Appendix 3
Population and Habitat Assessment Techniques

In order to assess the impact of current threats (Chapter 3) and conservation action needed to allow the recovery of the Ethiopian wolf (Chapter 10) it is important to determine the status and distribution of all remaining wolf populations. These data could then form the basis for any subsequent population monitoring and to assist with future management decisions.

Information on suitable habitat available to the species is also important to calculate the carrying capacity for wolves of different areas. For example, it will be necessary to evaluate the availability and suitability of sites for eventual reintroduction of wolves. The structure and biomass of the rodent community will play an essential part in the assessment of the areas.

Difficulties in accurate censusing have hampered many carnivore studies (Mills 1996). Indeed, most studies of carnivore distribution have been based on the use of signs, in particular faeces, footprints and kill remains. While these indirect methods do not quantify the number of animals present in a given area, they are particularly useful as a quick means of assessing the status of little known populations. Information of a quantitative nature, however, is needed to establish valid baseline data to monitor changes in numbers and distribution.

Techniques for Surveying Ethiopian Wolf Populations

Presence/Absence

Surveying techniques useful for short field visits to ranges of afroalpine habitats where Ethiopian wolf might be present.

Historical records. Collate previous wolf sightings for the area from the bibliography, and from interviews with wildlife officials, hunting guides, naturalists, tourists and aid workers that work or have worked in the area.

Interviews with local people. Interviews can provide confirmation of wolf presence in a given area. With the assistance of a local interpreter visit local settlements and interview shepherds living in the area using a standard questionnaire (Box. A3.1). Always use the most suitable local name(s) for the species. Present respondent with a photograph of a wolf. If any respondents report a wolf sighting, record the approximate location on a detailed map, and the date, time of day, habitat type, number of wolves and name of the observer in a data-sheet.

Reports of opportunistic sightings. When visiting suitable afroalpine areas carry out wolf searches either on foot, horseback or by car during trips across range, or scan range with binoculars from vantage points such as hills or cliffs. Record details of every individual sighting in customized data-sheets, including date, time, observation time, location, coordinates, altitude, group size, habitat type and name of the observer. Include information on age, sex and breeding whenever possible. Darker coat of males makes it easy to sex them. The large penile sheath, testis and the raised-leg urination position also help to identify males. Lactating females can be detected by their swollen teats and lighter coats. Animals under eight months old are considerably smaller than adults and therefore easily classified as young of the year. Pups (< 4 month old) are easily recognizable by size and dark brown coats.

Vocalizations. While camping in afroalpine habitat listen carefully for vocalizations at dusk, night and dawn. Communal call may give away clues on the number of packs in the vicinity, pack size, and position.

Calls can be grouped into two categories: alarm calls, given at the scent or sight of man, dogs, or unfamiliar wolves, start with a "huff", followed by a quick succession of high-pitched "yelps" and "barks". "Yelps" and "barks" can be also given as contact calls, and often attract nearby pack mates. Greeting calls include intense "group yip-howls", given at the reunion of pack members and to muster pack members before a border patrol. A lone howl and a group howl are long-distance calls used to contact separate pack members and can be heard up to 5 km away. Howling by one pack of wolves may stimulate howling in adjacent packs.

Box A3.1
Ethiopian Wolf Status and Distribution

QUESTIONNAIRE/INTERVIEW

Addressed to: People living within historical / present Ethiopian wolf range.
Subject: Presence and status of Ethiopian wolves in your area. Conflict with human interests.

Ethiopian wolves are one of Africa's most endangered animals and are unique to Ethiopia. Ethiopian wolves occurred originally in most Ethiopian mountains, where they inhabit Afroalpine heathlands and grasslands (wurch and high wurch). Today, they have disappeared from most places. We would appreciate your help in answering the following questions. We want to know whether Ethiopian wolves are still found in your area. Additionally, we would appreciate your views on Ethiopian wolves and other wildlife. Thank you for your assistance.

QUESTIONS

Personal details

1 – What is your **name**?
2 – Your **occupation**?
3 – Name of this **area**?
4 – Name of your **village**?
5 – **How long** have you lived here? (months/years)
6 – Do you live here all **year round**? (months/seasons)

Occurrence/Abundance

7 – Have you **personally** ever seen wolves in this area? (Y / N)
8 – Have you heard if **anybody else** has seen wolves in this area? (Y / N)
9 – How many **times** have you seen them within the **past five years**? (*n* times)
10 – How many times have you seen wolves within the **past 12 months**? (*n* times)
11 – **How many** wolves do you think are present? (*n* wolves)
12 – What is the **largest group** of wolves you have seen?
13 – What **time of the day** you are more likely to see wolves?
14 – Have you ever seen wolves in **any other area**? Where? When?

Reproduction

15 – Have you ever seen wolf **pups**? (Y / N)
16 – Do you remember **how many** pups you saw together? (*n* pups)
17 – At what **time of the year**?
18 – Have you ever seen wolves **mating**? (Y / N)

continued on next page

Population trends

19 – Do you think the wolf population in your area is **increasing**, **stable**, or **declining**?
20 – Please give your reasons for thinking so.

Mortality/Disease/Competition

21 – Have you ever found **dead** wolves? (Y / N)
22 – If so, **where**, **when**, **how many**, and what was the **cause** of death?
23 – Do you keep/own **domestic dogs**? (Y / N)
24 – **How many** dogs do you have?
25 – Have any of your dogs **died** recently? (Y / N)
– If so, **where**, **when** and what was the **cause** of death?
26 – What year, to the best of your knowledge, were these diseases last documented to occur in your area? **Anthrax**, **Rabies**, **Canine distemper**.
27 – On average **how often** do you see (how many days passes between you seeing) **Ethiopian wolves**? **hyaenas**? **common jackals**? **lions**? (everyday, every *n* days, every *n* weeks, not seen).
28 – Have you ever seen **wolves and dogs together**?
29 – What were they doing?

Public perception/Livestock losses

30 – **What do you think** of Ethiopian wolves?
31 – Do you feel their presence in this area is **bad** for people and their animals?
32 – In your opinion, can wolves live harmoniously in the same area with people? (Y / N)
33 – What is the attitude of local people towards wolves? **Positive**, **Indifferent**, **Negative** (dislike wild dogs), **Very negative** (will kill wild dogs)
34 – Has any livestock, to the best of your knowledge, been **killed by wolves** in or close to your area within the **past five years**? (Y / N) – Within the **past 12 months**? (Y / N)
35 – Have you ever seen wolves taking sheep, goat or calves out of **your** herd? (Y / N)
36 – Please give details.
37 – Has any livestock been **killed by other predators** (lions, hyaenas, leopards)? (Y / N)
38 – Please give details.
39 – Is there anything else you would like to tell us about the wildlife of this area?

Many thanks for your help. Please report to the Ministry of Agriculture, Forestry Project, or local Administration any sighting of Ethiopian wolves, den (breeding hole), dead wolf and any livestock carcass ***killed*** *by Ethiopian wolves.*

PLEASE DO NOT DISTURB ETHIOPIAN WOLVES. KEEP YOUR DOGS FROM HARASSING THEM

Wolf Abundance

The abundance and distribution of wolves in a particular mountain range may be assessed if the researcher can spend a longer period (weeks or months) in the area. There are several census methods, both direct and indirect, that might be used. The main methods used to study Ethiopian wolves in Bale have been survey transects of wolves, their signs and their prey, direct observation from vantage points of known animals, trapping, and radio-tagging.

Survey transects. Standardized walking transects may be used to assess wolf abundance, prey and habitat availability (see below). Walk or ride in roughly straight transects across range. Record in customized datasheets location, date, name of the observer, starting time, finish time and approximate distance covered. Observers may take advantage of any road traversing the range to do a road count. Counts may be stratified to take account of the representation in the area of main habitat types. For every individual sighting record time, distance to the transect in a perpendicular angle, group size, habitat type, age, sex and breeding status if possible. For survey design and data analysis follow standard line sampling methodology reviewed by Buckland *et al.* (1993). Line transect data may be analyzed using the software Distance described by these authors, although the sample sizes will almost certainly be low for Ethiopian wolves. Roads are often unsuitable as transect lines as they seldom sample the habitat well.

Extrapolation of wolf density. For large scale analysis of wolf density it is possible to rely on the availability of different vegetation types in a particular range. The estimated density of wolves in different plant communities may be extrapolated to the area of the plant communities calculated using detailed maps or remote sensing techniques. These may be either aerial photographs or satellite images used to see major plant communities. This technique was applied by J. Malcolm in Arsi (Chapter 2) and by Gottelli and Sillero-Zubiri (1990) to calculate the total wolf population and the potential carrying capacity of different mountain ranges.

Systematic sign surveys. If sample sizes are large and adequately stratified, by selecting plots or transects proportionately to habitat availability, it may be possible to estimate wolf abundance from indirect signs such as footprints, droppings and diggings.

In each plot or along transects search for wolf evidence. Look for droppings on top of earth mounds, rocks, bushes and edge of swamps or streams. It is important to determine whether the observer can discriminate wolf droppings from those of domestic dogs. Record other specific wolf signs (dens, prey remains and signs of digging) and evidence of rodent prey (see below).

Observation of known animals. For accurate estimates of population density more intensive methods are required. This requires knowing individual animals and usually involves catching and marking some individuals with radio tags, ear tags or ear notches. Alternatively, individuals may be identifiable by coat pattern differences and be censused through photographic methods. All known animals should be placed into four age categories: pups, up to four months old; juveniles, up to one year of age; subadults, up to two years of age; and adults.

The afroalpine landscape is typically fairly flat with short vegetation and most home ranges could be monitored from slopes, cliffs and rocky hills. Most travel within a study area can be accomplished on foot or horse-back. Scanning and observations can be made from vantage points during daylight (06:30 to 18:30 hrs). In most places the wolves are tolerant of human presence and detailed observations could usually be made from 20–500 metres. Whenever possible the wolf observed should be plotted to the nearest 100 m every 15 min. A hand-held GPS (global positioning system) is invaluable for this.

The Lincoln Index. The Lincoln index is a useful method to estimate animals' abundance and has been used widely (Seber 1973). A modified Lincoln index has been used in a number of large carnivore studies. It is a mark-recapture method relying on two important assumptions, that marked and unmarked animals have the same probability of being caught in the second sample and that the population must be closed, with no mortality or recruitment during the sampling period. In the modified version the total population is derived from the proportion of marked to unmarked animals resighted during a given observation period, making unnecessary to continue to capture animals.

Another modification to the Lincoln index relies on marked droppings and the rate of marked and unmarked droppings retrieved. For this purpose a small sample of animals need to be captured and injected with a Zn isotope (Kruuk *et al.* 1980). Alternatively coloured plastic beads may be fed to a sample of animals, and then compared the rate at which marked droppings are retrieved. Both methods only provide approximate population estimates.

Radio-telemetry studies. This technique is widely available today and has revolutionized studies of free-ranging vertebrates. With it it is possible to locate and monitor the movements and habits of elusive animals on a regular and predictable basis. Small (< 200 g), long-lasting transmitters (life span up to two years) should be favoured. In the BMNP Ethiopian wolf study radio-transmitters were predominantly used to locate the wolves for direct observations, but the radio-tagging data was also invaluable to quantify wolf movements and home range size.

Home range size and overlap may be evaluated using minimum convex polygons, or restricted polygons. The merits of these techniques and data analysis have been widely reviewed (*i.e.* Kenward 1987, White and Garrot 1990). Home range analyses may be carried out using one of the standard analysis packages such as Wildtrak for Macintosh (Todd 1992) or Range V for PC (Kenward *et al.* 1996).

Capture methods. If setting up a research programme it may be possible to capture wolves for fitting radio-transmitters, collect blood samples and morphological data. Be aware that any plans to trap wildlife in Ethiopia will require a formal application to EWCO and/or the regional authorities. In addition to confirming their presence trapping would allow collection of biological samples for genetic and epidemiological studies.

Ethiopian wolves may be trapped using rubber-jawed leg-hold Soft-catch ™ traps (N° 1½ and N° 3, Woodstream Corporation, Lititz, Pennsylvania, USA). Two to five traps set concealed in a circle around a dead bait of locally-caught rodents or a small lamb and laced with long distance call lure 600 and coyote & wolf gland lure No 100 (Stanley Hawbaker and Sons, Fort Loudon, Pennsylvania, USA). Traps need to be checked every two hours. On approaching the trap wolves should be covered with a blanket and immobilized with a hand injection of 3–4 ml/kg of Telazol (50 mg/ml), and individually marked with plastic ear tags (Rototag, Henley, U.K.). The trapping and handling methodology is discussed in detail by Sillero-Zubiri (1996).

Population Changes

In addition to quantifying wolf populations it may be possible to evaluate population trends.

Interviews. Properly conducted interviews can provide important data concerning the distribution and change in wolf numbers in addition to confirming wolf presence in a given area. The interviews also help to appraise public attitude towards Ethiopian wolves and other wildlife. Visit villages occurring within wolf range and talk to the village elders. Also talk to women and children, they spend more time out guarding livestock. Using a standard questionnaire (see Box A3.1) ask respondents for wolf occurrence in their area, abundance trends and evidence of mortality, occurrence of disease, breeding and/or evidence of hybridization with domestic dogs. Query about any large fluctuation in wolf sightings in the past and/or in the mortality of wolves and domestic dogs. Also enquire about livestock losses to predation by wolves or other predators.

Long-term systematic censuses. In conservation areas such as BMNP and SMNP wolves can be counted regularly along an established route. In the Sanetti Plateau of BMNP for example, records have been kept since 1983 by a regular animal count from a vehicle traversing the 32 km of road across the plateau (Chapter 2). Another count has taken place in the Web Valley since 1989, where all wolves, other wildlife and livestock are counted regularly on a circular horse-back census lasting approximately five hours.

Demographic modelling. Population Viability Analysis is a useful tool for gaining insight into the dynamics of a particular system, but not generally for making predictions about future outcomes. One such model is VORTEX (Lacy 1993). Using known population parameters (including reproductive and survival rates) and carrying capacity for an area VORTEX analyses the likely impact of the different threats to the population and how significant each may be in determining long term viability of the population under different assumptions about their rate, their impact on the population and the size and structure of the wolf population (Chapter 6). Similar models may be used to determine the loss of genetic variability of the population of survival under different levels of exploitation (such as hunting or culling).

Food-habits Studies

Knowledge of the food habits of a carnivore species is central to understanding many aspects of its behaviour and ecology. This may be achieved through direct

observations, and this should be the preferred method, provided that the observer does not disturb predator or prey in the process. A disciplined approach to data collection is important if direct observations are to yield good results. Alternatively faecal analysis may be used, this is the most common method for analysing carnivore food habits. For a discussion of both approaches for the Ethiopian wolf refer to Sillero-Zubiri and Gottelli (1995a).

Habitat Quality Assessment

Development of Predictors of Ethiopian Wolf Density

The role of the afroalpine rodent community in limiting the distribution of the Ethiopian wolves can be seen by the relationship between wolf density and diurnal rodent biomass index (Fig. A3.1). Independent observations of the density of wolves and a knowledge of the abundance and distribution of small mammal signs in a field study in the Bale Mountains established a significant correlation between wolf density and small mammal biomass in four study areas (Sillero-Zubiri *et al.* 1995a, 1995b). Areas with low rodent biomass index supported lowest wolf densities and vice versa.

Wolf density was positively correlated with giant molerat (*Tachyoryctes macrocephalus*) abundance measured from direct observation ($r = 0.996$, $df = 2$,

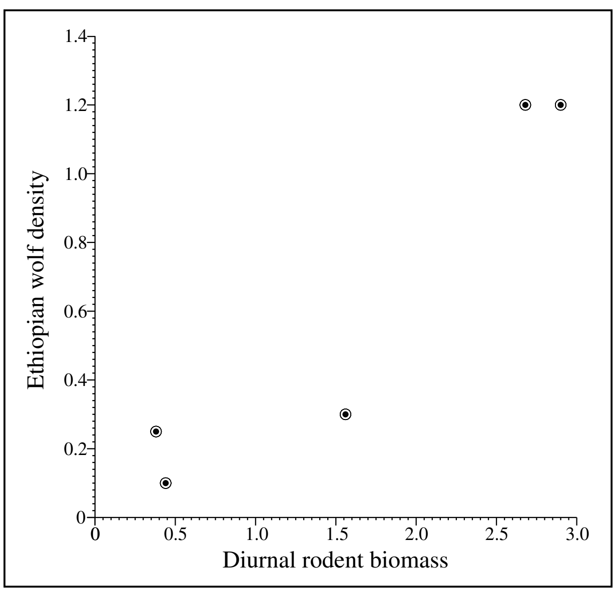

Figure A3.1. Relationship between wolf density and diurnal rodent biomass.

$p < 0.002$), suggesting that the species was vital in determining the presence of the wolf. Because they are roughly six times the weight of any other rodent, hunting molerats is likely to be considerably more efficient than hunting a smaller species, and indeed, where they are present, they constitute 37% of the wolves' diet (Sillero-Zubiri and Gottelli 1995a). In areas where the giant molerat is rare or absent, the common molerat (*Tachyoryctes splendens*) may replace the giant molerat in the wolves' diet.

There was also a positive correlation between rodent signs and wolf signs, droppings or diggings, along habitat assessment transects. The percentage of transect points at which wolf signs were found correlated positively with the average number of rodent burrows per transect point ($r = 0.666$, $n = 83$, $P < 0.001$), the percentage of transect points including rodent burrows ($r = 0.62$, $n = 83$, $P < 0.001$), and the percentage of transect points at which rodent alarm calls were recorded ($r = 0.585$, $n = 83$, $P < 0.001$). A similar correlation was found between wolf signs and average fresh giant molerat signs ($r = 0.383$, $n = 83$, $P < 0.001$)

From direct observations the relationship between molerat signs and density was extrapolated. Molerat numbers were estimated during day-long watches (see below) in 50 m x 50 m plots. In the late afternoon after observation the number of open plus freshly plugged molerat holes within the plot (henceforth called 'fresh signs') were counted. Fresh signs correlated significantly with minimum ($r = 0.882$, $df = 34$, $p < 0.001$) and maximum ($r = 0.863$, $df = 34$, $p < 0.001$) estimates of molerat abundance and could therefore be used as an index of relative molerat abundance along transects.

Another molerat sign bearing correlation with rodent and wolf abundance is the mima mound, distinctive mounds found in afroalpine grassland probably as a result of long-term giant molerat activity. The density of mima mounds varied widely between habitats. In swamp shore, for instance, 82% of all transect samples included at least part of a mima mound. Other grassy sub-habitats in Web and Sanetti had mima mounds represented in 18–44% of the samples. Mounds were more sparse in *Helichrysum* dwarf-scrub, concentrating along drainage lines (7.8% versus 4% away from drains), and almost absent in the ericaceous zone (0.6%). The presence of mima mounds was strongly correlated with the mean number of fresh signs per transect point ($r = 0.946$, $df = 8$, $p < 0.001$).

Habitat Assessment Transects

Diurnal rodent species compose up to 97% of prey volume in the wolves' diet in Bale (Sillero-Zubiri and Gottelli 1995a). These rodents are therefore of vital importance in maintaining wolf populations, and an understanding of rodent distribution, abundance and biomass in each one of the Ethiopian wolf populations is essential in planning for their future conservation.

The presence of giant and common molerats, and the biomass contributed by smaller rodents, may be used as an index of the suitability of a habitat or particular mountain range for wolves. Simple, inexpensive field techniques, such as transect sampling for molerat fresh signs and abundance of rodent burrows can be used for such an evaluation. Based on the correlations presented above we developed a quick method of sampling habitat quality by counting the abundance of rodent signs along transects (Sillero-Zubiri *et al.* 1995a, 1995b).

Line transects, of 20 sampling points at 25 m intervals, were surveyed on foot to assess the numbers of rodent burrows, rodent alarm calls and wolf signs (droppings and signs of wolf diggings) within a 5 m radius of each transect point. At each transect point percentage plant cover was estimated by eye. Using a pin and a 5 m string we walked a full circumference recording the number of fresh signs within each circular sample point. Transects were walked in the late afternoon to standardize for the fresh signs and calls of diurnal rodents.

The line transects were stratified to cover all habitat types. An index of molerat abundance was calculated for each major vegetation zone; the indices for each habitat subdivision were weighted by their relative abundance. In areas where the common molerat replaces giant molerat their sign abundance along transects may be assessed in a similar fashion, although it will be necessary to calculate a suitable ratio of molerat abundance and their signs similar to the index presented above for giant molerats.

We also examined the role of soil depth in limiting the distribution of molerats and studied the daily patterns of molerat emergence and wolf foraging behaviour to investigate the temporal availability of molerats to wolves. Soil depth was measured using an iron probe at a subsample of transect points for each habitat subdivision.

Estimating Rodent Prey Abundance

When some time (weeks or months) can be spent in a particular area other more intensive methods may be applied to estimate the abundance and distribution of rodent prey. In Bale the relative abundance of different rodent species and their habitat preference were assessed by direct observation, live-trapping or snap-trapping. From these data total prey biomass was estimated. These methods worked well in Bale and are presented here as guidance for similar studies elsewhere.

Direct Observation. The abundance of diurnal rodents may be assessed by direct counts in a demarcated plot. This technique was particularly useful for molerats because live-trapping them has proved impossible (Bayene 1986), ruling out capture-mark-recapture studies. Unfortunately it cannot be applied to common molerats since they seldom emerge to the surface.

50 m x 50 m plots were marked with pegs and string in the area to be sampled. The plot was then scanned with binoculars from a vantage point every 10 minutes throughout the day (08:00–18:00 hs), and the number of individual molerats and other rodents present on the surface each time counted.

Individual molerats can be identified from hole use patterns as, generally, only one individual occupies a burrow system (Yalden 1975). For each plot observation day, minimum and maximum numbers of individuals were estimated. These were based, respectively, on the largest number of individuals surfacing simultaneously, and on numbers inferred from mapping activity throughout the day. For grass rats the largest number of individuals surfacing simultaneously was used as the minimum population estimate. Where a plot is watched more than once the largest estimate may be used.

Live-trapping. Grass rat densities were estimated using a 0.16 ha grid of 50 collapsible aluminium Sherman traps (Sherman, Tallahassee, Fl., USA) set at 10 metre intervals, with two traps per point. Traps were pre-baited for two days with peanut butter/flour bait and then set at dawn and cleared at noon and dusk for three consecutive days. Different habitat types were sampled in consecutive trapping sessions.

Population sizes on trap grids were estimated by Capture Mark Recapture techniques using numbers of individuals and the Bailey Triple Catch estimate (Begon 1979). In order to obtain an estimate of absolute density for each species a boundary strip equivalent to half the average distance moved between traps by individuals captured on consecutive nights was added. In Bale half of the average distance moved by consecutively captured L. melanonyx, using data from both sites combined, was 10.8 m, giving a trap area of 0.38 ha. On average, half the nightly distance moved by A. blicki was 8 m, giving an effective trap area of 0.314 ha (Sillero-Zubiri et al. 1995b).

Snap-Trapping. The relative abundance of rodents in all habitat types, sub-habitats and seasons was assessed using transects of twenty metal snap traps (20 cm by 10 cm) set 10 m apart. Traps were baited with a paste of peanut butter and wheat/barley flour, and checked in the early morning, at noon and in the evening for three consecutive days.

Snap-trapping were carried out opportunistically, making it a good quick method to assess species composition and relative abundance in a new area. Relative rodent abundance was expressed as percentage trap success, that is, the number of animals caught per 100 trap days or nights.

Rodents caught in snap-traps were sexed, weighed and identified with reference to a collection of specimens, available from the BMNP or Addis Ababa Museum (Sillero-Zubiri et al. 1995c). Reproductive condition (signs of lactation, pregnancy or hymen perforation; testes size and position) were recorded for all rodents caught in snap traps. The proportion of captured adult females which were pregnant were assessed by determining pregnancy using macroscopic detection of foetuses in the uterus (Hanny 1964) in order to assess the breeding seasonality of each species. This method however overlooks foetuses in the first third of pregnancy and therefore underestimates total reproductive output. Mean numbers of implanted foetuses was calculated by dissection of sub-samples of females.

Prey biomass. The absolute biomass (kg/ha) provided by the main wolf prey species may be estimated by multiplying the mean weight of trapped animals by an estimate of species density. If enough trapping data is available this calculation may be carried out monthly or seasonally. Species density values for grass rats may originate from the mean number of individuals live-trapped per hectare; and for molerats as the mean minimum number of individuals observed per hectare.

A biomass index, incorporating all snap-trapped species and weighted for sub-habitats, was calculated in Bale by multiplying transect snap-trap success by the mean weight for each species; this effectively gave an estimate of the biomass contributed per 100 snap-traps per night. This crude biomass index was intended only for general comparisons of habitat zones relative to each other.