Rabies as a Threat to the Endangered Ethiopian Wolf (*Canis simensis*)

Karen Laurenson23, Fekadu Shiferaw24 and Claudio Sillero-Zubiri25

1 INTRODUCTION.

As a species becomes more rare and thus more endangered, its remaining individuals are likely to become confined to a few small and fragmented populations. Such small populations are vulnerable to epidemics of disease and, virtually by definition, small populations are unable to support in the long term species-specific pathogens that are a major threat to their viability (Dobson and Miller, 1989). Thus generalist pathogens such as rabies, which can infect a wide range of species, pose the greatest threat to endangered species. In recent years it has become apparent that rabies can be a real threat to endangered species, with mortality in African wild dogs (Alexander et al., 1993; Gascoyne et al., 1993) and Blandford’s foxes (Macdonald 1993) which survive in small fragmented populations. This has given a new dimension to concerns about rabies as a conservation issue.

The Ethiopian wolf is endemic to Ethiopia and is the world’s most endangered canid. Less than 400 individuals now survive in six fragmented populations in the afroalpine highlands of Ethiopia and only two of these populations may be viable in the long term. The species is ultimately threatened by habitat loss as expanding human populations push into afroalpine habitat. Nevertheless, canid diseases, particularly rabies, are the most immediate threat to the largest remaining population in the Bale Mountains National Park and may also be threatening other populations. This paper briefly outlines the problem that rabies has posed to the critically endangered Ethiopian wolf, presents data on the incidence of rabies and the size and dynamics of the dog population around the park and outlines the future actions that will be taken.

1.1 Background to the problem.

The Bale Mountains National Park (BMNP) lies in the south-eastern highlands of Ethiopia and includes some 1000 km² of land over 3000 m, being thus the largest area of afroalpine habitat on the continent (Hillman 1986). The local communities who live around the area are Muslim agropastoralists who rely on cultivating barley and their herds of cattle and sheep for their livelihood. Some 2500 people live inside that park, some on a seasonal basis, and are accompanied by their domestic animals, including domestic dogs. These dogs can come into contact with Ethiopian wolves and hybridisation has occurred (Gotelli et al., 1994).

The BMNP harbours the largest wolf population with the two areas of prime habitat separated by some 15 km of lower quality habitat (Figure 1). This population declined from its apparent peak in the 1980s of some 500 individuals, to some 120-160 animals in 1995 (Figure 2). In 1990 and again in 1991/1992, one of us (CSZ) found that many wolves had disappeared and observed others dead or dying (Table 1). Clinical signs included ataxia, anorexia and convulsions (Sillero-Zubiri et al., 1996). Within 3 months in 1990, 12 of 23 known individuals on the Sanetti plateau in the north west of the park died or disappeared. Over five months in 1991-1992, 41 of 53 known wolves in five packs died or disappeared in the Web valley in the north east of the park. Three of the six Web Valley packs were decimated and eventually disintegrated. Close correlation between rates of known mortality and unaccounted wolf disappearance was evidence that missing wolves died of similar causes to the ones found dead. Hybrid wolf/dogs survived better than pure wolves, but we do not know whether this can be explained by better resistance to rabies or to a lower chance of exposure. Rabies Serotype 1 virus of canid origin was isolated from three brain samples collected from wolves.

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Figure 1: Ethiopian wolf habitat, Bale mountains National Park
Table 1: Rabies in the Ethiopian Wolf Population Bale Mountains National Park*

<table>
<thead>
<tr>
<th>metapopulations</th>
<th>Year</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web Valley</td>
<td>1991/92</td>
<td>41/61</td>
</tr>
<tr>
<td>Sanetti Plateau</td>
<td>1990</td>
<td>12/23</td>
</tr>
</tbody>
</table>

Survivors: Wolves 1/16
Hybrids 3/3 (Fisher Exact Probability=0.004)
Rabies virus (Serotype 1 canid origin) isolated from three wolf brains tested.


Between 1992 and 1995, the wolf population declined further (Figure 2). Anecdotal reports from local communities revealed a widespread epidemic in domestic dogs inside the park in 1993, with clinical signs consistent with infection from canine distemper virus. A limited serological survey of survivors and other dogs revealed seropositivity in dogs born before the epidemic, but no evidence of antibodies to CDV in dogs born since 1993. Whether this epidemic affected sympatric Ethiopian wolves is unknown, as no monitoring was carried out at that time.

Figure 2: Ethiopian wolf monitoring index, Sanetti plateau, Bale Mountains National Park

2 Methods.

Questionnaire surveys were used to estimate both the incidence of rabies and the demographic characteristics of local rural and urban dog populations. In three towns (Dinsho, Goba, Robe) and three rural areas around Dinsho, 30-70 households were sampled randomly. If dogs were owned by the household, a more extensive questionnaire was carried out to estimate the number of dogs owned, their age, sex, reason for ownership etc. The size of all households was established and details of rabies cases that interviewees had seen or heard about were collected. Further details were collected from owners of all dogs vaccinated in a trial vaccination programme in two areas.

Dog population sizes in each area were estimated from the dog : human ratio, a technique adopted in several studies (Wandeler et al., 1988; Brooks 1990: Matter 1991; Cleaveland 1996). Human population estimates for 1996 in each warida in the region, broken down into rural and urban areas, were obtained from local administrative offices. Estimates of the number of households in each kabele, or the population size, were obtained from the chairman or other official of each kabele studied. Some difficulty was encountered in obtaining these figures and their accuracy may be suspect; estimates of the town population sizes varied between sources.

Population age structures were determined for urban and rural dog populations, by plotting \( \log_e \) (proportion in age class) by age class. The reciprocal slope of these plots, 1/b, calculated by Microstat 3, gave a measure of the birth interval, which in a population with a stable age distribution is equivalent...
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to life expectancy. Population growth was estimated from questionnaire data as follows, where \( N_{96} \) = present dog population size of sampled households, \( n_n \) = number of dogs acquired in previous year and \( n_d \) = number of dogs died or lost in previous year:

\[
\text{Change in population} = \frac{n_d - n_n}{N_{96} - n_n + n_d}
\]

3 RESULTS AND DISCUSSION.

3.1 Rabies epidemiology.

There were no recent records of confirmed rabies cases in any species in the area. However, this in no way reflects the true picture of rabies incidence, for two reasons. First, few sick dogs were taken to the veterinary clinic and local people thought that they could recognise the clinical signs of rabies and tried to kill animals with clinical signs as soon as possible. Second, if cases were presented to clinics, there were few storage facilities for samples and the diagnostic laboratory was over 400 km away. Veterinarians usually made a diagnosis on clinical grounds and arranged to have the animals destroyed.

However, interviews with local residents and personal observations suggested that rabies was endemic in the Bale region (Table 2). These data suggest that the incidence of rabies in dogs, livestock and humans is very high in the area adjacent to the BMNP, with a conservative estimated annual incidence of 0.83-2.25 humans and 1199-2123 dogs per 100000. Livestock losses were estimated to be up to 1 cattle death per 12 households per year, equivalent to US $7.5 per household per year, a significant proportion of the GNP.

Table 2: Estimated incidence of unconfirmed canine and human rabies cases, Bale Region.

<table>
<thead>
<tr>
<th>Area</th>
<th>Estimated incidence of canine rabies /100000/year</th>
<th>Estimated incidence of human rabies /100000/year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Most conservative estimate</td>
<td>Least conservative estimate</td>
</tr>
<tr>
<td>Urban</td>
<td>2123</td>
<td>5613</td>
</tr>
<tr>
<td>Rural</td>
<td>1199</td>
<td>2167</td>
</tr>
</tbody>
</table>

(Most conservative estimates of incidence in dogs were calculated from the total number of rabies cases reported in last year, but using only one case each month. Least conservative estimates included reports of more than one case per month, but excluded replicated reports where possible. For humans, most conservative estimates are based on the assumption that all cases in last 3 years were reported and maximum population estimate. Least conservative estimates use minimum population estimates and only cases reported in last year).

Incidence comparison is difficult because reported WHO (1992) figures refer only to confirmed cases. The most accurate comparison is probably the incidence of human rabies, as such cases are noteworthy in the community and are generally diagnosed on clinical grounds by trained personnel. On this basis, the incidence of rabies in the Bale Region is as severe as any region in the world, being comparable to that in the Indian subcontinent and higher than in most other parts of Africa.

Older inhabitants (> 50 years) were asked if the incidence of rabies had changed over their lifetime. Of 12 such interviewees, 83% thought that rabies was now more common. Accounting for the reason behind this increase, five respondents suggested that human and thus dog numbers had increased, four suggested that dogs were not as well cared for now, one person said that the dogs did not get enough food and so could not fight off diseases and one suggested that there were now more common jackals and that they were the rabies reservoir. In addition, one person added that the spatial demographics of the human and thus dog population had changed, as well as increased, so that there was now more contact between dogs. Three respondents did not know why rabies might have increased.

Unconfirmed rabies infections were reported as the most common cause of mortality in dogs, accounting for an estimated 20% of dog deaths overall, where deaths due to poisoning in dog control
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campaigns were included. Excluding this cause of mortality, rabies accounted for 25.5% of dog deaths.

Rabies was well known by community members, with 93% (n=227) reporting that they were aware of rabies as a public health and economic problem. Indeed, 67% of owners cited rabies transmission as the major disadvantage of owning a dog. Significantly more people in rural than urban areas had seen animals with the disease (Fisher exact probability, p=0.04). Of 25 people questioned in more detail, 19 (76%) could describe accurately the clinical signs associated with rabies and knew that there might be both ‘mad’ and ‘dumb’ forms of the disease.

Approximately 85% of interviewees, including owners and non-owners of dogs, thought it would be good to try to control rabies in the areas by dog vaccination, although many people did not know that vaccination was a rabies control method before being interviewed, nor understood how vaccination worked either in humans or animals. Six respondents raised the issue of wildlife reservoirs for rabies in the area, because they had seen some wild species, particularly common jackals and genets or mongooses, with symptoms of rabies. They asked how rabies in these wild species could be controlled, as, in their understanding, controlling the disease in dogs would not completely protect their cattle.

3.2 Dog demography.

There were significantly more dogs per household and dogs per human in rural areas around Dinsho than in the urban centres of Dinsho, Robe and Goba, with rural dog density averaging 16.0 dogs per km² and urban dog densities at 290 per km² (Table 3). However the dog:human ratios were lower in rural than in urban areas at 1:4.6 and 1:14.3 respectively. In addition, an estimated 125-175 dogs live inside the park in Ethiopian wolf habitat for at least part of the year.

Dog populations were male biased in urban areas and in high density rural areas, but less biased in the lower density rural areas (Table 3). Male bias was achieved by leaving female pups out in the countryside at 4-6 weeks of age. These pups either starved to death or were eaten by predators. Occasionally they would be rescued and taken into someone’s home.

<table>
<thead>
<tr>
<th>Landuse</th>
<th>Dog density(km⁻²)</th>
<th>Dog/human</th>
<th>Sex ratio(M/F)</th>
<th>Annual change in size of dog population</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (range)</td>
<td>Mean (range)</td>
<td>Mean (range)</td>
<td>Mean (range)</td>
</tr>
<tr>
<td>Urban</td>
<td>290 (230 – 380)</td>
<td>1:14.3 (1:10.8-1:16.7)</td>
<td>0.83:0.17 (1:0.22 - 1:0.16)</td>
<td>+7.7 (-17 - +40)</td>
</tr>
<tr>
<td>Rural</td>
<td>16 (10.3 - 23.7)</td>
<td>1:4.6 (1:4.1 - 1:4.8)</td>
<td>0.63:0.37 (1:0.82 - 1:0.33)</td>
<td>+7.5 (+2.1-+17.6)</td>
</tr>
</tbody>
</table>

The dynamics of the dog populations varied between different areas with negative population growth or no growth in urban areas such as Robe (0%) and Goba (-17%) where dog control programmes had been carried out within the year previous to the survey. In contrast, the dog population in Dinsho had increased markedly (40%) in the previous year and the rural populations had, on average, increased by 7.5%. This level of increase would lead to a doubling of the population in approximately 10 years.

The median age of both rural and urban dog populations was 2 years (Figure 3) although the turnover rate (the percentage of the population less than 1 year old) in the rural population was slightly higher (26%) than in the urban dog population (18%). The average life expectancy of the rural dogs was 2.8 years, whereas that of urban dogs was 2.7 years.
4 CONCLUSION AND ACTION PLAN.

Dog density in the Bale region is high in both urban and rural areas, well above the apparent threshold for rabies endemicity (Cleaveland and Dye, 1996). Anecdotal reports suggest that its prevalence has increased from epidemicity to endemicity over the last 40-50 years, with an increase in the number of people and their dogs. The human population has also expanded into areas of prime wolf habitat and it is likely that for wildlife in the Bale region and Ethiopian wolves in particular, rabies is a human-associated problem that is increasing. The high rate of mixing of the dog population, at least on the north-western side of the park, and the degree of overlap and contact between domestic dogs and wolves, means that the probability of rabies and other canid diseases invading the Ethiopian wolf population is significant.

Preliminary models to examine the consequences of periodic disease outbreaks for the persistence of Ethiopian wolf populations were constructed (Mace and Sillero-Zubiri 1997). These suggested that the Bale Mountains' wolf populations was very likely to become extinct within 50 years when rabies epidemics occurred at a frequency of 1 every 7 years on average. With a lower frequency of rabies epidemics, the wolf population was less likely to become extinct, although extinction was again almost certain when canine distemper epidemics were introduced.

Figure 3: Age structure of domestic dog population, Bale region

Thus rabies and other canid diseases should be perceived as a real threat to the continued existence of the Bale Mountains Ethiopian wolf population and of the species generally. Management of canid diseases must be included as an important part of any action to help conserve this endangered species. The Ethiopian Wildlife Conservation Organisation and the IUCN Canid Specialist Group therefore decided on a short and long term strategy to ameliorate the situation (IUCN Ethiopian Wolf Action Plan 1997; Laurenson and Sillero-Zubiri, 1997). In the short term, vaccination of domestic dogs inside and immediately adjacent to Ethiopian wolf habitat was recommended to give the existing population an improved chance of recovery. In the longer term, it was recommended that both disease and dog control should be improved by:

- an owner education programme to encourage responsible dog ownership
- a large scale rabies vaccination programme that would both benefit the local community and conservation objectives
- a programme to improve dog population control.
In addition, it was recommended that the following should be investigated:

- the threat that canid disease posed to other wolf populations should be investigated
- the role of wildlife in the persistence of these generalist canid pathogens, particularly rabies and canine distemper
- the role of vaccination of rabies and other canid viruses on dog population dynamics.

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5 REFERENCES.


MACE and SILLERO-ZUBIRI 1997


WHO 1992