) were caused by predators. The great majority of deaths (67 or 55%) were ascribed to natural causes such as pneumonia and the ingestion of poisonous plants. Although it concerns an avian predator, and not a canid, Houston and Maddox's studies (1974) of predation by carrion crows on lambs show elegantly the grave inequality between the farmer's suspicions and the biologist's data. Similarly, Hewson (1984) shows how, despite a fearful representation, red foxes in west Scotland were responsible for killing only a small percentage of lambs, which were actually dying.

Even livestock that is seen being consumed by a predator may have died of natural causes and, subsequently, been scavenged by the predator. For instance, although the South American grey zorro is believed by some to kill livestock, evidence suggests that the great majority of all livestock consumed is scavenged (Jaksic and Yanez 1983). On the other hand, it appears that crab-eating zorros in Brazil are a persistant minor nuisance through their depredations on chickens (D. Macdonald, pers. obs.).

Oddly enough, not all animals reported as dying are known to have lived. Calf losses are frequently assumed to have occurred if a cow thought to be pregnant is put out to pasture and, sometime later, is then sighted without a calf. However, when cows thought to be pregnant by ranchers were tested, 27% (40 of 150) were found to be "false" pregnancies (Fritts 1982). This overestimate of pregnancy leads to an overestimate of the number of calves in a herd; this then leads to an overestimate of losses. The wolves, in the end, are blamed.

Deaths that are verified as canid kills may not have been caused by the species of canid suspected of doing the damage In Minnesota, Fritts (1982) reported that coyotes were responsible for approximately 10% of the deaths thought to have been caused by wolves. In Leon, Spain, 47 sheep and 11 goats were "killed" by wolves in a two year period. In fact, nearly 50% of the sheep thought to have been killed by wolves were actually killed by feral dogs (Salvador and Abad 1987). In Italy, 50% to 80% of the sheep thought to have been killed by wolves were probably killed by feral domestic dogs (Boitani 1982).

Why are so many losses that appear to be due to natural causes, or other predators, blamed on a particular species such as wolves? In many cases, the blame for such mis-reporting is, in part, due to abuses of programmes developed to protect wolves. In many parts of the world, where wolves are rare or endangered, ranchers are compensated for losses due to wolves, but not for other causes of livestock mortality. Hence, kills known to have been made by coyotes, foxes, or feral domestic dogs are called wolf kills so that a rancher can collect compensation (Italy—Zimen and Boitani (1979), Macdonald and Boitani (1979); Minnesota, U.S.A.—Fritts (1982); Leon, Spain—Salvador and Abad (1987)).

The data in Table 1 also clearly show that juvenile animals are at a greater risk than adults. Calves are eaten at higher rates than cattle, lambs more frequently than sheep. This suggests that canid predation will be the greatest problem at times when livestock are bearing and raising their young. Of course, at other times of the year, canids are surviving on other types of food. Hence, if young animals can be protected, canids may well stop eating livestock, and switch to more easily acquired foods.

Clearly, the influence of wolves on domestic livestock will depend on the interactions between wolves and their wild prey. The extent of predation on livestock, for instance, may be directly related to the quality or quantity of other prey species.

An example of such a interaction has recently been elucidated by Mech et al. (1988). In the summer in Minnesota, white-tailed deer fawns constitute a large part of a wolf's diet. The vulnerability of fawns to predation appears to be a function of the previous winter: a bad winter results in more vulnerable fawns. Furthermore, there is less wolf predation on domestic livestock after a bad winter. The increased vulnerability of fawns appears to result in a decline in wolf predation on domestic livestock.

In a study of a small pack of wolves in the availability of a third type of "prey," human refuse, might also influence patterns of predation on livestock. In Spain, wolves appeared to compensate for reduced prey (roe deer) numbers by eating more garbage (Salvador and Abad 1987). If garbage had not been an easily acquired resource, perhaps wolves might have switched to domestic livestock.

Fritts (1982) notes that in Alberta, cattle are much more heavily preyed upon in closed, brushy habitats (3.3%) than in open habitats (1.3%). The increase in predation in closed habitat may be due to increased risk of predation due to limited visibility, or to wolf habitat preference: in northwest Minnesota, wolves were rarely observed in pasture areas and spent most of their time in the woods (Fritts and Mech 1981).

Canid Predation on Wildlife

It is often assumed that canid predation on wildlife reduces the amount of wildlife available for human consumption and sport. Before such an assumption can be made, data must be collected which address the following questions: 1) Is the harvest of the prey species by humans on a scale with that of canids? If, for the most part, humans are the major predator in a system, removing other causes of predation may result in only a marginal increase in human harvests. 2) If canids are removed from an ecosystem, or reduced in number, does the prey they eat become available to man or do these animals die from other natural causes? For example, canids often specialize on young animals. If removal of canids results in a greater rate of predation by other predators (e.g. bears, birds of prey) or increased natal mortality from starvation or disease, canid reduction alone is unlikely to result in greater human harvests of adult animals.

In this section, we review the available literature and attempt to answer the following questions: 1) Do canids control prey populations? 2) In those circumstances in which canids do control prey populations, will killing predators ("lethal control measures") significantly reduce the damage done by canids? 3) If killing predators does not work, are other non-lethal control measures possible?

Do Canids Regulate Prey Populations?

Assessing the impact that canid populations have on prey populations can be extremely complex. The complexity of the ecosystem (e.g. the number of prey and predator species), variations in weather patterns, and the ability of both prey and predator to emigrate and immigrate will influence a particular predator's ability to regulate the population of a particular prey.

Despite these complications, carnivores in general, and canids in particular, are often thought to regulate game animal populations. If this is the case, then removal of canids will increase the amount of game available to hunters. How often, and in what circumstances, do canids regulate prey populations? We will answer this question by looking at a few well documented case studies.

Wolves, Caribou, and Moose

Perhaps the most frequently studied canid/prey systems are those including wolves, caribou, and moose. In some studies, wolves are found to regulate prey numbers, while in others wolves are thought not to be important in these processes. What is critical to note is that two studies of a single ecosystem have come up with contradictory results.

The best such example is the relationship between wolves and the caribou of the Nelchina caribou herd in south-central Alaska. In the period 1950 to 1961, the caribou population increased dramatically. In 1961-1962, the population crashed and fluctuated at a low level until 1972. Caribou population levels were stable from 1972 to 1976, and increased thereafter (Van Ballenberghe 1985).

Caribou calf mortality during this period was correlated with winter severity, not wolf predation (Van Ballenberghe 1985). The increase in herd size preceeded wolf control measures which were instituted in the early 1950s. This suggested that wolf control measures were not responsible for the large increase in caribou numbers. This appears to be conclusive evidence that wolves do not control caribou populations.

A second study, using the same data, came to the opposite conclusion. Re-analysis of the data suggests that predation by wolves on young animals was the most consistent natural limiting factor in the dynamics of the Nelchina herd (Bergerud and Ballard 1988).

The population dynamics of the Nelchina caribou herd are obviously complex. Usually, female caribou in the Nelchina herd reduce the level of predation to which they are exposed by calving on a high plateau where wolf population densities are lower. Bergerud and Ballard (1988) note that in 1964-1966 late snowfall prevented caribou females from reaching the calving grounds. In these years, there was large calf mortality due to predation. Obviously, without wolves, there would have been no predation: but is the increased predation due to high wolf population density or random weather patterns? Would a large majority of the calves have died as they were born in late snow outside the usual calving grounds? In other words, did wolves kill animals that were already doomed? Perhaps the focus on wolves is also misguided. Wolves, alone, certainly are not the sole cause for the subsequent declineof the Nelchina herd. Both authors (Bergerud and Ballard 1988; Van Ballenberghe 1985) agree that whether wolves or snow were to blame for the initial reduction in the recruitment of young, the major cause of population decline after 1966 was overhunting by humans: at its worst, in 1971/1972, hunters killed 44% of the herd.

Despite the apparent differences in interpretation of the Nelchina data, and differences in conclusions drawn in so many studies, several recent reviews of wolf-caribou-moose systems agree with Mech (1970:268-277) that in certain circumstances, at certain times, wolves can control ungulate populations.

Most prey populations appear to cycle, the length of the cycle being related to the species' body size (Peterson et al. 1984). Once ungulate numbers are at or near their peak, most authors are in agreement that wolves do not produce a decline in ungulate numbers (but see Bergerud 1988). Declines are caused by combination of weather, overhunting, and food limitation. (Peterson et al. 1984,Gauthier and Theberge 1987; Mech et al. 1987).

When ungulate numbers are declining, predation alone may be sufficient to depress herbivore density during the final period of a herbivore population decline (Keith et al. 1977; Peterson et al. 1984; Gauthier and Theberge 1987; Mech and Karns 1977). If prey densities are low, then predators may exert a controlling effect upon their numbers (Peterson 1977). The ready availability of other prey (beaver, moose) may allow wolves to survive at high numbers even when their primary ungulate prey has declined (Gauthier and Theberge 1987, Bergerud 1988).

In situations where the initial decline is caused by the ungulate population exceeding its food supply, wolf predation may further reduce ungulate numbers, extending the period over which prey populations remain at low levels. The decline in herbivore density may allow forage to recover. If wolf numbers decline due to decreased prey numbers, disease, or active control, forage conditions are sufficiently improved to allow herbivore population numbers to increase rapidly (Peterson et al. 1984). Wolves do not usually cause the initial decline in prey numbers. They may, in some circumstances, prolong prey declines.

Zorros and Rabbits

In Chilean Tierra del Fuego, 24 South American grey zorro, *Dusicyon griseus*, were introduced in 1951 in an attempt to control a burgeoning population of 30 million introduced European rabbits (*Oryctolagus cuniculus*) (Jacksic and Yanez 1983). The culpeo, *Dusicyon culpaeus*, was already present on the island but at low densities due to persecution by humans.

Before the effect of introductions could be assessed, myxomatosis was introduced and the rabbit population crashed and has remained low since. Jaksic and Yanez (1983) suggest that both zorro species may play a part in controlling rabbits but that zorros alone probably could not control an infestation: rabbits account for 18.4 % of the diet of the culpeo and only 3.3% of the diet of the grey zorro. Foxes might show a greater preference for rabbits if their numbers greatly increased; however, because rabbit populations increase geometrically faster than those of foxes, they believe it is unlikely that foxes would be able to regulate a rapidly expanding population. Similarly, red foxes introduced to Australia have not controlled rabbit populations there (Macdonald 1987).

Foxes and Gamebirds

In Europe canids have long been viewed as important in reducing bags of gamebirds, and have been persecuted as a result. In 1912there were 22,000 gamekeepers in Britain alone (Potts 1986). This view has been rigorously tested only recently, however, when a number of predator-removal experiments have sought to determine exactly what effect canid predation has upon the size and available harvest of gamebird populations.

One study on partridges (*Perdix perdix*) was carried out in southeast England. Of two experimental areas, of similar size, partridge density and history of keepering, predators (foxes, stoats, and corvids) were controlled intensively on one and protected on the other (Potts 1986). After just one year, partridge density on the predator control area has risen from 223 birds to 338, while that on the predator protection area had fallen from 230 to 196. This rise seemed to occur through nest losses, which remained constant in the predator protection area, but fell where predators were controlled. Under predator control, the numbers of broods seen at the age of 6 weeks rose from 21 to 34, while under predator protection this rise was from 16 to just 17. However, these preliminary results cannot be evaluated until the experiment is complete. This will involve reversing the procedures so that the predator control area becomes a protected area, and *vice versa.* A similar study near Bonn in West Germany (cited in Potts 1986) showed a mean annual bag of 5.7 ±0.8 under predator protection, and 10.9 ±1.9 under predator control. Potts was able to mimic this difference by a computer simulation using population parameters "stolen" from his own study, with nest predation as the only factor differing between areas with and without predator control.

Potts tried to model his study population over 20 years and got a very good approximation to the real situation. Then he put chick mortality (inflated by modern herbicides) and nest predation (inflated by the cessation of predator control) back to their 1976 levels from the beginning of the study. By doing this, he was able to "prevent" (retrospectively) the decline in the partridge population that he had observed. By the end of the run, an annual bag of 40 birds per square km would have been possible. However, when he considered only predator control, (i.e. left in the herbicides), he found that restoring it "would have increased breeding stocks in recent years—*but it would not have prevented a steady decline"* (his italics). The bag would have been just 5 birds per square kilometre, and the cost of keepering to control the predators would have amounted to £300 per bird shot. He concluded that predation pressure had simply accelerated a decline that had been ultimately caused by modern herbicides.

Another study was carried out on two small islands in the Gulf of Bothnia—predators (red foxes and martens) were trapped and shot each winter on one of the islands, while no predators were removed from the other (Marcstrom et al. 1988). After five years, predators were no longer controlled on the one island, and were allowed to recolonize across the sea ice. Predators were then removed from the other island, and the study continued for four more years. Populations of capercaillie (*Tetrao urogallus*), black grouse (*T. tetrix*), hazel grouse (*Bonasa bonasia*), and willow grouse (*Lagopus lagopus*) were monitored on both islands throughout the study, as were those of small mammals.

Predator removal on each island caused increased chick production—on average, broods from predator-control areas contained 68% more young than those in areas where predators were not removed. Furthermore, on islands with predators, 59% of females produced broods, as compared with 77% on islands without. These figures correspond to a 2.2-fold increase in chick productivity following predator removal, from 1.94 young/hen to 4.25. Adult populations were, however, less affected by the removal of predators—a 2.2-fold increase in productivity was predicted to lead to a 2.5-fold increase in adult population, but the counts that revealed the productivity change showed just a 1.6-1.8-fold increase. No change was detectable in the small mammal populations, which continued to cycle on both islands throughout the study. However, when predators remained on each island, the gamebird populations fluctuated in synchrony with the small mammals, while this relationship was destroyed in the absence of strong predation. It has been suggested that predators "transmit" population cycling to gamebirds by preying more heavily upon them when their principal prey, small mammals, are at low abundance.

It seems, then, that fox and marten predation influences the gamebird populations through the medium of chick survival, and that the predation pressure varies through time according to the abundance of alternative prey. Thus, when small mammals are rare, the predators suppress the gamebird populations more effectively—especially just after a rodent "peak" when large numbers of predators, experiencing a rapid decline of their mammalian prey, take many gamebird chicks.

Studies of predators other than canids suggest that factors exogenous to predator-prey interactions may be responsible for regulating ungulate populations. In the Serengeti, Tanzania, wildebeest populations have increased dramatically since the elimination of rinderpest despite concurrent increases in the lion population (Norton-Griffiths and Sinclair 1979). In Idaho, both mule deer and elk increased in numbers despite heavy predation by both mountain lions and humans (Hornocker 1970). That predators may, in some circumstances, exert control over prey populations is highly probable. Predators are not, however, uniquely responsible for fluctuations in prey numbers.

Reducing Losses—Lethal Control

In the great majority of cases the level of livestock losses attributed to canids appears to be exaggerated. Similarly, the data suggesting that canids and man are in direct competition for game are ambiguous. Even if every death ascribed to canid predation is verified, in many cases such small percentage losses suggest that it should be possible to reduce losses to a level which will allow wild canids, livestock, and game to coexist.

In principle, one can seek to cut losses to predators either by reducing the numbers of predators (lethal control) or by reducing their access to, or the availability of, the prey (non-lethal control). In practice, predator-reduction is much the most common approach and, on first principles, much the least promising. Canids can be killed in a number of ways, by shooting, poisoning, or trapping. Each of of these methods has its relative advantages and disadvantages.

From the point of view of conservation, lethal methods that are not species specific (trapping, poisoning) frequently result in the inadvertent killing of "non-target" animals. In areas where common predators coexist with rarer animals, non-specific lethal controls result in what can only be called reckless endangerment of the rare or vulnerable species. In the Soviet Union, Ovsyanikov (pers. comm.) suggests that poison bait programmes aimed at elimination of wolves may have inadvertently eliminated dholes in areas where the two species overlap. In Italy, poison baits laid to kill red fox are known to be dangerous for dogs, children, and wolves (Boitani 1982).

No matter what method of lethal control is employed, however, reducing predator numbers is an expensive process that requires a long-term commitment on the part of a government or private producers. Although data that elucidate this are few, we have chosen two examples which illustrate this point. The case of the arctic fox in Iceland will serve to demonstrate this point in relation to livestock (P. Hersteinsson has kindly provided the following unpublished data); the second, that of wolves, can be used to examine the problem in relation to game species.

Loss of livestock, particularly lambs, is the major reason for attempts at controlling arctic fox in Iceland. Each year, a maximum of *24%* of Iceland's lambs are lost to predation by foxes (the true figure, for reasons cited previously, is probably much smaller). The annual crop of lambs is approximately 900,000 individuals, and the value of each lamb is U.S. $50, resulting in a mean loss to ranchers of U.S. $0.9 to U.S. $3.6 million per annum from predation.

Hunting to control foxes has been undertaken for centuries. The earliest laws promoting hunting of arctic fox in Iceland date from 1295 A.D., while the legislation governing the present hunting was enacted somewhat more recently (1958). Hunting of the arctic fox in Iceland is jointly sponsored by the Department of Agriculture (2/3 of costs) and local authorities (1/3 of costs). The hunting is undertaken by professional hunters hired by local authorities. The cost of this program is approximately U.S. $200,000 per annum. The hunt is a year-round activity and kills, annually, approximately 900 adult foxes and 1,300 cubs in a population of 2,000 adults.

A hunting programme which costs the government approximately 10% of the value of the annual loss in lambs might be viewed to be a success. However, whether the hunting has any impact on fox populations, or livestock losses for that matter, is debatable. Despite intensive hunting, with the annual harvest of nearly 50% of the adult fox population, arctic fox population levels in many parts of Iceland have been increasing since they reached their low in 1974. Fox populations appear to be cyclical and are probably not regulated by hunting. The pattern of population and sub-population growth is unclear, however it appears that a protozoan parasite, *Encephalitozoon cuniculi*, may contribute to regulation of the long-term cyclical patterns of population size. Of course, control of predators on an island is easier than it is on the mainland where immigration and emigration further complicate control efforts.

In those situations in which wolves have been shown to depress ungulate population levels, the most frequent management response is to kill wolves. But wolves, like many canids, can be very productive. A wolf pack usually produces one relatively large litter of five to six pups. When populations are not saturated, 22-41% of all wolf packs produce multiple litters (Harrington et al. 1982). In other areas, only 10% of the packs may produce multiple litters (Ballard et al. 1987). Hence, reducing wolf numbers may result directly in a larger number of young wolves.

What this means is that even when suffering an annual mortality of 50%, a wolf pack can remain stable in its numbers. Natural mortality appears to vary between 10% (Mech 1970) and 20% (Ballard et al. 1987). Removing 20% to 30% of the population appears to result in stable population numbers (Pimlott 1967,Gassaway et al. 1983). To effect a significant reduction in wolf population levels, a control programme must kill, annually, between 40% to 50% of the wolf population, although in some areas, removal of greater than 35% may be "all" that is necessary to reduce wolf populations (Keith 1983). These estimates were confirmed in a recent study (Ballard et al. 1987). An experimental reduction of wolves of 42%-58%, although resulting in reduced wolf numbers, also led to several new waves of immigration and an increase in births.

Nature abhors a vacuum, and carnivores appear to be no exception to natural laws. Canids are frequently killed as a control measure in areas where ecological factors such as abundant food have made them a pest. But for every predator killed, there may be another just waiting to move into such prime habitat. A local lethal control programme for wolves in Canada did not decrease wolf number but led to an increase in immigration with new wolves moving into the area to compensate for artificially low population densities (Ballard et al. 1987). This clearly shows that even total removal will only result in a temporary respite from canid predators unless an area is completely isolated. In those cases where a short respite from predation allows a prey species to "escape" the predator's control, a temporary reduction may be all that is needed.

The role of humans in altering the ecological landscape cannot be ignored. Development and human activities, even in the most remote areas, can have a profound impact on predator-prey interactions. For example, during calving, caribou "escape" predation from wolves either by spacing themselves out in areas where wolves are rare (woodland caribou) or by giving birth in calving grounds outside the range of wolves (tundra caribou). If humans disturb the mobility of the caribou, the impact of predation can greatly increase (Bergerud 1988).

Even in areas where predator numbers have been drastically reduced, such as wolves in Spain (Salvador and Abad 1987), Italy (Boitani 1982), and Norway (Naess and Mysterud 1987), or African wild dogs in Zimbabwe (Townsend 1988) or South Africa (Mills pers. comm.), the conflict between producer and predator continues. Several authors have noted that a few wolves have evoked spirited and vociferous debate throughout Norway (Naess and Mysterud 1987; Anon 1989).

Reducing Losses—Non-Lethal Controls

While humans may be limited in the means available for killing predators, numerous methods of non-lethal control have been pursued. A variety of non-lethal controls have been tested. The effectiveness of various control measures for the prevention of predation by coyotes has recently been reviewed by Andelt (1987) and in a volume edited by Green (1987). Their findings, augmented by results from studies on other species of predators, are summarized in Table 2.

The path of least resistance to a state resembling harmonious coexistence of predators and livestock producers involves limiting the opportunity for conflict. Improvement in animal husbandry may not be costly and may have significant results.

Table 2. Efficacy of Non-lethal Control

Method	Canid	Prey	Region	Effectiveness and Comments	Source
Herders	Coyotes	Sheep	U.S.A.	Presence of herders reduces losses.	Andelt 1987
Guard Dogs	Wolves	Sheep	Portugal	Greatest deterent is sheep dog and herder.	Flower 1971
	Coyotes	Sheep	U.S.A.	Dogs can greatly reduce predation, problems.	Andelt 1987
	Wolves	Sheep	Italy	Losses greatest in areas not using traditional herding/sheep dog methods.	Boitani pers. comm.
	Coyotes	Sheep	Western U.S.A.	80% success rate. Dogs cost effective.	Green and Woodruff 1987
Disposal of Prey Carcasses	Coyotes	Sheep	Various studies	Carrion may attract coyotes, introduce sheep as food. Burial or removal reduced predation loses.	Andelt 1987
	Wolves	Cattle	Minnesota	Carrion may attract wolves and introduce them to cattle as potential food.	Fritts 1982
Confinement	Coyotes	Sheep	Kansas U.S.A.	Predation largely nocturnal; nightime confinement greatly reduced losses.	Andelt 1987

Proper disposal of livestock carcasses, either those killed by predators or those resulting from natural mortality, appears to reduce subsequent predation. Confining animals at night, or during their infancy when they are most vulnerable, also reduces losses to predators.

Perhaps the most cost effective method of non-lethal predator control is the one we have used historically: guard dogs. Guard dogs, in conjunction with shepherds, have been used for millenia throughout the world. Of course, dogs are most effective in certain situations. Their efficacy is increased in small herds, and in the presence of a shepherd. An international trend to increasing the scale of production in all aspects of agriculture may limit the traditional use of guard dogs.

Several studies note, however, that guard dogs in conjunction with fencing can greatly reduce livestock depredation by carnivores (see Green and Woodruff 1987). As 80% of all sheep producers, and 50% of all sheep produced in the western United States are raised within fenced pastures (Green and Woodruff 1987), the increased use of guard dogs may be particularly effective in these areas. Boitani (pers. comm.) argues strongly that traditional use of guard dogs by Italian shepherds was pivotal to the historical coexistence of wolves and sheep farming.

Most lethal control programmes, such as the one described in Iceland, attempt to limit the growth of the predator population. A simpler, and possibly more cost effective way to achieve the same goal is to reduce predator fertility. Behavioural techniques seem destined to failure (Barnum et al. 1979). Recent studies suggest that anti-fertility drugs, administered through improved baits, may be an econcomical means of predator control (Stellflug et al. 1978). A second method of fertility reduction, hormone implants, has been used successfully in field trials to limit reproduction in the African lion, *Panthera leo* (Orford et al. 1988).

Methods of repelling canid predators have not been extensively explored. Those trials which have been made have found that most repellents appear to be either useless, or not cost effective. Behavioural modification of reproduction, whereby coyote calls are played at a high frequency to simulate dense coyote populations, had no effect on reducing fertility. The use of emetics and repellants, although occasionally providing short-term deterrence, appeared not to be cost effective. However, this approach merits more attention. Frightening devices and live trapping were of some use in particular circumstances.

One option in predator control that is rarely discussed involves the choice of "prey." The data in Table 1 suggest that rates of predation by canids vary with the species of livestock being raised and the predators which are most abundant. Goats appear particularly vulnerable to predation from coyotes, while cattle, for the most part, are relatively immune. The choice of the type of livestock to be raised in a particular area may be influenced by various factors: market demand, the type of forage available, cultural traditions, or historical accident. However, in areas where a particular species of predator is causing problems with a particular species of livestock, one answer is to remove the predator. Where culturally, ecologically, and economically possible, a simpler solution might be to raise a different type of animal.

Reducing Losses—Public Opinion

Public attitudes to the various methods of lethal and non-lethal control of canid predators, and regional differences in opinion, have to be taken into account by the controlling authorities. In a survey conducted in the United States, attitudes to various coyote control methods varied widely among methods (Fig. 1). Clearly, non-lethal control measures are far more acceptable

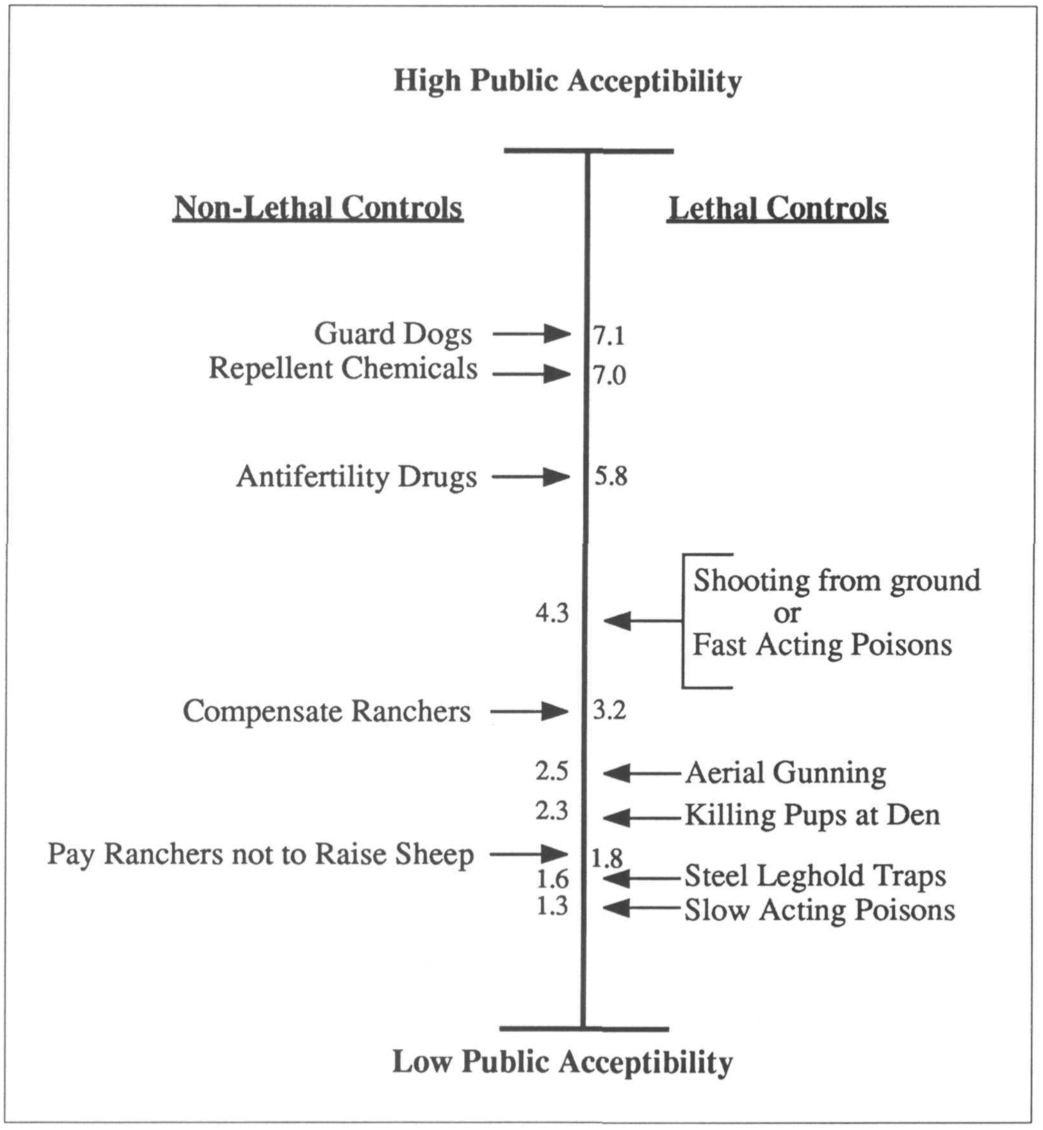


Figure 1. Public acceptance of methods of coyote control (after Andelt 1987).

than methods that involve killing coyotes. The only exceptions to this are forms of direct compensation to farmers and ranchers. However, compensation is not a form of control, but a form of govermental recognition that the costs of predation should be borne by the public at large. As noted above, compensation without confirmation of canid depredation can lead to abuse; perhaps people are reacting to abuse of the system, rather than justified claims for compensation?

In the above analysis and discussion, we have assumed that the important question to ask is how to mitigate the costs of depredation of livestock by canids. However, in many circumstances, the costs of predation may be irrelevant. When wild predators kill domestic animals, people often react instinctively rather than logically. For instance, in Norway, five or ten wolves eat approximately 0.02 percent of the county's annual sheep production. Despite the infinitessimal losses incurred, these few wolves have invoked a spirited public controversy (Naess and Mysterud 1987). Such a controversy would not have occurred had domestic dogs been responsible for the losses, or had a few sheep died in a spring snowfall. Canid predation, or more generally predation by wild carnivores, is seen as a loss which can and should be controlled: not an act of God, but the result of negligence on the part of the producer. Altering this pre-conception sufficiently that a low level of canid depredation is acceptable may do more for the conservation of canids than anything else.

12. Canids and Disease

Introduction

Having considered two significant sources of mortality amongst canids, namely predator control and the fur harvest, it seems appropriate to mention that many canid populations are subject to serious outbreaks of disease. To date there is no complete review of the impact of diseases on canids worldwide, but there are sufficient snippets of information to suggest that disease may be an important factor in many populations, and may even regulate some (see, for example, the report of Hersteinsson's work on arctic foxes, Chapters 6 and 11). Reports vary from distemper in the bat-eared foxes of the Serengeti to leishmaniasis in the crab-eating zorro and hoary zorro of Brazil (Lainson et al. 1969). However, most notorious, probably most widespread, and certainly best studied is rabies.

Here, we will illustrate the potential importance of disease in canid conservation by reviewing briefly the example of rabies amongstred foxes in Europe. This example serves to emphasise two points: a) that there are substantial management problems concerning species which are not endangered and b) that modem techniques offer ecologically exciting solutions to wildlife disease problems.

The Example of Rabies

The wild species implicated as vectors of rabies vary regionally, but worldwide the one mammalian family most commonly involved is the Canidae(Macdonald and Voigt 1985). Thereare at least occasional reports of most species of canid contracting rabies, and some members of the family are significant vectors, sometimes the major wildlife vector, in many regions. For example, golden jackals in North Africa, India, and, along with wolves, in the Middle East; black-backed jackals in parts of Southern Africa; arctic foxes in the far north, raccoon dogs in Eastern Europe and Asia; and red foxes throughout Europe and much of North America. Outbreaks of rabies have been implicated in losses of endangered species such as African wild dogs, and raise substantial fears concerning relict populations such as the Simien jackal.

Rabies is a viral disease, generally transmitted when saliva is 'injected' into a susceptible animal that is bitten by an infectious one. Although all mammals can contract rabies, species differ in their susceptibility and in the symptoms they show. Raccoons and some mongooses, for example, are amongst those that can survive the disease and become immune. Red foxes, in contrast, are highly susceptible, and once infected have little or no chance of survival.

There are different strains of rabies virus, more or less specific to groups or species. For example, although cats are highly susceptible to the domestic dog's strain, they are not especially susceptible to the red fox strain. Foxes are very susceptible to their own strain, but not very susceptible to cat or dog strains. Except in Yugoslavia and Turkey, where the dog strain exists in wolves, Europe is swamped with the vulpine form. The existance of these strains of virus may explain many previously puzzling aspects of epidemiology. For example, this may explain why foxes in Denmark and the Netherlands remain free of rabies in regions where serotine bats are infected.

The history of rabies and its control in Europe illustrates important lessons for canid conservation. Rabies has come and gone in Europe throughout recorded history (whether it was dog or fox strain is generally unknown, although in Britain during recorded history rabies occurred almost exclusively in dogs). Coincident with the turmoil of the Second World War, the twentieth-century epidemic erupted in Poland and subsequently spread steadily across Europe in foxes. Since 1939, rabies has spread some 1,400 km westward, the front wave advancing between 20-60 km per annum (Toma and Andral 1977). On average, and with much variation, there has been an advance of about 4.8 km per month, interspersed with occasional leaps forward of up to 100 km (e.g. in 1982 in Yugoslavia, a focus erupted in Croatia, some 400 km ahead of the front wave). The toll has been fantastic. For instance, in 1982 13,971 rabid red foxes were recorded in the 11 central European countries where sylvatic rabies predominates. Nobody knows what proportion of rabid foxes are reported, but it is likely to be very low; Braunschweig (1982) guessed that it would be between 2-10%.

When rabies penetrates a new area, the foxes suffer an epizootic outbreak. With the fox population approximately decimated, the incidence of the disease dwindles and remains low during a 'silent' phase for two or three years. Thereafter, secondary peaks recur, often at intervals of 3-5 years following the first epizootic. Over a wide area, these cycles in reported case-incidence are out of phase with each other, giving the impression that the foci of enzootic rabies move around. Superimposed upon this inter-annual periodicity in the incidence of reported rabies is a seasonal pattern. There is a peak in cases in late winter, and a trough in mid-summer. There is similar seasonality in the monthly velocity with which the front line of the disease advances. In Germany, for instance, the spring increase in velocity is detected in February, whereas the incidence starts to increase about a month later (Bogel et al. 1976). Another pattern in the behaviour of the disease concerns its victims: in May-June, subadult foxes compose a smaller proportion of those reported dying from rabies than they do of those dying from other causes. In contrast, subadult males are disproportionately common in the sample dying from rabies in the autumn, whereas adult females are disproportionately common in such samples in spring.

Many of the characteristics of rabies epizootics can be interpreted in terms of fox biology (reviewed, for example, by Macdonald 1980 and Macdonald and Voigt 1985). Such links make it a priority to study the behaviour of those canids involved in rabies transmission, both in order to understand the behaviour of the disease, and to predict the consequences of attempts to manage it. For example, the behaviour of the disease in Europe can be related to the behaviour of foxes. The inter-annual periodicity of the disease reflects the population dynamics of the vector. After a fresh epizootic has swept through an area, some 60-80% of susceptible foxes will have perished. The result is that there are insufficient survivors to sustain the outbreak, which then peters out. Thereafter, the recurring enzootic waves of disease indicate that fox populations have recovered sufficiently to support further outbreaks. The late winter peak in incidence coincides with the social disruption and territorial incursions associated with the dispersal of subadults, competition for territories and the chaos of courtship. The disease front appears to chart a route through habitats characterised by high fox populations, probably spreading from one territory to the next during clashes between residents.

However, spread between neighbouring foxes cannot be the whole story, because all else being equal it would lead to slower advance of the disease front where territories are smaller and populations generally larger, whereas, if anything, the opposite is the case. Some leaps forward by the disease may be caused by the minority of foxes showing the notorious "furious" form of rabies, in which berserk, fearless individuals travel aimlessly. However, these symptoms are rare in foxes (although quite common in dogs), and the rabid foxes studied in the wild have behaved rather normally until they were overtaken by terminal paralysis (Andral et al. 1982). The speed at which the disease spreads is probably much influenced by the footloose, adversarial lifestyle of itinerant foxes and the dispersal of cubs. Johnston and Beauregard (1969) hypothesized that not only did the fox's behaviour in winter increase the likelihood of exposure to rabies, but also the stressed condition of dispersing subadults might further increase their susceptibility to infection (see also Artois and Aubert 1982).

The persistance of rabies, and the success of attempts to control it depend fundamentally on a measure known as the contact rate. The contact rate for a population is the average number of susceptible individuals infected by each diseased animal (see Bailey 1975). Contact rate is not constant, but a complicated function of the social organisation and density of the vectors, and thus of the frequency of meetings between them. Contact rate must be 1.0 or greater in order for rabies to remain enzootic (May 1983). It is straightforward to see that understanding rabies in canid populations demands an understanding of factors affecting contact rate. However in the stochastic world of complex animal populations, measurement of contact rate is notoriously difficult. This is largely because the frequency with which individuals meet, and hence the potential contact rate of the disease, is a reflection of their population density, social organisation, and their ecology.

Assuming that fox population density, and therefore perhaps contact rate, are determined partly by resource availability, various authors have sought to relate the behaviour of rabies to habitat charactersitics. The assumption is that habitat characteristics are correlated with the abundance of fox food (Macdonald et al. 1981). Although this approach is weakened by its inability to cope with cyclical variations in prey populations or, directly, with mortality pressures, it has shown some promise (e.g. Harris and Rayner 1986). For example, Jackson (1979) found that the velocity of the epizootic varied between land classes. Ross (1981) found a clear association between the velocity of the rabies epizootic in France and the presence of limestone bedrock. A plausible, but untested, explanation for associations of this sort is that the habitat features in question support high densities of foxes which have a high contact rate.

The Control of Rabies

The intention of control policies for wildlife rabies is, ultimately, to reduce contact rate below 1.0, thereby breaking the chain of infection. Thus the traditional European approach has pivoted on the principle that the disease would die out if enough foxes could be killed so that numbers among the survivors were so low that the average infectious individual died before it infected a susceptible one. This policy has been pursued across Europe by armies of game and forest rangers, aided by hunters, who have both shot foxes and gassed them (pumping Cyclone B into their dens, or spooning in powder which gives off hydrocyanic gas). An important aim has been to reduce the numbers of infected foxes so that the threat to humans was reduced. Across Europe the numbers of foxes slaughtered annually in anti-rabies campaigns are unknown, but it must run into many thousands. Similar tolls have been commonplace amongst canids in many parts of the world. An often quoted but still poignant set of statistics is that summarising the arguably unsuccessful 1953 campaign in Alberta: in 18 months the approximate toll was 50,000 red foxes, 35,000 coyotes, 4,200 wolves, 7,500 lynx, 1,850 bears, 500 striped skunks and 164 cougars (Ballantyne and O'Donoghue 1954).

The starkly obvious question is whether the effort put into killing foxes in the attempt to eradicate rabies has succeeded. It has probably reduced the number of cases of rabid foxes somewhat, and temporarily reduced fox density (which rabies also does very swiftly). It may have protected man, but it has conspicuously failed to eradicate the disease, or even to slow its progress across Europe. One exception to this gloomy answer is the case of peninsular Denmark where, on three separate occasions, rabies has been eradicated within two breeding seasons by surprisingly rudimentary methods (gassing dens with stirrup pumps, supplemented in West Jutland by poisoning with strychnine at feeding sites) (Westergaard 1982). Of course, one would expect the great variation reported in canid behaviour and population densities from region to region to complicate the control of animals whose population dynamics are anyway rather resilient. One consequence of variation in fox population density between habitats is that baiting schemes may need to be adapted to widely different numbers of foxes (see Macdonald 1977, p. 89), and this requires a flexible strategem which can be adjusted to local circumstances.

The high intrinsic rate of increase that typifies fox populations militates against attempts to reduce their numbers by killing them. The complicated nature of their social system weakens the argument that reducing fox numbers is likely to lead to a concommittant reduction in social contact amongst the survivors. For these reasons, some ecologists have argued that killing foxes was unlikely to reduce contact rate sufficiently, and for sufficiently long, to eradicate rabies, or even to control it very effectively (Macdonald 1987). The same ecological principles suggest that an alternative, oral vaccination, is more likely to succeed (Bacon 1985). The possibility of controlling rabies by vaccinating them against rabies became a serious possibility with the publication of preliminary results by Steck et al. in 1982. The idea is to vaccinate foxes against rabies, thereby reducing the number of susceptibles in the population not by killing them, but by making them immune. This approach also circumvents the possible counterproductive consequences of destabilising the foxes' social system. Considering the destabilising effects of killing schemes on fox society, Macdonald (1987) argues that the proportion of the fox population that must be killed to eradicate the disease is likely to be different from, and larger than, the proportion that must be immunized to achieve the same end. Furthermore, there is now mounting evidence that vaccination can be cheaper, and it is obviously more humane. Most compelling of all, it appears to work.

The first pilot studies were undertaken in Switzerland in 1978 and involved monitoring the progress of fox rabies up the arms of Y-shaped valleys. At the entrance to one arm of each Y, every effort was made to kill foxes, whereas at the entrance to the other arm of the valley, chickens' heads loaded with oral vaccine were scattered. The foxes ate the chickens' heads and inoculated themselves. Subsequently, rabies spread among the surviving foxes in the arm of the valley where others had been killed, but was stopped in tracks by the barrier of healthy, inoculated foxes (Steck et al. 1982).

Early misgivings about the risks of vaccine-induced rabies in non-target species arose because the vaccine used (SAD ERA) was a "live attenuated virus vaccine"—that is, a live rabies virus prepared so as to reduce greatly its virulence. These fears have largely been quelled by the development of a safer, more efficient live vaccine (SAD-B19). Added to this, new possibilities have emerged: genetic engineering has produced what may turn out to be an even better vaccine. A relatively innocuous virus called *Vaccinia* (the orthopox virus used in the eradication of smallpox) has its genetic composition manipulated to incorporate elements of the rabies virus. The resulting "recombinant *Vaccinia"* has sufficient traits of the real rabies virus that, when eaten by foxes, it stimulates immunity to the disease (Blancou et al. 1986). So far only preliminary trials have been completed in the field (in Belgium by Professor P.P. Pastoret) of the recombinant vaccine, but massive field trials have now been completed using the attenuated live virus vaccine. These trials, in Switzerland, West Germany, Italy, Austria, Luxembourg, Belgium, and France, have been impressively successful. Meanwhile, the search is on for other genetically engineered vaccines. Furthermore, other ideas may have a role: Bacon and Macdonald (1980) proposed supplementing oral vaccination with baits containing birth control agents, thereby slowing the surge of unvaccinated recruits into the population every breeding season.

Kappeler et al. (1988) report that between 1978 and 1985 they distributed more than 600,000 SAD ERA vaccine baits throughout an area of 45,000 sq km in Switzerland. The result: aside from some inaccessible parts of the Jura Mountains, rabies has been virtually eliminated from Switzerland. Schneider and Cox (1988) similarly reported massive trials between 1983 and 1987 involving placement of more than five million vaccine baits over 60% of West Germany. The result was that 72% of foxes killed by hunters in those areas had eaten the baits and expressed antibodies against rabies—i.e. the baits gave protection from rabies to almost three quarters of the fox population. Not only has rabies almost disappeared from the vaccinated area of southern Germany (and persisted elsewhere, where traditional methods were employed), but not one case of vaccine-induced rabies was found there (three such cases occurred in Switzerland).

Conclusion

The advances in vaccine technology bring real prospects that oral vaccination of foxes will lead to the eradication of rabies as a disease of European wildlife within a decade. This offers significant lessons for canid conservation. Vaccination may offer a good solution to limiting rabies in other canids, including rare species; there are proposals, for example, to distribute oral vaccine against rabies to silver-backed jackals in Zimbabwe. Vaccination may also present prophylactic protection for rare species if an epidemic threatens; the precarious circumstances of Simien jackals and African wild dogs immediately come to mind.

13. Conclusions and Action Planning

Introduction

There are 34 species in the canid deck of Canis. In the preceding chapters we have cut the deck by species, by region, and by topic. Each hand thus dealt has given us a different perspective, and we have drawn conclusions as we came to them. We do not plan to introduce any new information at this late stage in the Action Plan but, at risk of being repetitious, we will present here a synthesis of salient conclusions that are scattered elsewhere in the text. Our aim is to make these conclusions as accessible as is possible. In so doing, we run the risk that hurried readers will jump to the conclusion that there is no need to read any other chapter. Anxious that this incorrect conclusion should not cause our efforts to be squandered, we would point out that this chapter is not a summary of the booklet, but rather a drawing together of selected threads that might otherwise have remained untied.

In seeking generalizations about the conservation of the Canidae, one is abruptly confronted with the aphorism concerning comparisons of chalk and cheese. We are dealing with some species about which much is known (e.g. the arctic fox), others that have rarely been seen in the wild (e.g. the small-eared zorro). Some species appear destined to an existence as imperiled fugitives (e.g. wild dogs), others are thin on the ground but widespread (e.g. side-striped jackal), while others seem almost ineradicable (e.g. red fox). Some may be essentially gregarious (e.g. dholes); some essentially solitary (e.g. maned wolf). The list of potential contrasts is almost limitless. Against this background, our attempts at generalizations clearly merit scepticism! However, while we would not argue that the scientific management of populous species is any less challenging than the conservation of imperiled ones, we do see a greater cost in bungling the latter. For that pragmatic reason we confine our final recommendations to the most threatened canids.

Fortunately, remarkably few canids are in dire straits (Table 1). Only nine species pose critical problems to conservation, and only three of these are endangered. In satisfying contrast to the plight of many carnivores (cats—Joslin and Jackson in prep; mustelids and viverrids—Schreiber et al. 1989), nearly half of the world's canids (15) are, by any objective criterion, not in immediate need of additional protection. A further 10 species may be in tolerable circumstances, although this judgement carries the proviso that more information is required. Of the remainder, three are in danger of extinction and six are vulnerable or rare.

Changes in IUCN Status Categories

Both the IUCN Red Data Book classifications and the listing of a species in CITES (Table 1) can be viewed as short-hand summaries about the status, abundance, and distribution of a species (Table 2). But, like shorthand, these classifications provide only cryptic statements about the causes and speed of extinction or population decline. Scanning Table 1 will give a clear picture of the global status of the world's canids; to understand the ecological and economic rationale behind these classifications, however, we urge the reader to refer to earlier chapters and to read the species conservation summaries below.

The decision to change a classification cannot be taken lightly. "Crying wolf too often will inevitably lead to a backlash when the wolf actually appears. Classifying a Rare species as Vulnerable, or a Vulnerable species as Endangered, only devalues efforts at collecting accurate and detailed information. Leaving a species listed in CITES when trade no longer threatens that species serves only to burden unecessarily beleagured customs officers.

That being said, the stakes are too high to gamble with a species future; better to be safe, than sorry. Diamond (1988) notes that in countries where ecological surveys are common, and "armies of amateur naturalists" tromp out into the woods annually to collect data on species distribution and abundance, there is little doubt as to the status of a particular species. However, in many countries, particularly those in the tropics, our knowledge of plants and wildlife is sparse. Even for animals which appear to be common, data on population density, or trends in population numbers are unknown.

This dichotomy means that in those countries where our data are good, Red Books are fairly accurate; in other areas, the Red Books represent a summary of usually imperfect information. The IUCN categories provide a solution to this problem; until adequate information is available to state with certainty the status of a particular species, we must assume the worst. If, after attempts at observation, sightings of the species are few, a status of Vulnerable or Endangered may be warranted; if nothing is known about a species, that species must be classified as "Insufficiently Known" until data are collected to prove otherwise.

This caution has led us to suggest reclassification of a third (11 of 34) of the canid species. Our first recommendation is that the African wild dog be classified as Endangered. Data collected for this report, and a more detailed species specific study (see Chapter 4) show clearly that the wild dog is declining

Table 1. Conservation of the world's canids; status and recommendations

English Name	Scientific Name	IUCN	CITES	Recommended Changes
Species in Danger of Extinction				
African wild dog	*Lycaonpictus*	Vulnerable	Not Listed	List as Endangered
Simien jackal	*Canis simensis*	Endangered	Not listed	No change
Red wolf	*Cants rufus*	Endangered	Appendix I	No change
Vulnerable and Rare Species				
Bush dog	*Speothos venaticus*	Vulnerable	Appendix I	Move to Appenix II, review trade
Dhole	*Cuon alpinus*	Vulnerable	Appendix II	No change, review trade
Grey wolf	*Canis lupus*	Vulnerable	Appendix II &I	No change, monitor trade
Grey zorro	*Dusicyon griseus*	Not listed	Appendix II	List as Vulnerable, introduce quotas
Island grey fox	*Urocyon littoralis*	Not listed	Not listed	List as Rare
Maned wolf	*Chrysocyon brachyurus*	Vulnerable	Appendix II	Remove from CITES
Bengal fox	*Vulpes bengalensis*	Insuff. known	Not listed	No change
Species Requiring Further Information				
Blanford's fox	*Vulpes cana*	Not listed	Appendix II	List as Insuff. known, review trade
Corsac fox	*Vulpes corsac*	Not listed	Not listed	List as Insuff. known
Fennec	*Fennecus zerda*	Not listed	Appendix II	List as Insuff. known, review trade
Hoary zorro	*Dusicyon vetulus*	Not listed	Not listed	List as Insuff. known
Pale fox	*Vulpes pallida*	Not listed	Not listed	List as Insuff. known
Rüppell's fox	*Vulpes rueppelli*	Not listed	Not listed	List as Insuff. known
Sechuran zorro	*Dusicyon sechurae*	Not listed	Not listed	List as Insuff. known
Small-eared zorro	*Dusicyon microtis*	Not listed	Not listed	List as Insuff. known
Swift or Kit fox	*Vulpes velox*	Under review	Not listed	No change
Species Requiring No Immediate Protection				
Arctic fox	*Alopex lagopus*	Not listed	Not listed	No chnage
Azara's zorro	*Dusicyon gymnocercus*	Not listed	Appendix II	No change
Bat-eared fox	*Otocyon megalotis*	Not listed	Not listed	No change
Black-backed jackal	*Canis mesomelas*	Not listed	Not listed	No change
Cape fox	*Vulpes cana*	Not listed	Not listed	No change
Coyote	*Canis latrans*	Not listed	Not listed	No change
Crab-eating zorro	*Cerdocyon thous*	Not listed	Not listed	No change
Culpeo zorro	*Dusicyon culpaeus*	Not listed	Appendix II	No change
Dingo	*Canis familiaris dingo*	Not listed	Not listed	No change
Golden jackal	*Canis aureus*	Not listed	Not listed	No change
Grey fox	*Urocyon cinereoargenteus*	Not listed	Not listed	No change
Raccoon dog	*Nyctereutes procyonoides*	Not listed	Not listed	No change
Red fox	*Vulpes vulpes*	Not listed	Not listed	No change
Side-striped jackal	*Canis adustus*	Not listed	Not listed	No change
Tibetan fox	*Vulpes ferrilata*	Not listed	Not listed	No change

throughout its range; extinction is probable unless efforts to reverse this decline are continued and expanded.

Our second recommendation is that the grey zorro be listed as Vulnerable. We suggest this change for a combination of reasons. Data collected on the population densities of this species are much disputed (Chapter 5). Trade in the grey zorro is uncontrolled and extensive (Chapter 9). If we accept the argument made by several correspondents that the species is being over-harvested, present levels of trade could decimate even a large population of the species in very short order. Given that the Argentine government has classified the species as endangered, and that in Chile there is poor enforcement of laws protecting the grey zorro, the species should be reclassified as Vulnerable until evidence is presented to the contrary.

Recent changes in taxonomy have confirmed the specific status of the island grey fox (Chapter 2). As an island endemic, the species must be listed as Rare. Given the protection afforded the species by its occurrence in a reserve and in an area of Navy operations that excludes the general public, there is little immediate threat of extinction.

Of 11 proposed changes in IUCN status categories, by far the greatest number of changes are for eight species about which we know very little. These animals are from two groups — zorros from South America (hoary, Sechuran, small-eared) and foxes from north Africa and the Middle and Near East (Blanford's, Rüppell's, fennec, pale, and Corsac foxes). By reclassifying these animals, we hope to encourage further research into their distribution and abundance.

Proposed Changes in CITES Status

When international trade endangers a plant or animal, listing that species under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) provides a method, however imperfect, of monitoring the extent and patterns of trade in that species (see Chapter 9). Of course, CITES listing concerns trade and trade only; that a species is not listed in a CITES appendix does not mean that the species is not endangered from some other force of extinction such as habitat loss.

As species should be placed in the CITES Appendices only when trade endangers their survival, so species should be removed from CITES only when data collected suggests that trade is not a threat to the species. Only one species, the maned wolf, fulfills this criterion. Seven years of data on trade in this species shows no trade other than the exchange of live specimens, many of which are captive bred (Chapter 9). No commercial use of the pelts of this animal could be found (Chapter S).

In addition to de-listing the maned wolf, we recommend a change is status for two further species. The bush dog, like the maned wolf, is a vulnerable species; yet little trade in products derived from this species was recorded in the seven year period 1980 to 1986. We are certain that an Appendix I listing is unnecessary; for the moment, the species should be moved to Appendix II, reserving the possibility to de-list it completely in several years if no further trade develops.

Our final recommendation concerning the classification of canids under CITES is that trade restrictions, in the form of export quotas, be placed on the grey zorro. Uncertainty about its status in both Argentina and Chile (Chapter 5) and high levels of trade are a potent combination, which could lead to rapid decline and the eventual extinction of the species.

Trade should be reviewed for an additional three species now listed in Appendix II: Blanford's fox; the fennec; and the dhole. All three of these species have been traded in the past 8 years, but the source of skins and the levels of trade remain ambiguous.

Table 2. Summary of classification definitions

CITES Classification

Appendix I: All species threatened with extinction which are or may be affected by trade. Trade authorized only in exceptional circumstances.

Appendix II: (a) All species which may become threatened with extinction unless strict regulation is enforced; (b) other species which must be subject to regulation so that trade in endangered or potentially endangered species can be brought under control.

Appendix III: All species which any Party to CITES identifies **as** being subject to regulation within its jurisdiction for the purpose of preventing or restricting exploitation, and as needing the cooperation of other Parties in the control of trade.

IUCN Classification

Extinct: Species not definitely located in the wild during the past 50 years.

Endangered: Taxa in danger of Extinction and whose survival is unlikely if the causal factors of its decline continue operating.

Vulnerable: Taxa believed likely to become Endangered in the near future if the causal factors of its decline continue to operate.

Rare: Taxa with small world populations that are not at present Endangered or Vulnerable

Indeterminate: Taxa known to be Endangered, Vulnerable or Rare but information is lacking as to which of these categories is appropriate.

Insufficiently Known: Taxa that are *suspected* but not definitely known to belong to any of the above categories due to lack of data.

Threatened: A general term which may be used to describe a species in one of the above categories.

Conservation Status of the World's Canids and Priorities for Action

At the risk of repetition, we urge each reader to review those sections of this report that address the status of species in which they, or their governments, might have an active interest In Chapters 4 through 8, we provide detailed information on the biology, distribution, and conservation status of each of the 34 canid species. In Chapters 9 through 12, problems of general interest to anyone interested in the management, trade, or conservation of canids are discussed.

In the following section, we summarize the status of each of the world's canids and present action priorities for each species where we think immediate conservation work is necessary. Unlike previous chapters, where we have grouped species geographically, species in this section are grouped according to their conservation status. Categories are listed in order of risk of extinction. Our categories are derived from those of the IUCN Red Data Books (e.g. Thornback 1976) with the slight modification that we have put Vulnerable and Rare species in a single category. In addition to discussing the status of each species as we see it, we have included the present status afforded each species by IUCN and CITES (the Convention on International Trade in Endangered Species of Wild Flora and Fauna).

The aim of ranking species categorically is to give a general indication of conservation priorities. The acid test for ranking priorities in the action plan is the potential for extinction. However, as our crystal ball is at best clouded, we urge the reader to consider priorities by category rather than by individual species. Within each category, species are listed in alphabetical order by scientific name. Note that this summary does not include details on patterns of abundance and distribution, information which is found in the species accounts. Our categories include:

Endangered Species: Those species most threatened with extinction and whose populations are declining throughout their range.

Vulnerable and Rare Species: Those whose populations are either small or threatened. This may include species which are under direct threat due to factors such as loss of habitat or the introduction of diseases, other pathogens, or competitors. A species may also be included in this section simply because it is an endemic and, hence, by its very nature, rare.

Insufficiently Known Species: Those species about which insufficient information is available to make recommendations.

Species Requiring No Immediate Protection: That a species requires no immediate protection does not mean that populations are necessarily safe *ad infinitwn.* Rather, it indicates that either populations are safe or measures have been taken to ensure the long term survival of several large populations of the species. We have been consciously conservative, placing species in the category "Insufficiently Known" whenever a lack of data is clearly apparent (Diamond 1988).

Simien jackal (*Canis sinensis*). (Photo by C. Sillero-Zubiri)

Endangered Species

Red wolf (*Canis rufus*)

IUCN Status: Endangered.

CITES Status: Appendix I.

The red wolf is believed to have become extinct in the wild. A captive breeding population, established at the Point Defiance Zoological Gardens in Tacoma, Washington, U.S.A. provided animals for a reintroduction programme in the 477 km^2 Alligator River National Wildlife Refuge in North Carolina. Eight individuals were introduced in 1988.

Support should be continued for efforts to re-establish the red wolf in the wild. Despite near extinction, public perception of the red wolf is still poor. Further reintroduction in parks in the southeastern United States should be coordinated with an intensive education programme.

Simien jackal (*Canis simensis*)

IUCN Status: Endangered.

CITES Status: Not listed.

As an endemic found only in the highlands of Ethiopia, with a total population of well under 1,000 individuals, the Simien jackal is inherently prone to extinction. The problems intrinsic to small population size are magnified by the way in which remaining individuals are distributed: the great majority (500-600) of the remaining Simien jackals are in Bale Mountains National Park. Hence, a single catastrophic event such as disease epidemic or a severe change in climate could wipe out the species. Cross-breeding with domestic dogs threatens the long-term survival of the species; fragmentation of the population may also increase the risk of extinction through hybridization with domestic dogs. Current research and conservation programmes are overdue. Recommendations resulting from this research may well improve the status of the species. However, until such a time as the population levels have stabilized, new populations have been established, and protected areas secured, the status of the species should remain Endangered.

The population in Bale Mountains National Park appears to be stable or growing and will have a good chance of survival with proper management of the area. The remnant populations to the north and west of the Rift Valley (Simien and Shoa) may not be viable. The programme to save this species should include:

1. A survey of their range, particularly those areas which have not been visited for 50-100 years.
2. Further efforts to gazette and enforce boundaries of Bale Mountains National Park.
3. Work with provincial administrators to control and if necessary relocate some pastoralists now living in the Bale Mountains National Park.
4. Continue to monitor habitat condition regularly and take action if deterioration is detectable.
5. Given the extremely fragile nature of the one remaining population, a captive breeding programme should be started with the aim of re-establishing and/or supplementing remnant populations.

6. Genetic screening of aberrant individuals suspected to be hybrids with domestic dogs. If these animals are found to be hybrids, their removal is recommended and further genetic screening should be undertaken to determine, if possible, the extent of genetic introgression of domestic dogs into the jackal population. Many of these activities are included as part of a current research project within the Ethiopian Wildlife Conservation Organization by C. Sillero-Zubiri and D. Gottelli. The project is supported by Wildlife Conservation International.

African wild dog (*Lycaon pictus*)

IUCN Status: Vulnerable.

CITES Status: Not Listed.

Despite its current Red Data Book classification of "Vulnerable," a recent survey of the status of the wild dog (Frame and Fanshawe in prep.) provides strong evidence that this species is probably the most endangered large carnivore in Africa. Of 32 countries for which we have data, the species is extinct, or nearly so, in 19. In six countries, the species is extremely rare, but populations are more or less stable. In one country, the Sudan, there is the possibility that a viable population remains; however because of war and drought, the present status of the wild dog is unknown. Only six countries support populations that may be viable into the next century: Botswana, Ethiopia, Kenya, Tanzania, Zambia, and Zimbabwe. Even in these countries, a sanguine attitude could easily lead to extinction. In Kenya, Tanzania, Zimbabwe, and Zambia, populations have declined by at least 30% in the last decade. Little is known about absolute population numbers in Botswana and Ethiopia.

Research projects have been proposed, or are now active, in four of the six countries in which potentially viable populations of wild dog still exist: Kenya, Tanzania, Zimbabwe, and Botswana. Details of the objectives of these projects are listed below. In addition to the research being carried out, we recommend the following:

1. Listing of *Lycaon pictus* as an Endangered species by IUCN.
2. Complete legal protection in all countries. At the moment, in parts of their range, wild dogs enjoy only partial protection. Until population levels recover, total protection is critical.
3. Support for education programmes to discourage harassment and shooting of *Lycaon* by ranchers.
4. Detailed research on the causes of population decline (genetics and disease) and causes of conflict with humans.

Our recommendations reflect a strong bias towards local education and and a better understanding of the ecological basis of the wild dog's nomadism. Because wild dogs are nomadic, a conservation strategy which relies on populations that reside only in protected areas is unlikely to succeed. Many extremely large parks and reserves (Kruger, Hwange, Serengeti) do not appear to provide sufficient area to support a viable population of wild dogs. Further recommendations on this species will be made by Frame and Fanshawe (in prep.) in their final report.

Vulnerable and Rare Species

Maned wolf (*Chrysocyon brachyurus*)

IUCN Status: Vulnerable.

CITES Status: Appendix II.

The status of the maned wolf appears to have improved slightly in the last decade. Two threats—further agricultural expansion and conflict with humans—appear to be the most immediate causes for concern. The first can only be addressed by encouraging local governments to support farming practices that are compatible with wildlife use. The second threat, persecution by people, can best be dealt with through education. Programmes being conducted in Argentina and Brazil appear to be addressing the question of education and should be encouraged and supported. No change in the status category is recommended.

Grey wolf (*Canis lupus*)

IUCN Status: Locally Vulnerable.

CITES Status: Populations in Bhutan, India, Nepal, and Pakistan in Appendix I, all others Appendix II.

Except in Canada, Alaska, and the Soviet Union, wolf populations are either in steep decline or are already reduced to remnants. Protection outside these areas is poor, competition with farmers over livestock (both real and perceived), and a poor public image make conservation of this species difficult.

In all areas where decline is precipitous (see Chapter 6), education.research, management, and protection (legally, where currently absent; in reality where unenforced laws exist) are required. Among the areas we discuss in the Population and Status section, the top priorities for action are:

1. Mexico: a survey is needed; protection of habitat and reintroduction should be implemented.
2. Southwestern United States: reintroduction coordinated with education.
3. Europe: reintroduction coordinated with education.
4. Northwestern United States: in this area, research, reintroduction, and education efforts are needed.
5. Norway/Sweden: despite low population numbers (<10), persecution persists and is a hot political issue. A strong education effort is needed to reduce perceived conflict.
6. Middle East: persecution persists throughout the Mideast. Further protection and education are critical.
7. India: a survey to determine the status and distribution of remaining animals is necessary. Further protection and education are needed.
8. Southwest Asia: a survey to determine the status and distribution of remaining animals is critical. Further protection and education are needed.
9. Michigan/Wisconsin: research should be continued in this region, and coordinated with further protection and education.

At its meeting in September 1989, the Wolf Specialist Group identified the following particularly urgent priorities:

1. Survey of status and distribution of the wolf in Mexico. Funds are needed for a systematic survey to locate any wolves, to determine where suitable habitat remains for possible reintroduction, and to prepare a plan for re-establishment of a wolf population (U.S. $30,000 needed).
2. Portugal wolf study. A back-up telemetry receiver is needed for the Portugal wolf project which has been underway since 1983. Valuable data are lost each time the existing receiver breaks down, and a second receiver would also allow more efficient use of radio-tagged wolves and prey animals (U.S. $1,850 needed).
3. Wolf survey and ecological study in Poland. A diesel land-rover is necessary to facilitate this project because petrol is too expensive and restricted in availability, while diesel fuel is abundant and inexpensive (U.S. $10,000 needed).

Dhole (*Cuon alpinus*)

IUCN Status: Vulnerable.

CITES Status: Appendix II.

The dhole, like the African wild dog, is a species that is unlikely to survive outside protected areas except in extremely remote areas. Furthermore, large areas are required to support viable populations. The occurrence of the dhole in several large parks in India (particularly Periyar, the Mudumalai, Bandipur and Nagarhole complex, and Kanha) is encouraging. Tiger reserves established in southern India should provide protection to other populations of dhole.

The recent unexplained declines in Chitawan National Park, and earlier unexplained declines in the Soviet Union, however, are worrying. Whatever their cause (disease, decline in prey abundance), they remind us that even genetically viable populations are rarely "safe."

Perhaps the healthiest populations of the dhole are in Burma. Political instability complicates assessment of these populations at the moment. Further information is also required on populations in the Soviet Union and China. No change in status category is recommended.

Information is urgently required on the status, abundance, and distribution of the dhole in southeast Asia. In particular, information on the status of the dhole in Burma is needed before further recommendations can be made.

The use of poisons against wolves (*Canis lupus*) in the Soviet Union may also threaten remnant dhole populations; we agree with Ovsyanikov and Bibikov (1987) that this and other indiscriminant methods of predator control should be banned.

Grey zorro (*Dusicyon griseus*)

IUCN Status: Not listed.

CITES Status: Appendix II.

The species appears to be common in parts of its range. Estimates of abundance in Chile are, however, controversial. The extremely heavy use of this species for pelts (Mate and Jaksic 1986; Mares and Ojeda 1984), combined with relative uncertainty about its population status, suggest that a sanguine attitude is inappropriate. Better population estimates are needed for Argentina and Chile. Stricter enforcement of existing laws is required in Chile. Analysis of data collected by CITES as a result of the recent reclassification (Appendix II) will require the situation to be re-evaluated in the next few years. Given that the Argentine government has classified the species as endangered, and that in Chile there is poor enforcement of laws protecting the grey zorro, the species should be reclassified as Vulnerable by the IUCN unless sufficient data can be presented to contradict information we have collected.

Better estimates of population densities and absolute population numbers in both Chile and Argentina are urgently required. Although trade in this species has declined somewhat in recent years, levels of harvesting are still very high. Confusion and disagreements concerning previous surveys suggest that surveys should be made by parties without an economic interest in the species.

Bush dog (*Speothos venaticus*)

IUCN Status: Vulnerable.

CITES Status: Appendix I.

No change in the IUCN status category is recommended. Given the lack of information on the species, we consider these conservative classifications as warranted until evidence to the contrary can be documented.

The bush dog is a priority species for census data for distribution and abundance. The literature concerning the bush dog in the wild is limited to occasional sightings in one area or another. Nothing is known about the ecology or the behaviour of the species in the wild. Captive breeding programmes should be encouraged, although earlier efforts have been mostly unsuccessful.

Island grey fox (*Urocyon littoralis*)

IUCN Status: Not listed.

CITES Status: Not listed.

As an endemic whose population is known to be small, but not subject to any immediate threat, the island grey fox must be considered "Rare." As all six island populations are believed to be distinct subspecies, the island grey fox represents an unusual example of evolution of a carnivore on oceanic islands.

We support the U.S. Navy's proposed elimination of feral cat populations on two islands: San Clemente and San Nicholas. Where domestic dogs are present, we recommend the imposition of quarantine to prevent inadvertent transmission of diseases. Should populations decline in the future, captive breeding should be considered.

Bengal fox (*Vulpes bengalensis*)

IUCN Status: Insufficiently Known.

CITES Status: Not listed.

Further information is needed on the Bengal fox in parts of its range other than India. The status of this species appears to be changing rapidly. A recent reappraisal of the species' status in India shows that populations outside protected areas appear to have disappeared or been decimated by sport hunting, apparently with no use of the pelts after the animals are killed. As these data from India are the only recent surveys available the status of this species should be carefully monitored.

The Bengal fox, despite having once been extremely common, is not known to exist in any protected area. The establishment of reserves for the Indian great bustard may also result in inclusion of the Bengal fox in protected areas. Bustard sanctuaries have been, or will be established in Karnataka, Andhra Pradesh, MadhyaPradesh,Mabarashta,Ragasthan,and Gujarat. Surveys of these bustard reserves should be made to assess fox occurrence and population densities.

The greatest threat to the species is wanton killing of foxes for sport. As the pelts do not provide a saleable product, and the fox is not known to be a crop pest, an education campaign aimed at curbing sport killing appears to be the best way to provide protection for the species in many parts of India, both inside and outside of reserves.

In other areas (Pakistan, Nepal), surveys are needed to determine the status and distribution of the Bengal fox. These surveys could be coordinated with surveys for the Corsac fox (see page xx).

Insufficiently Known Species

Small-eared zorro (*Dusicyon microtis*)

IUCN Status: Insufficiently Known.

CITES Status: Not listed.

As there remains insufficient information on this species, we can make no firm recommendations as to conservation status. However, given that little information exists, and that the rain forests in which the small-eared zorro is found have come under increasing pressure in the last decade, a classification of Vulnerable might well be appropriate.

Sechuran zorro (*Dusicyon sechurae*)

IUCN Status: Insufficiently Known.

CITES Status: Not listed.

The Sechuran zorro remains one of the least known of the South American canids. At the very least, the species should be classified as "Insufficiently Known." Unlike the small-eared zorro, however, the Sechuran zorro lives in a region in which a census and/or a research project could be conducted.

Small-eared zorro and Sechuran zorro

What little information we have on these species suggests that ecologically they could not be more different from one another. Yet, from the point of view of conservation, our recommendations are similar for both species. Captive breeding programmes, or at least captive populations, should be established if possible until some estimate of existing wild population numbers can be made. Further legal protection should be encouraged throughout the range of both species. Given the near total lack of data on the biology of the species, we would strongly recommend research into the ecology and behaviour of these species, including the collection of data on abundance, diet, and social behaviour.

Hoary zorro (*Dusicyon vetulus*)

IUCN Status: Not listed.

CITES Status: Not listed.

Given the lack of information on this species, we recommend that it be included in the IUCN Red List of Threatened Animals as Insufficiently Known.

The overlap in distribution of the hoary zorro and maned wolf in Minas Gerais, Brazil, suggest that a research project (and efforts to secure protected habitat) can be coordinated with work on the maned wolf. A captive breeding programme, or at least a captive population should be established if possible. Legal protection should be encouraged.

Fennec fox (*Fennecus zerda*)

IUCN Status: Not listed.

CITES Status: Appendix II.

Little is known about this species. We recommend that its status category be changed, and that the fennec fox be included in the IUCN Red List of Threatened Animals as "Insufficiently Known." We make this recommendation despite that, given its habitat requirements, it is unlikely that the fennec fox will be in any danger of extinction in the near future.

Blanford's fox (*Vulpes cana*)

IUCN Status: Not listed.

CITES Status: Appendix II.

As a result of a recent study in Israel, we have a basic understanding of theecology and behaviouroftheBlanford'sfox. Information on the abundance and distribution of the species outside of Israel is incomplete. A specimen recently trapped in

Oman may belong to a distinct population deserving recognition as a subspecies. A photograph in Gasperetti et al. (1985) identified as a red fox (Plate 1, p. 405) may well be a specimen of Blanford's fox. These two sightings and known populations in Israel suggest that the distribution of Blanford's fox is much larger than originally believed (see below). This cannot be determined until further specimens are trapped. Until new records have been made it must be assumed that Blanford's fox inhabits appropriate habitat throughout the Middle East.

Turkmen folklore has it that these foxes appear only every twenty years. This could imply cycles of abundance of foxes or their prey, or climatic swings from which the animals benefit There is no indication that the fox is declining in numbers, hence no change in its status category is needed. Israel constitutes a small part of the range of this species. More information on distribution and abundance elsewhere in the Middle East are needed.

Arctic fox (*Alopex lagopus*). (Photo by G.W. Frame)

Corsac fox (*Vulpes corsac*)

IUCN Status: Not listed.

CITES Status: Not listed.

So little is known about the corsac fox that reclassification to "Insufficiently Known" is required. Nothing is known about the biology of the species, its local or regional abundance, and details of distribution.

Surveys to determine the abundance and distribution of this species are needed. We urge the authorities responsible for wildlife conservation in those countries in which this species is found to conduct such surveys to provide baseline information.

Pale fox (*Vulpes pallida*)

IUCN Status: Not listed.

CITES Status: Not listed.

The pale fox is perhaps the least known canid of Africa and the Middle East. There is no present threat to the species through trapping, however, the total lack of information concerning this species suggests that a change in its status category to "Insufficiently Known" would be prudent

Rüppell's fox (*Vulpes rueppelli*)

IUCN Status: Not listed.

CITES Status: Not listed.

As with the fennec fox and pale fox, next to nothing is known about the status and distribution, and little about the biology, of the Rüppell's fox. What little we know suggests that as areas of the Middle East are developed, problems may arise. The diet of the Ruppell's fox is very similar to that of the larger red fox (*Vulpes vulpes*). As the red fox coexists well with humans, competition may, in the future, force the Ruppell's fox out of some of the ecologically richest areas in its range. Although there is no direct threat to the species through trapping, we recommend a change in its status category to "Insufficiently known" until further information on status and distribution are collected.

Swift or kit fox (*Vulpes velox*)

IUCN Status: Northern subspecies Endangered, status is under review.

CITES Status: Not listed.

The "lumping" of *V. velox* and *V. macrotis* species is probably the most controversial aspect of this review (see O'Farrell 1987; Scott-Brown et al. 1985, 1987). Taxonomic considerations aside, members of this group of species appear to be widely distributed and populations appear to be uniformly healthy with the exception of the San Joaquin kit fox. The presence of the species can be used as an indicator of a healthy prairie ecosystems.

Data on annual harvests suggest that the foxes may be locally abundant, but increased monitoring and censusing is needed to establish the size and extent of most populations. A small part of the range of the San Joaquin kit fox is protected by its inclusion in the U.S. Naval Petroleum Reserves (O'Farrell 1987). No change is recommended.

Populations of the kit fox appear abundant. However, due to relatively large efforts at harvesting, the following research needs should be met:

1. Increased habitat protection.
2. Research on distribution and abundance are required in the United States and Mexico.

Species Requiring No Immediate Protection

Crab-eating zorro (*Cerdocyon thous*)

IUCN Status: Not Listed.

CITES Status: Not Listed.

There appears to be little threat to this species at the moment. Substantial habitat encroachment, disease, and harvesting for fur have not been reported in any country.

Culpeo (*Dusicyon culpaeus*)

IUCN Status: Not listed.

CITES Status: Appendix II.

The status of this species appears to differ from country to country. In Argentina, healthy populations appear to exist, despite intensive trapping for fur. In Chile, the species appears to be threatened, both from habitat loss and suspected illegal hunting with pelts trans-shipped to Argentina. Sufficient legislation is in place to protect the species but the laws must be enforced. No change in status category is recommended at this time, but special attention should be paid to the population decline in Chile. If populations in Chile become endangered, perhaps the only option would be to ban all trade in the species until the Chilean populations recover. See Chapter 9 for a discussion of use for pelts.

Studies of the culpeo are a high priority within Chile (Cattan pers. comm.). We agree that further research is needed.

Azara's zorro (*Dusicyon gymnocercus*)

IUCN Status: Not listed.

CITES Status: Appendix II.

There appears to be a healthy population of Azara's zorro in Argentina which could easily support the legal trade reported for 1984. However, little is known about the abundance and distribution of this species outside of Argentina, or about the trade in the species which is not reported. Recent inclusion of the species in Appendix II of CITES should clarify the situation. Methods of identification which can distinguish pelts of the Azara's zorro from those of the grey zorro need to be developed. That this species has been afforded protection in various countries suggests that it is both a valuable resource and one that may be in danger of over-exploitation. No immediate changes in status category is required.

Arctic fox (*Alopex lagopus*)

IUCN Status: Not listed.

CITES Status: Not listed.

With the exception of local threats to particular subspecies (see below), there appears to be no immediate threat to the survival of the arctic fox. Given its widespread abundance, further conservation measures are not a high priority. Nonetheless, other authors and correspondents have made several recommendations:

1. Garrot (1984) advocated protection of den sites. *Alopex* must re-occupy previously used dens as tundra is frozen in March-April when denning begins.
2. Assessment should be made of the real impact of *Alopex* predation on domestic stock in Iceland (Hersteinsson pers. comm.).
3. Trapping at den sites, a practice formerly common in the Soviet Union, should be prohibited, as it may destroy socio-demographic structure of breeding populations (Ovsyanikov 1985; pers. comm.).

Coyote (*Canis latrans*)

IUCN Status: Not listed.

CITES Status: Not listed.

The coyote has greatly expanded its range in this century. Although this is good in terms of the viability of the species, the expansion has brought the species into closer contact with humans, and in particular their domestic dogs and livestock. Little can be done to stop the interbreeding of coyotes and domestic and feral *Canis familiaris.* Although many researchers believe the extent of such interbreeding is minimal, some work is needed to assess the level of the mingling of the gene pools. The often unrestrained (and perhaps unjustified) killing of coyotes for livestock protection appears to have abated. However, where coyotes and sheep do come into contact, policies should be developed to allow the two to coexist (see Chapter 11). Efforts should be made to improve animal husbandry to achieve this goal.

Raccoon dog (*Nyctereutes procyonoides*)

IUCN Status: Not listed.

CITES Status: Not listed.

Given the widespread distribution of the species, and relative abundance in several areas, no changes in conservation status are recommended. However, an assessment of the population in China is needed. If local extirpation is imminent in China (i.e. populations small and declining throughout their range), an attempt should be made to secure sufficient protection for those individuals remaining. Knowledge of the population size in the Soviet Union would be valuable given the large number of exports from wild caught pelts.

Grey fox (*Urocyon cinereoargenteus*)

IUCN Status: Not listed.

CITES Status: Not listed.

The grey fox, able to live in urban and rural environments, is not immediately threatened. However, despite the extensive use of the species in the fur trade, little is known about population densities in any area, or about those factors which regulate population size. See Fritzell (1987) for extensive list of proposed management research.

Red fox (*Vulpes vulpes*)

IUCN Status: Not listed.

CITES Status: Not listed.

The red fox currently has the widest distribution of any canid and is common throughout its range except for some areas of the southern United States. No change in status category is needed.

Side-striped jackal (*Canis adustus*)

IUCN Status: Not listed.

CITES Status: Not listed.

Of the three jackal species in Africa which are still common, the side-striped jackal is the rarest. Its nocturnal habits make assessment of the population status difficult. However, there is no indication that the species is disappearing from its present range and, hence, no changes in the status category of the species is recommended.

Bat-eared fox (*Otocyon megalotis*)

IUCN Status: Not listed.

CITES Status: Not listed.

In the Serengeti, two study populations fluctuated due to outbreaks of rabies, which can occur several times a year. Approximately 25% of the study population was affected in each bout (Maas, pers comm.). In several areas (Zimbabwe, Tanzania) population numbers are believed to undergo rapid and wide fluctuations. Whether this is due to changes in the foxes' preferred prey, harvester termites, or due to disease epidemics is unknown; however, disease is suspected to be the cause. Bat-eared foxes appear to be particularly abundant in short grass habitat associated with cattle ranching. No change in the status category recommended.

Cape fox (*Vulpes chama*)

IUCN Status: Not listed.

CITES Status: Not listed.

Despite its narrow distribution (found only in South Africa, Namibia, and southern Botswana), the species is abundant where it occurs. Locally, the Cape fox is heavily hunted to control its purported predation on lambs. Although there is no evidence that this threatens local sub-populations, the level of offtake in some areas (15% **a** year) could lead to conservation problems. No change in status category is suggested. Information on abundance and distribution for the Cape fox and all other carnivores occurring in southern Africa is being assembled by the African Carnivore Survey (C. and T. Stuart) and is expected to be available in August/September 1989.

Black-backed jackal (*Canis mesomelas*)

IUCN Status: Not listed.

CITES Status: Not listed.

The black-backed jackal is a common species found at relatively high densities in many parts of Africa. Its ability to adapt to new conditions (including urban areas) suggests that the species may well be able to coexist with humans despite increasing urbanization and agricultural expansion in many parts of Africa. No conservation measures are recommended.

Golden jackal (*Canis aureus*)

IUCN Status: Not listed.

CITES Status: Not listed.

The golden jackal is locally abundant and widespread. Its range includes much of north Africa, the Middle and Near East. Little is known about subspecific differences and absolute population numbers are not available for many localities. Nonetheless, given the golden jackal's ability to coexist with humans, its wide distribution, and its local abundance, we considered the species extremely safe from extinction. No conservation measures are needed.

Dingo (*Canis familiaris dingo*)

IUCN Status: Not listed.

CITES Status: Not listed.

Throughout their range, dingoes are under grave threat of becoming "genetically extinct" because of hybridization with the more common domestic dog. The populations least affected by hybridization are those of northern Australia and Thailand (Corbett 1988a). However, increasing European influence in Thailand may result in a range expansion of the domestic dog, at present found only in major cities (Bangkok, Haadyai, Chiangmai).

No immediate action is required. However, information should be collected on the extent of genetic introgression in both the Thai and the Australian dingo populations.

Tibetan or Tibetan sand fox (*Vulpes ferrilata*)

IUCN Status: Not listed.

CITES Status: Not listed.

Information on the Tibetan fox is only slightly better than that available for the Corsac fox. Nonetheless, recent reports confirm that it is both widespread and abundant. There are no known threats to its survival. Although an increased understanding of the biology of the Tibetan fox would be welcome, we do not believe the species presents a conservation problem at this time.

Summary of Action Needed for Priority Species

Endangered Species

Red wolf (*Canis rufus*)

Recommendations

1. We strongly urge that a second site for reintroduction be found and stocked as soon as is technically and politically possible.
2. Continue captive breeding programme.
3. Assure protection at first reintroduction site.

Justification

1. The red wolf was extirpated in the wild in the 1960s and 1970s.
2. Having been brought back from near extinction by the captive breeding of 18 individuals, the red wolf has been introduced to a single site in North Carolina, U.S.A.

Simien jackal (*Canis simensis*)

Recommendations

1. Continue and improve protection in the Bale Mountains National Park.
2. Larger populations must be established outside the Bale Mountains National Park.
3. A captive breeding programme should be established to provide animals for reintroduction.
4. As was done with the red wolf, genetic screening must be made to ensure that animals bred in captivity and reintroduced are not jackal/domestic dog hybrids.

Justification

1. The most endangered canid in sub-Saharan Africa.
2. As an endemic found only in the highlands of Ethiopia, with a total population of well under 1,000 individuals, the Simien jackal is inherently prone to extinction. A single catastrophic event could wipe out the species.
3. The problems intrinsic to small total population size are magnified by the way in which remaining individuals are distributed: the great majority (400/500) of the remaining Simien jackals are in Bale Mountains National Park.
4. Cross-breeding with domestic dogs may threaten the long term survival of the species.
5. Fragmentation of the population may increase the risk of hybridization with domestic dogs.

African wild dog (*Lycaon pictus*)

Recommendations

1. Promote complete legal protection of wild dogs in all countries in which they occur; introduce a widespread education programme in east and southern Africa, particularly aimed at children and livestock producers.
2. Support research which aims to reduce or eliminate conflict between game/livestock producers and wild dogs.
3. Provide strict protection of potentially viable populations including Kruger National Park, South Africa; Hwange National Park, Zimbabwe; Moremi Reserve/Chobe and Mxai pan National Parks complex, Botswana; Luonga Valley National Park, Zambia; Serengeti Ecosystem, Tanzania and Kenya; Selous Game Reserve, Tanzania.
4. Continue research on husbandry in captivity.
5. Hold a workshop aimed at creating a survival plan for the species using population viability analysis.

Justification

1. Probably the most endangered large carnivore in Africa.
2. Of 32 countries for which we have data, the species is extinct, or nearly so, in 19. In six countries, the species is extremely rare, but populations are more or less stable. In

Grey wolf (*Canis lupus*). (Photo by K. Hollett)

one country, the Sudan, there is the possibility that a viable population remains.

3. Only six countries support populations which may be viable into the next century: Botswana, Ethiopia, Kenya, Tanzania, Zambia, and Zimbabwe. In Kenya, Tanzania, Zimbabwe, and Zambia, populations have declined by at least 30% in the last decade.

Vulnerable and Rare Species

Grey wolf (*Canis lupus*)

Recommendations. In many areas, there is a critical need for surveys, education, protection, and reintroduction (especially Yellowstone National Park). Where prey species have been extensively depleted (e.g. Italy), reintroduction of prey as well as predator should be effected. Not all these activities are required in each region; for details see Chapter 6. Priority should be given to these activities in the following areas: Mexico, southwestern U.S.A., central and southern Europe, northwestern U.S.A., Norway/Sweden, the Middle East, India, southwest Asia, Michigan/Wisconsin U.S.A.

Justification. In much of its range, the grey wolf is threatened with extinction. Causes of extinction, or potential extinction, include loss of habitat to agriculture, hunting, interbreeding with domestic dogs, and active persecution by man caused by depredation of domestic and game animals.

Bush dog (*Speothos venaticus*)

Recommendations

1. Surveys of distribution and numbers are needed to confirm the status of this species.
2. Captive breeding programmes should be considered but require careful thought since earlier attempts have had limited success.
3. Studies of the behaviour and ecology of this species in the wild are an academic priority, and could contribute to formulating conservation plans.

Justification

1. Nothing is known about the ecology or the behaviour of the species in the wild; what little we know suggests that the species is rare throughout its range.
2. Captive breeding programmes have been mostly unsuccessful.

Dhole (*Cuon alpinus*)

Recommendations

1. Information is urgently required on status, abundance, and distribution, especially in Burma, China, and the Soviet Union.
2. The use of poisons against wolves (*Canis lupus*) in the Soviet Union should be banned in areas where the two species coexist, as poisoning may threaten remnant dhole populations.

Justification

1. The dhole is a species which is unlikely to survive outside of protected areas except in extremely remote regions.
2. The recent unexplained declines in Chitawan National Park, Nepal, and earlier unexplained declines in the Soviet Union are worrying. Whatever their cause (disease, decline in prey abundance), they remind us that even genetically viable populations are rarely "safe."
3. Perhaps the best populations of the dhole are in Burma. Political instability complicates assessment of that population at this time.

Grey zorro (*Dusicyon griseus*)

Recommendations

1. Surveys of population status, especially in Chile and Argentina.
2. Fur harvest quotas should be implemented until reliable data are available on population numbers.
3. Stricter enforcement of existing laws is required in Chile.

Justification

1. There is extensive trade in this species.
2. Harvests are uncontrolled.
3. No reliable information exists on population density or distribution.

Maned wolf (*Chrysocyon brachyurus*)

Recommendations

1. Coordinate and expand education programmes.
2. Convene an SSC workshop on this and other South American canids.
3. Encourage reintroduction programmes.
4. Implement land use planning which encourages coexistence of humans and maned wolves.

Justification

1. The status of the maned wolf appears to have improved slightly in the last decade.
2. Further agricultural expansion and conflict with humans remain causes for concern.
3. The first can only be addressed by encouraging local governments to support farming practices which are compatible with wildlife use.
4. The second threat, persecution by people, can best be dealt with through education. Programmes being conducted in Argentina and Brazil appear to be addressing the question of education and should be encouraged and supported.

Island grey fox (*Urocyon litoralis*)

Recommendations

1. The U.S. Navy's proposed elimination of feral cats on two islands: San Clemente and San Nicholas should be supported.
2. Where domestic dogs are present, quarantine regulation should be imposed to prevent inadvertent transmission of diseases.

Justification. The fox is endemic to **a** small archipelago. Total population size is known to be small, however none of the sub-populations appears to be subject to any immediate threat

Insufficiently Known Species

Canids of North Africa and the Middle East

Establishing conservation priorities for this region is, at best, difficult So little is known about each species that assessing the need for, and value of, various conservation measures requires a leap of faith we are unwilling to make. However, there are several actions of a general nature which need to be taken:

1. Comprehensive surveys to determine both the species present and their relative densities. Priority should be given to surveying protected areas, as animals living within their boundaries should will be afforded higher levels of protection.
2. Further work on the interactions among humans, red fox, golden jackals, and the rarer species of fox. It appears that the range expansion of the red fox associated with increased human development may pose the single greatest threat to the long-term survival of all the other fox species (Hersteinsson and Macdonald in prep.).
3. If necessary, reserves should be established which include desert foxes.
4. An attempt should be made to develop self-sustaining captive populations if surveys do not reveal healthy wild populations.

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In the course of writing this action plan, we entered into correspondence with nearly two hundred individuals and organizations. The action plan could not have been written without these people. Many were known to us before we started, people who were either experts on a particular species, or a particular region, or people involved in one of the many aspects of wildlife conservation. Among this first group are the members of the IUCN/SSC Canid Specialist Group (see Appendix 1).

Many of our correspondents, however, were not on our original mailing list. Some wrote us expressing an interest in canid biology and, probably much to their surprise, soon found themselves being mercilessly questioned for information in their particular area of interest. Others were recommended to us by people already on our distribution list.

In the following pages, we list the names and addresses of our correspondents, with their particular field of interest following the address. No doubt, despite an effort to be as thorough as possible, we have neglected to contactpeople who mighthave been approached for information and advice. If you feel yourself among that group, please send us your address and become a member of our information network.

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