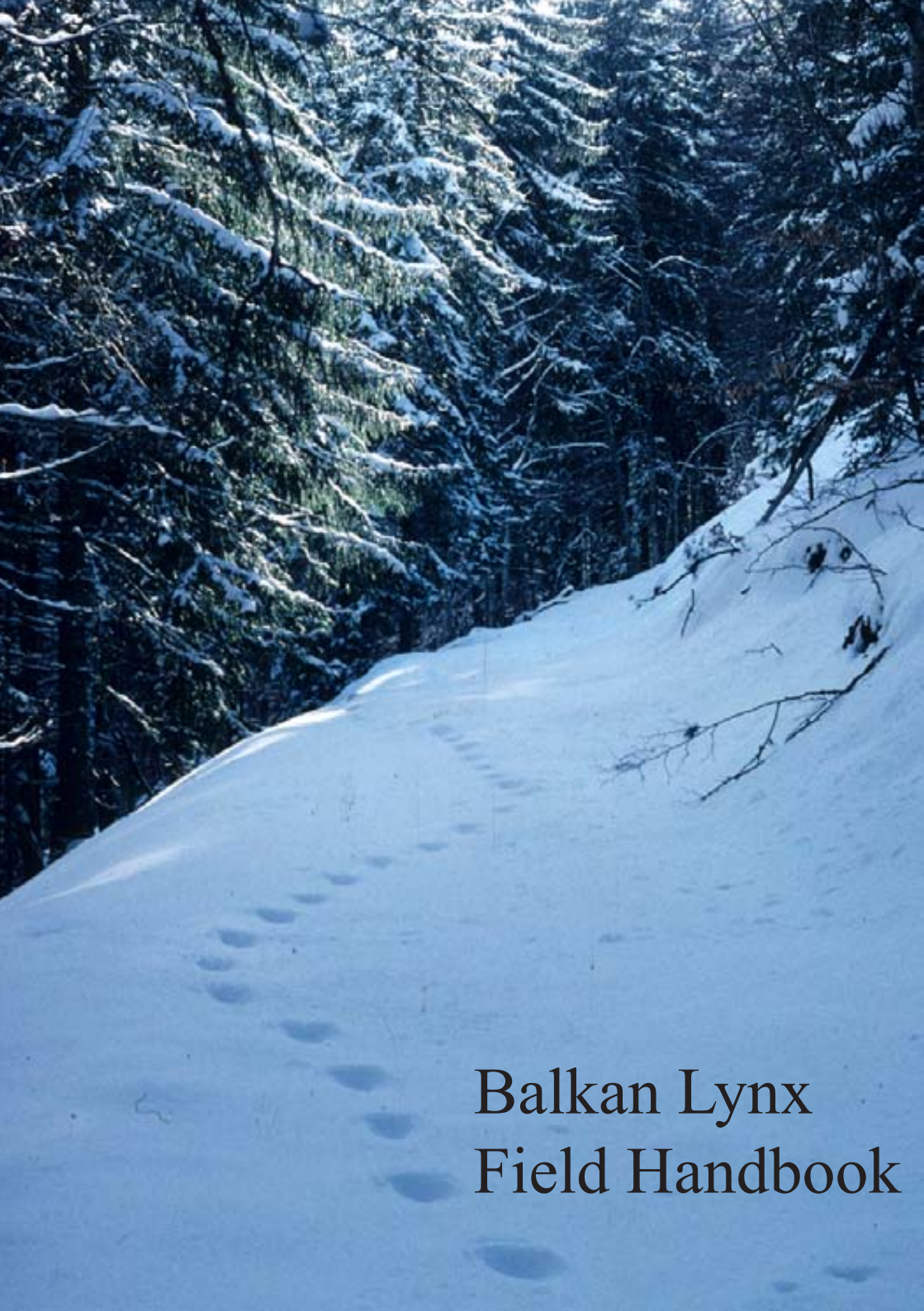

Balkan Lynx Field Handbook

Supported by the Federal Agency of Nature Conservation with financial means of the Federal Ministry of Environment, Nature Conservation and Nuclear Safety, Federal Republic of Germany. The Balkan Lynx Field Handbook is a part of the Balkan Green Belt project of EURONATUR.

Balkan Lynx Field Handbook

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1. Introduction

The Field Handbook for the Monitoring of Lynx compiles information relevant for the collection of data and observations from free-living lynx. This handbook was produced to facilitate the survey and monitoring of the lynx in the south-western Balkans, mainly in Albania and in the FYR of Macedonia. The lynx from this region is considered an own subspecies, *Lynx lynx martinoi*, which is critically endangered. The status of the Balkan lynx is not well known, but the total size of the population is most likely below 100 individuals, with a decreasing tendency (von Arx et al. 2004). For Albania, Zoto (2000) estimates that the lynx population had decreased by 50 % during the past 50 years and is today as small as 25 individuals. Conservation measures are urgent, but targeted conservation actions can only be implemented if the distribution and status of the Balkan lynx is known. If once a conservation programme is established, the monitoring of the population must continue, so that we know whether the conservation actions are effective and can adjust the programme whenever needed.

This handbook is not an instruction on how to organise the monitoring – monitoring concepts are outlined in a special document, in the Guidelines for the Monitoring of Lynx, also produced for the monitoring workshop for the Balkan lynx hold 15–17 November, 2005, in Mavrovo National Park, FYR of Macedonia. The handbook provides practical information useful in the field. A monitoring programme is only successful, if the people collecting the information in the field are skilled and motivated! But personal skills and motivation is not enough; all members of the monitoring network need to follow the same principles and procedures.

The ecological and biological information about the Balkan lynx are extremely scarce. Most of the information on lynx presented in this handbook is taken form studies on the lynx done elsewhere, in Scandinavia, in Poland, in the Alps or in the Carpathians. We assume that the Balkan lynx does not strongly differ from the Nordic or Carpathian lynx in its basic biological features and in its ecology. But it is important to emphasis that this is an assumption, and that (sub)specific information on the Balkan lynx are urgently needed. What does this mean? Each user of this handbook should remain critical and carefully compare the information given in this manual with the observation she or he makes in the field, and – if they differ – report back to the authors of this handbook.

The information presented in this manual were not specifically produced for this purpose. We have taken them from various works, which are listed in the references (chapter 6). For more detailed information, we refer to the original publications, which however are mainly in English, German, or French.

The authors hope that this little handbook is useful during the fieldwork and will eventually help to save the Balkan lynx from extinction. Any feedback regarding errors and completions is welcome!

2. Species Information

Demography

Mating takes place from February to mid-April (Balkan lynx January to February according to Miric 1981). Males follow the females to check their reproductive status. Oestrus lasts about three days. The male accompanies the female all that time, and they copulate often. During this period, they also often feed together on a prey, mostly killed by the female. It is occasionally possible to observe the female with the kittens from the last year and the male together during the mating season.

Female lynx with young (just before separation) in the Swiss Jura Mts.

Five days old lynx kitten in a den well protected from weather and predators in a rock lair in the Swiss Jura Mountains.

Birth takes place 67–74 days after conception, usually late May/early June (if Miric's observation regarding the early mating season is correct, Balkan lynx could give birth already in April). Litter size varies from 1–5, but most often, 2–3 kittens are born. A newborn lynx cub weighs about 300 g. Kittens are born in a well-sheltered den that is dry and has only one to few entrances. Kittens are moved several times to different dens before they start following the mother at their own. Dens can be found in a rock heap, a rock lair, a rootstock or an earth lair.

The female does not bring food to the den. The kittens only start eating meat when they can follow the female to the kill, at about the age of three months. Kittens stay with the mother until the next mating season. They leave the mother at the age of about 10 months in March or April, when they have a weight of 9–14 kg.

Young lynx feeding on a kill in September

Land tenure system

The lynx inhabits forested areas in most of its range. Only the Central Asian subspecies, *L. l. isabellinus*, lives in an almost treeless environment. In Europe, the lynx used to live in all types of forest from the Mediterranean hard-leaved forest to the northern boreal forest. Today, the lynx is restricted to the remaining large forest complexes of the continent. Reasons for the recovery of the species in Europe during the 20th century were the expansion of forest and the recovery of prey (roe deer).

Lynx are solitarily living animals, except for females and the young of the year. Both males and females occupy individual home ranges ("territories"), which they mark with gland secretion, urine and maybe faeces. The females choose their territories according to prey and habitat resources needed to rise the kittens, the males set up their territories to grant access to females. The home ranges of males are larger than those of females; they monopolize one or two, rarely more females. Consequently, home ranges of males overlap to a certain extent, whereas ranges of females overlap only slightly, and sometimes hardly touch. In Scandinavia, some mothers were observed to have totally overlapping home ranges with their daughters.

Home range sizes vary considerably depending on habitat type, composition of prey community, and availability of prey. According to the literature, individual home range size ranges from 25–2000 km², but old estimates were too low. Studies based on telemetry have brought precise estimates of home range size of lynx in Europe: 180–2780 km² for males and 98–759 km² for females. The highest values were found in the northern or mountainous regions of Scandinavia. Miric's (1981) estimate of 18–38 km² (mean 30 km²) for a Balkan lynx' home range is rather small and needs verification by means of monitoring methods like radio telemetry.

Carpathian lynx resting on a rock in dense cover during daytime.

There is little seasonal variation in the home range size of males, but females occupy very small home ranges while nursing kittens (late spring to summer). In Scandinavia, female lynx roamed over 33–100 km² during the first eight weeks following birth, and then extended their home ranges gradually until winter. Mean distances travelled by lynx per night ranged from 1–45 km. The highest movement activities are observed in males during the mating season. Females with kittens, usually travel over short distances. When a lynx has a fresh kill, it stays in its proximity for several days. The activity pattern is determined by sunrise and sunset. Lynx are mainly active at dusk and at night, and rest during daytime, except for the rutting period when lynx are active also during daytime.

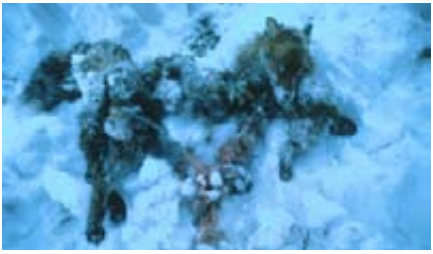
Feeding ecology

Prey of lynx range from mouse to moose. Staple prey are small ungulates and hares. The genus *Lynx* is generally specialised in hunting lagomorphs, the Eurasian lynx, however, has evolved into a hunter of small ungulates in many parts of its range, most prominently in Europe. Only in north-eastern Europe and parts of Siberia, mountain hares are the main prey. From the ungulate guild, lynx select the smallest species: roe deer, chamois, or musk deer. In northern Scandinavia, semi-domestic reindeer are in some areas the most frequent prey. Red deer will occasionally, moose or wild boar seldom fall prey to lynx. In areas with low ungulate availability, lagomorphs, foxes, birds and rodents can be essential prey. Lynx diet varies seasonally; small prey and young ungulates are killed mostly in late spring and summer. The composition of the Balkan lynx' diet is not known, some observer however suppose that hares are an important prey.

A lynx consumes on average 1–2.5 kg of meat per day. Wherever lynx prey on large ungulates (red deer, wild boar), the youngest prey category is selected. In roe deer, however, which has the same body mass as the predator, all age and sex categories are preyed upon. The impact of lynx on prey populations can strongly differ from region to region and over time. Lynx do not eradicate their prey, but in marginal habitat or in specific situations, the predation impact can be considerably high. An increasing number of scientific studies on lynx-prey relationships show how complex, varying and dynamic the system is.

Roe deer is the lynx main prey in most of Europe.

In mountaineous regions, chamois is a very important lynx prey.



Red fox is the 3rd most important prey in Switzerland.

Where ungulates are scarce, hares play an important role in the lynx diet.

At the edge of the roe deer's range in northern Europe, lynx killed 30% of the roe deer population on a yearly basis. In Switzerland, re-introduced lynx considerably reduced roe deer or chamois abundance in some situations. The impact however changes over time. In the north-western Swiss Alps, lynx killed only 6-9% of the estimated roe deer population in the mid-1980s; about ten years later, the predation impact in the same area was estimated to be 36-39%. In Poland up to 36% of roe deer and 13% of red deer were taken by lynx. The influence of lynx predation on a local ungulate community depends on the structure of the prey community, age and sex structure of the ungulate population, number and social structure of the lynx population, other causes of mortality and abiotic factors. Lynx show a numerical and functional response to changes in prey abundance and availability, and consequently, lynx predation is an important factor shaping the density, the distribution, and the behaviour of the main prey species.

All reviews of depredation by lynx concluded that livestock losses (sheep, goats, poultry) to lynx are relatively low compared with those to other large predators, and that in most European countries, the lynx is not regarded as a major problem to livestock husbandry (see Kaczensky 1996, 1998, 1999). This seems also to be true for the Balkan lynx range countries. The exception is Norway, where the number of sheep killed by lynx has steadily increased over the past years and reached some 7'000–10'000 from 1996-2001. Depredation on sheep is a consequence of unattended pasturing in carnivore habitat. This form of sheep husbandry is typical for regions where large predators were absent or scarce for a long time. In the re-introduced lynx populations in the Swiss Alps or in the French Jura Mountains, depredation caused severe public conflicts, although the number of sheep killed by lynx was low compared to the total losses to other causes. The problem was more psychological: farmers had lost the tradition of coexistence with large predators and did not accept the lynx as part of the natural system.


Lynx on a killed sheep. In countries where the tradition to coexist with large carnivores was never lost, lynx depredation is not considered a problem.

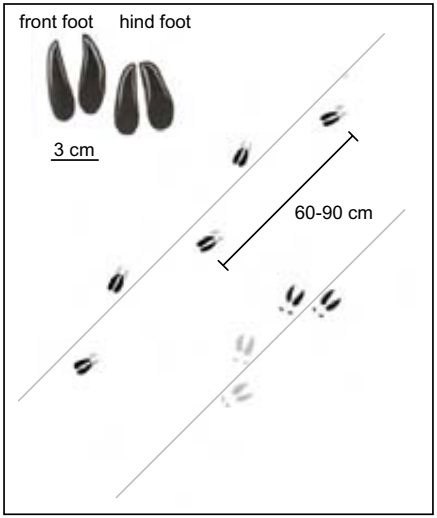
In all European countries were depredation by lynx occurs, compensation schemes have been implemented to mitigate the conflict with livestock breeders. This is a measure not only meant to support the acceptance of lynx, but also because there is today a general agreement that those who live with the large carnivore – protected by national laws and international treaties – should not need to suffer financial losses. A compensation system with a mandatory examination of cases of depredation in the field can be an important part of a monitoring system.

3. Field signs
3.1. Tracks, movement patterns and associated signs

Roe deer
Capreolus capreolus

Adult coat sandy to red-brown in summer and grey-brown in winter. Black nose and moustache, white chin. White to buff patch on rump, in winter inverted heart-shape in females, kidney-shape in males. In winter, females have a tuft of white hairs projecting backwards between the hindlegs resembling a tail.

Tracks



Of all European ungulates, the roe deer has the smallest footprint. They are elongated, 4-5 cm long and ca. 3 cm wide. Gait: 60-90 cm, feet slightly turned outside. The hind paw is put in the front paw (drawing, left track; hind foot black, front foot grey). When fleeing, the dewclaw shows well in the leaping track (drawing right track, lower photo).

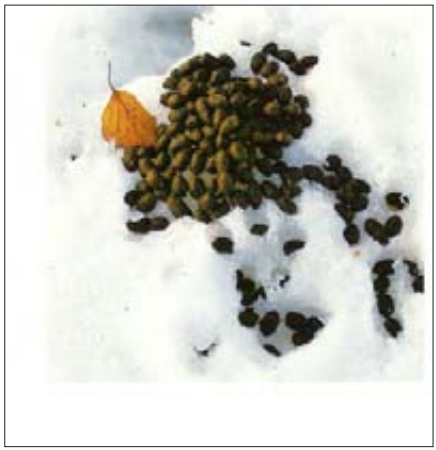
Scats

Droppings smaller than red deer: 10-14 mm long and 7-10 mm wide. Shiny black or dark brown cylindrical pellets. In summer droppings, the pellets build coalescent lumps (upper photo). In winter, cylindrical pellets remain independent, pointed at one end, round at the other end (lower photo).

Caution! Domestic sheep and goat droppings look very similar (p. 20-21).

Habitat

Woodlands, usually with open ground within, and access to edges of fields. May occur entirely in the open in agricultural areas, but the essential feature is ususally in close proximity to food and cover.

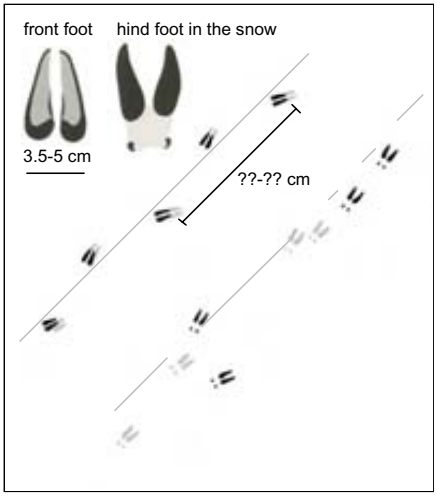


Chamois

Rupicapra rupicapra

Contrasting marks on either side of head extend from ear over eye to muzzle. Fairly long, upright horns, bent back in shape of hook. Horns in both sexes, but thicker and more hooked in males. Coat in summer pale brown, dark brown legs, dark stripe along back. In winter the whole body is darker.

Tracks



Footprint 6 cm long, 3.5-5 cm broad. The hooves are well separated, but usually parallel. Feet slightly turned outside. In the snow and when fleeing, the dewclaw becomes visible (drawing, right track).

Scats

Individual droppings almost spherical. Diameter ca. 1.5 cm. The pellets are often crushed and are then flattened.

Caution! Domestic sheep and goat droppings look very similar (p. 20-21).

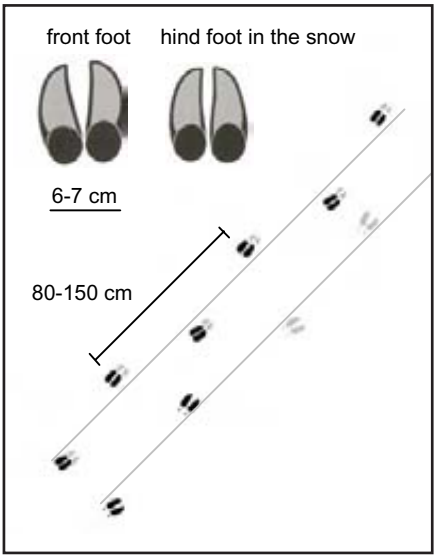
Habitat

Rocky, precipitous mountains. Summer and autumn: meadows around tree line and above. Winter and spring: in forests and down to the villages (photo).

Red deer
Cervus elaphus

Second largest European deer. Coat short and reddish in summer, dark brown in winter. Rump patch creamy coloured extending dorsally above short beige tail – not clearly marked with black as in Sika and fallow deer.

Tracks



Track relatively broad and with the outer edges of each half of the hoof curve symmetrically towards the tip. Adult forefoot track 8-9 cm long, 6-7 cm broad. Hindfoot smaller: 6-7 cm long, 4-5 cm broad.

Scats

Faeces variable according to diet. Winter droppings firm consistency (upper photo). Individual droppings elongated and acorn shaped; 2-2.5 cm long, diameter 1.3-1.8 cm. When they are fresh, the droppings are black and shiny, with time they get brown and dull. In summer with a fresh diet, feces are mush pat (lower photo).

Habitat

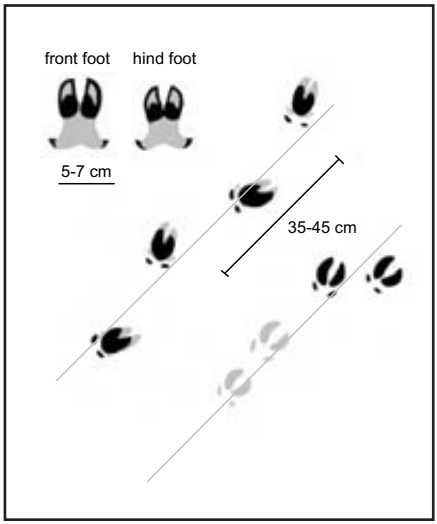
Generally occupies open woodland and feeds at edge or in grassland. In some areas in habitat without forest and in high mountains also at or above the upper timber limit.

Wild boar

Sus scrofa

Powerful, pig-like appearance, laterally flattened with large head and short stocky legs. Dark coarse pelage with a strong smell. Males have upwardly pointing canine tusks. Summer coat of bristly guard hairs, still relatively long and dense. Winter coat (photo) dense, longer hair with thick underfur and dark.

Tracks



Whole track trapezoid shape as dewclaws almost always leave clear impression (drawing, photo). Footprint of adults 6-9 cm long and 5-7 cm broad. When walking or trotting they put the hind foot slightly behind the front foot so a double print of the dewclaw is visible (drawing left track). In the galop all four feet are well visible and the hoofs are wide spread (drawing, right track). At the lower left corner of the photo, a lynx footprint is visible.

Scats
Droppings ca. 7 cm long, often sausage-shaped, but variable according to diet.

Habitat
Deciduous woodlands, thrives on cultivated land if it has access to good cover (woodlands, reed beds).

Associated signs
Wild boars like to wallow on muddy ground. On the example on the photo, the shape of the animal is visible where it was laying down.

Domestic goat
Capra spp.

Tracks
Goat claws are getting narrower towards the tip. They are usually well spread, convex at the outside and concave at the inside. The dewclaws are not visible in the track.

Scats
Droppings are cylindric, ca. 1 cm long. Sometimes they are flatened at one end or both ends. Most often they are in piles (photo).

Domestic sheep
Ovis spp.

Tracks
5-6 cm long, 4-5 cm broad. Resembles the track of a roe deer, but it is broader, and the tip of the hoove is rounded. The dewclaw is so high on the leg that it never shows in the track.

Scats
Droppings very similar to goats, but more often clumped.

Birds

Capercaillie *Tetrao urogallus*
Black grouse *Tetrao tetrix*
Hazel grouse *Bonasa bonasia*
Rock partridge *Alectoris graeca*

Tracks

Capercaillie: 10-11 cm long, 8-9 cm wide (photo). Lives in old grown forests with a lot of blue berries.
Black grouse: 7-8 cm long, 6-7 cm wide. Prefers more open habitat.
Hazel grouse: 5-5.5 cm long, 4.5-5 cm wide. Lives on lower altitude in mixed forests.

Scats

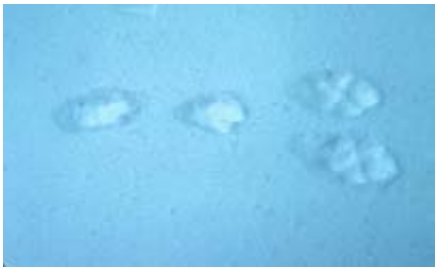
Capercaillie: Droppings several cm long, 1.2 cm thick (photo). In Winter they consist mainly of remainings of pine needles.
Black grouse: Droppings about half the size of the capercaillie. Often consists of birch buds.
Hazel grouse: Droppings 1.5-2 cm long and 6-7 mm thick. Contains remainings of catkins of alder, birch and hazel.

Brown hare *Lepus europaeus*

Rabbit *Oryctolagus cuniculus*

Tracks

Brown hare: Front paw with five toes, but most often only four are visible in the tracks, hindfoot with 4 toes. Length: 5 cm, width 2.6-3 cm. The length of the hindpaw footprint depends on the ground, and varies between 7 and 12 cm. The width is 3.5 cm. Hares are moving by hopping. The hare track has a very typical pattern with the front paws set ahead of the hind paws (photo). Depending on the speed of movement, the distance between this pattern and the next varies greatly from 50 cm to 1.5-3 m.



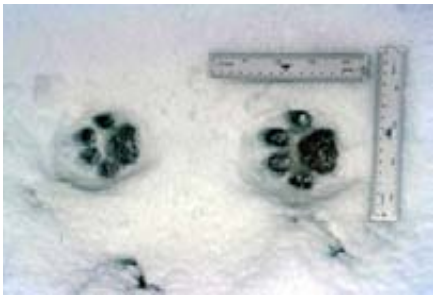
Rabbits: Rabbit footprints are slightly smaller and the difference between hindfoot and forefoot is hardly visible. Forefoot: 3 cm long, 2.5 cm wide. Hindfoot: 4 cm long, 2.5-3 cm wide.

Scats

Brown hare: Oblate and firm, diameter 15-20 mm. In Winter light brown (upper scat photo), in summer darker to almost black. Hares leave their droppings near their feeding places.

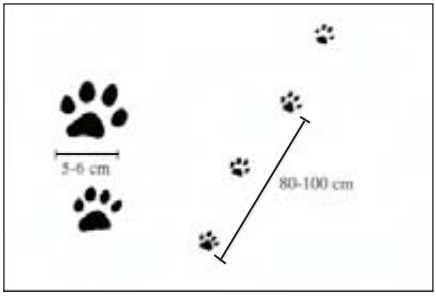
Rabbit: Very similar to the brown hare, but considerably smaller and more round: diameter 10 mm (lower scat photo). Rabbits live in colonies and use their scats to mark their territory. They place latrines on conspicuous places.

Eurasian lynx
Lynx lynx



Tracks

Lynx have – like all cat species with the exception of cheetahs – retractable claws. Threrefore, the claws are not visible in the track (photo top right; sharp marks of claws sometimes visible in steep terrain). The track is round with a diameter of 7-9 cm (Balkan lynx might be smaller) for adults, and the toes are asymmetrically distributed (photo middle right). The front paw is larger thand the hind paw. Single footprints can be confused with dog tracks where the claws do not mark. In deep snow, lynx tracks can be confused with chamois, which have almost the same gait.



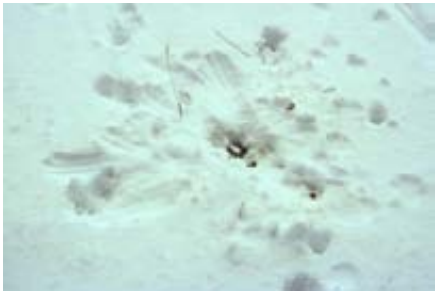
Lynx usually walk in an alternating pattern and infrequently galop. Lynx trails meander through forest and open habitat (photo right) "purposefully", unlike dogs, which often search to the right and left. Lynx are solitary except for the mating season, when males and females may walk together (photo) and families of mother and kittens, which however can walk for long distances in each others tracks in the snow, so that it is impossible to count the animals until they split.

Scent marking

Lynx frequently mark their territories by urination scent-posts. Both sexes mark, especially during the rutting season. They mark visually conspicuous points, like isolated rocks (photo) or trees, but also corners of barns (photo) or wood piles. Many spots are repeatedly visited, so that the marking place becomes visible and smells strongly when moist.

Scats

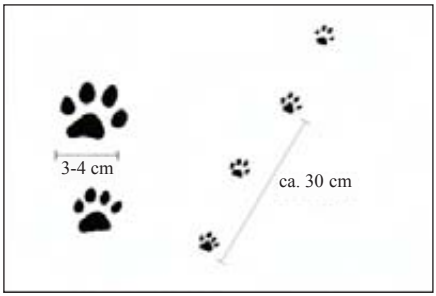
Lynx scats are elongated with one end often tapering, general in several pieces (photo), each measuring 3-5 cm in length and 2-3 cm in diameter. Scats can also be shapeless, almost liquid if not containing prey remains as hairs and pieces of bones. Eurasian lynx tend to cover their scats with snow, leaves or earth (photo right bottom). Unlike the other lynx species, it is not sure whether Eurasian lynx use scats for marking.



Wildcat

Felis sylvestris

Tracks



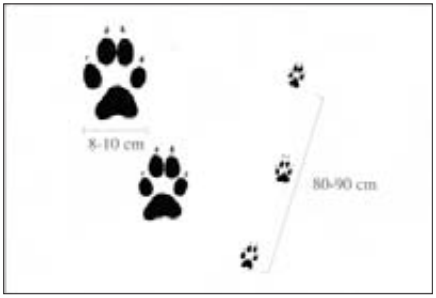
Footprint: with 3-4 cm slighly larger and less round than the domestic cat. The paws are also more hairy underneath (drawing). Tracks can easily be confused with domestic cats. Same shape as lynx, but considerably smaller.

Scats

Scats are 6-8 cm long and 1-1.5 cm thick. Depending on the diet, it can also be liquid. Scats are covered with snow, leaves or earth inside the territory, but along territory borders, they are also deposited in a very obvious way on tree trunks or stones, similar to the red fox.

Wolf
Canis lupus

Tracks
Footprints are oval, front paws about 11 cm long and 8 cm wide, hind paws are smaller with 8 cm length and 7 cm width (drawing). The two middle toe pads are often coalescent (photo), which hardly can be seen in the track (photo). Wolf tracks can hardly be distinguished from a dog's track. The only way to distinguish between them is to follow the tracks over longer distances in order to assess the moving pattern and behaviour.



In snow, trailing is common: the members of a pack follow in the exact trail of the leader to save energy. But once in a while they split up (photo).

Scats

Wolf scats are thick cords that are sometimes folded. The end of the scat that leaves the anus last has a pointed tail. When the scats are broken into segments, only the last one has a tail. The colour varies from almost black (photo to the right) to white (photo below). Often large items are present in the scats (pieces of larger bones, small bones, teeth, feathers etc.).

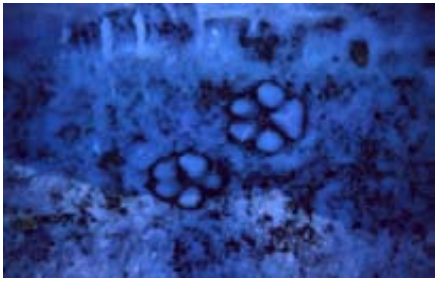
Scent marking

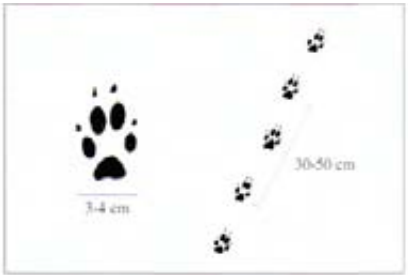
Like all canids, wolves use scats to mark their territory. They deposit them at elevated positions. Scratch marks may be found near the scat. These scratchings, which are made by the hind feet, probably help to circulate the associated odors.

Red fox
Vulpes vulpes

Tracks

Footprints are oval, 5 cm long and 3-4 cm wide. The hind foot is slightly smaller than the fore paw. In the snow, the footprint often looks rounder than on firm ground where it is elongated. Walking prints are 30-50 cm apart. All four toes print associated with claw marks which tend to register more markedly than those of hares.





In snow, the track of a fox appears as a beaded straight line (drawing, photo) when they move from one place to another. In the search of food, their track meanders a lot.

Tracks of a red fox (left) and a lynx (right).

Scats

Red fox scats vary greatly in size and appearance depending on the quantity and kind of food eaten. Usually fox scats have elongated segments and are 8-10 cm long, with a diameter of 2 cm. Fur in fox faeces form sometimes curly ends. Fox scats are brown or black; if the fox has eaten a lot of bones, it is white. Depending on the season, hairs, feathers, fruit pips, bone parts and beetle elytras are visible.

Scent marking

The red fox uses scats to mark its territory. They are therefore deposited on prominent sites such as molehills, stones (photo), a tree stump or tussocks of grass (photo), and at the junctions of trails. Urine-marks are common. Foxes have a special secretion gland with a strong smell to scent-mark.

Golden jackal
Canis aureus

Similar to wolf, but smaller, and more tawny. Also more slender than wolf, shorter legs, smaller paws and bigger ears.

Tracks

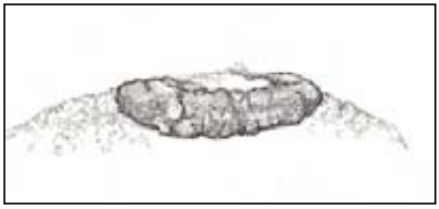
Footprints are smaller than those of wolves (photo). They are 6.5-8 cm long and 4-6 cm wide. Toes 3 and 4 are often grown together like in wolves. This can also be seen in the tracks (lower photo where you can also see wild cat tracks).

Comparison of red fox, golden jackal and wolf footprints:

Red fox Golden jackal Wolf

Scats

Droppings generally left singly on prominent sites such as tussocks, bushes or boulders (drawing), but occasionally large middens of many droppings accumulate, generally near territorial borders.



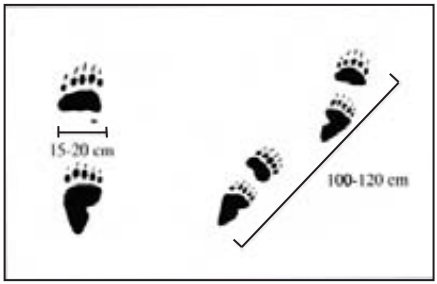
Habitat

Semi-arid country with cover (e.g. steppe, reedbeds, marshes), open country including grassland and farmland. Den is characteristically a burrow in dense cover.

Brown bear

Ursus arctos

Tracks



Distinctive footprints of adult hindfoot about same size as humans, but broader and prominent claw marks. Size of footprint from hind foot: up to 22 cm long at the age of 5 years.

A bear is a plantigrade and has five well recognisable toe pads. Left and right can easily be distinguished.

In a typical walking gait, the hind foot is a little forward of the front foot (left drawing). When they move fast, bears use a transverse galop (drawing in the centre). Going up steep hills, they use bounding (right drawing).

Scats

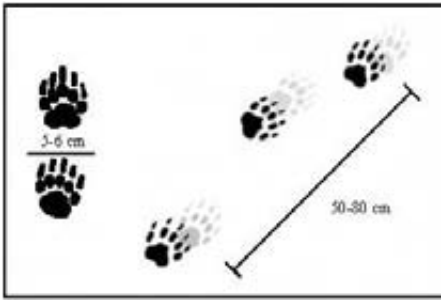
Bear scats may be confusing at times, though generally they have a distinctive form, with a tendency to maintain a fairly even diameter. The diameter can be as big as 6-7 cm. Bear will eat meat whenever they can, killing animals as large as a moose, or feeding on carrion. On such a diet the scats are likely to consist chiefly of hairs and bones (upper photo). But a bear is pretty much a vegetarian, and many scats contain grass and roots. In fall, when they eat mainly fruits, scats are often liquid (lower photo).

Bear trees

Bears bite and pull off strips of bark from the trunks of pine, spruce and fir trees. Then they will scrape off the juicy substance on the wood with their teeth, leaving vertical tooth marks. Bears like to rub themselves, usually on a tree, occasionally on a bush or stump. Often such a tree is in a prominent place, on a point or beside a trail, where it easily comes to the notice of the bear, and is scratched repeatedly until it can be recognized as an established "bear tree". Generally resin oozes out, and hairs stuck in or cling to the bark (photo). This type of tree has been construed as a signal tree, a means of showing the height of the bear and serving as a challenge to rivals. Undoubtedly it is also a place for comfortable rubbing.

Badger
Meles meles

Tracks



Footprints register 5 toes and broad plantar pads. Heel marks show in soft mud or snow. Fore print is larger than hind. Hind foot length is 9-11 cm. Forefoot width of an adult is about 4.5-6.5 cm. Forefeet have very prominent claw marks. The hind foot is often in the front foot (drawing, photo). Badger tracks have been mistaken as tracks of young bears!

Scats

Droppings are often in shallow pits at latrine sites, especially near sett and near territorial boundary. Scats vary from firm consistency (photo below) to a shapeless heap (right photo). They contain remaining of insects, hairs of small rodents, berries and grains.

3.2. Kills

3.2.1. Assessing the cause of death

When analysing a dead animal, the first question to be answered is: "Has it been killed or was it consumed by scavengers after its death?" Signs of presence of a predator around a carcass do not mean that the animal was killed!

If an animal has been eaten by a scavanger only post-mortem, the tissue did not bleed! Holes and scratches at the cadaver show no signs of bleeding, this means that they are not red. The certainty of the identification of the cause of death depends on the freshness of the carcass. If it is fresh, different signs allow identifying the predator or other causes of death, what is however difficult or impossible when the cadaver is old or only a few bones are left. It is important to examine a carcass as early as possible! Under wet and warm conditions, carcasses decompose rapidly. In summer, insects such as flies (maggots!) or wasps can consume a considerable portion of a carcass.

Certain prey species belong to the diet of different predators. A roe deer for instance is not only the main prey of lynx, but can also be killed by dogs, wolves, foxes, and exceptionally even by bears. Additionally, scavengers like foxes, badgers, mustelids, birds of prey or ravens can distort the typical signs of a predator. From a fly up to a bear, many animals can feed on a kill and change its appearance.

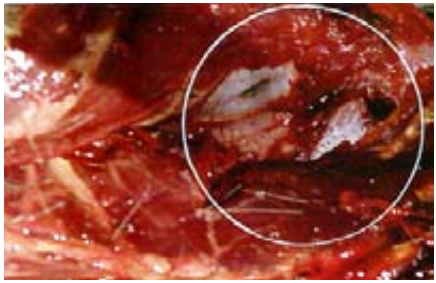
The entire body needs to be searched for signs of predation. They are sometimes only visible after the whole hide is removed. Important criteria for the identification of a predator are:

- Type and distribution of (deadly) injuries;
- Type of lesions of the skin (scratches, perforations);
- Number, distance and distribution of the skin perforations;
- Distribution and extension of bleedings;
- Lesion of the muscles;
- Lesion of the bones;
- Way of utilisation.

3.2.2. Hunting and feeding behaviour of lynx

The lynx is an ambush hunter. It sneaks up to its prey as close as possible and then reaches it with a few leaps, tearing it down with its sharp claws. It kills large prey with a bite in the throat (photo). Smaller animals (fawns, foxes, marmots) can be bitten in the neck or head. The lynx sometimes also bites through the backbone of very young fawns and hares, and the head is occasionally separated from the body.

The sharp teeth of lynx leave deep holes with clear, unfrayed edges (photo right top). The lynx kills through strangulation. It bites over the windpipe and squeezes it with a very strong bite until the victim does not move any longer. The larynx is most often broken. The distance between the canines is 30-34 mm (photo right below). The number of skin perforations is generally low, from 0–10; sometimes a lynx bite does not even go through the strong skin of a roebuck. The prey seems to die also from shock.



Around the windpipe bleeding can be observed (photo left top). Lesions and bleeding of the hypodermis on the rest of the body are generally missing, except for scratch wounds from the claws when the lynx grabs the prey to bring it down. Claw marks often become only visible if the hair of the prey is removed or if the animal is skinned (photo left below).

Lynx most often eat the kill on the spot. When the prey was killed in the open, they may drag it into cover, e.g. to the next forest edge (photo right). The lynx eats about 1-3 kg per night, males exceptionally 5-6 kg if they have not been eating for several days during the rutting season, and females with 2 or 3 kittens up to 10 kg. If not disturbed, lynx return several nights to the kill until no meat is left (photo p. 40).

Lynx start feeding on the hindquarters (right top), rarely on a shoulder (photo p. 41). While feeding on the muscle parts, the lynx may turn the hide inside out. In extreme cases, the head is finally hidden in the hide like in a bag (right below). The skeleton remains together, and generally no parts are removed. The lynx eats the muscles, the soft part of the rips, heart, lung, and liver.

The digestive tract is never eaten (except from fawns still nursed). The lynx removes it (left top) and sometimes hides it beside the kill. The large bones, the hide and most often the head are not eaten. However, of young ungulates, the brain can be consumed, and young lynx tend to eat the tongue and the cheek muscles (left below). Of smaller prey animals (fawns during their first weeks of life, hares) only the head and the feet are left over, often not more than some hairs and blood can be found.

Lynx often covers prey with grass, leaves (right) or snow. Sometimes only the end bit, where the lynx has been eating, is covered.

When young lynx start feeding on kills, they often play with it and nibble at the ears or at the nose (right). The kill then also looks less orderly, because they tear off parts. On the kill on the right, ravens removed the eyes, and lynx kittens were nibbling on the nose, and tried to cover it with branches, which is very unusual.

Kill of a subadult lynx. The young animal started to feed on the shoulder, which is rather rare.

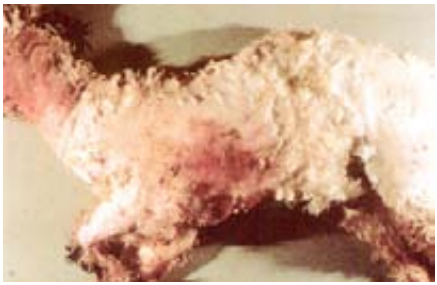
Besides the small ungulates, red fox can form an important part of the diet of subadults and females with kittens.

Smaller prey animals are killed through a bite in the neck or the backbone. The head gets occasionally separated from the body. Where ungulates are rare, hares are an important prey.

3.2.3. Distinguishing lynx kills from other kills

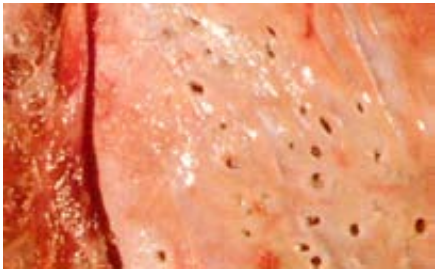
Red fox

Foxes follow their prey and bite it repeatedly into the legs and the belly (photo) to bring it down. Several foxes can work together when hunting larger animals. The small puncture wounds from the long, thin canine teeth can be found over the whole body.



To kill larger prey is a heavy fight for red foxes. The fighting place is often large, and blood can be found all over.

If the prey is brought to the ground, the fox kills it with numerous bites in the throat. When the hide is removed, skin perforations and bleedings can be found at several parts of the body, and at the throat, many small holes look like a sieve (right middle), looking similar to buckshot.



The distance between the canines of the red fox is 19-28 mm (left bottom) – the importance of such measurements should however not be over-estimated, as the hide and muscles can be squeezed and stretched.

The fox usually starts feeding from the back or on the belly (then feeds first on the digestive tract). This is an important difference between canids and felids: Lynx never, canids often consume the stomach and the intestines. Only on livestock, even canids normally avoid the digestive tract. Occasionally, foxes also start to feed on the hindquarter, the throat or around the anus. They tend to separate large bones at the joints (photo).

Foxes often carry off the head and legs and bring them to their den. In older publications, the removing of the head is often attributed to the lynx, which is however wrong. It is a clear indication for the red fox (right).

Wolf

Wolves chase their prey and hunt if possible with pack mates. Small to medium-sized prey are killed with a bite in the throat. Larger preys are first grasped at the hind legs causing severe injuries (photo) with lesions all over the body. Prey hunted down is often bitten into the nose and suffocated.

If brought to the ground, the victim is killed through bites in the throat. As wolves tend to shake when biting, the injuries are – compared to a lynx kill – severe. The distance between the canines is 35-40 mm (left).

Wolves start feeding on the digestive tract, the hindquarters or the back, like the examples of the donkey (photo right above) and the wild boar (an important prey species, photo below) show. Animals are often used on different parts, especially if several wolves are feeding on the kill.

If undisturbed, wolves remain close to the kill until it is totally consumed (right). When disturbed, the may carry off parts to a secure place. Of smaller prey, only parts of the skin, some bones and the content of the rumen, of larger prey, the skeleton and the entire skin are left behind. Larger packs can use a kill in a very short time. Small families or individual wolves feed several days on a killed ungulate.

If killing is as easy as with unattended sheep, wolves do not return to their kill (photo), but make a new one. They can also kill several animals in one night without ever consuming them. If breaking into a flock of sheep, wolves can occasionally produce a mass slaughter. Wolves (but also dogs) often injure several animals by biting them into the legs (lower photo) without killing them. Sheep in panic hurt themselves by running into the fence.

Dogs

The dog is equally chasing its prey and bites wherever possible, mainly into the legs (photo right), the flanks or the belly.

Many dogs are not experienced killers and often need to bite several times. (Some hunting dogs however may kill an ungulate as neat as a lynx or a wolf.) When a dog bites into the throat, it shakes vigorously the prey until it is dead (photo), leaving heavy injuries.

Injuries made by dogs are obvious and coarse, and are distributed over several body parts (photo). Often the dull dog teeth (compared to those of lynx or fox) leave often deep lesions in the muscles without even penetrating the skin.

The distance between dog canines varies greatly between dog breeds (20-62 mm) as the example of a Great Dane and a dachshund illustrates (photo).

Tissue lesions and haematoma are common. The dull claws of dogs (and wolves) leave scratches on the skin without breaking the skin and without bleeding (photo), in contrast to the lynx, where the sharp claws easily penetrate the skin (photo p. 39).

Like other canids, dogs open the body often at the belly and rip out the digestive tract (photo).

The discrimination between kills of dogs and wolves is only exceptionally possible. Often the result of the analysis is "big canid". Dogs are less experienced killers and often do not consume their kills. The distance to settlements or the number of animals killed can give a hint to the predator, but are seldom sufficient to identify it with enough certainty. To distinguish between dog and wolf, additional analyses like genetic identification of scats, saliva or hairs are needed.

Bear

Brown bears kill their prey with one or several blows of a front paw. They usually hit the animal in the face, on the neck or the back. Muscles hit by such blows are heavily bruised, skulls and backbones broken. There is often blood around mouth and nose (photo right).

Tracks of the strong claws are well visible (photo). Larger animals like calves, foals or red deer are killed through bites in the back and neck. This leads to massive injuries.

The distance between canines in brown bears is 60-90 mm (photo).

Bears open first belly and thoracic cavity to get at the intestines and other organs. Later they eat the muscles. The animal is literally torn apart and parts are spread over a larger place. Skin and bones remain untouched. A bear can consume more than 10 kg per day and finishes the prey if remained undisturbed. When disturbed, a bear can move a kill for several hundred meters.

Scavengers

With the exception of lynx, all carnivores also frequently scavenge. Besides wolves, red foxes, bears and badgers, many birds and wild boars consume carcasses.

In many parts of Europe, the most frequent scavengers on lynx kills are red foxes and ravens or crows. Ravens first gauge out the eyes. Then they feed on the soft muzzle to get to the tongue. They also start feeding at the anus or around the belly button, or between the ribs (upper right photo). It is typical for scavengers to pluck the hairs. A characteristic sign of scavenging birds at a carcass are tendons and ligaments remaining laciniated at the large bones and joints when pieces of muscles are torn off (lower right photo).

Wild boars are efficient scavengers (photo). A horde can finish a large carcass over night. They are capable to consume even large bones and the hide. Strong boars can chase away a predator such as a lynx from its kill. If they find young fawns, hares or weak ungulates, they may even kill them. Wild boar also like to start feeding on the intestines (photo).

Other causes of mortality

Besides being killed by a predator, an animal can have died from **many other causes**. Some of the most common are:

Injuries from shot wounds

The entrance hole is normally smaller than the exit hole and therefore less well recognisable. With decomposition of the carcass, the bullet wound can change. Small calibers may leave very inconspicuous wounds hard to discover.

Car accident

Animals hit by cars can move over a far distance from the road before they die. Typical for traffic victims are large haematoma, internal trauma and broken bones.

Unknown reasons

Finally, there are all the cases where the cause of mortality can no longer be determined because the carcass is too old. This skeleton of an ibex has no signs that would allow identifying the cause of mortality.

Disease

There are a large number of diseases (viruses, protozoa, external and internal parasites) that can weaken an animal and eventually lead to death. This chamois (on the left) died from mange.

Avalanche

In mountainous areas, avalanches are an important winter mortality factor. This animal (on the left) died in an avalanche and was consumed by scavengers when it melted out.

3.2.4. Checklist for kill identification

Criteria	Yes/ no	Lynx		Red fox		Dog		Wolf		Bear		Post-mortem scavenging	
Cause of mortality		F	S	F	S	F	S	F	S	F	S	F	S
Bite in the throat (with bleeding)													
With **many** point-shaped bleedings in the subcutis													
With **few** point-shaped bleedings in the subcutis													
Muscles around the throat torn													
Skull smashed													
Neck broken													
Other injuries													
Large-scale bleeding in subcutis and muscles, muscles **not** torn													
Large-scale bleeding in subcutis and muscles, muscles **torn**													
Few and fine claw markings that are perforating the skin													
Broad claw markings that are rarely penetrating the skin													
Bloody point-shaped bite marks on the back, at the legs, on the belly and around the anus													
Utilization													
Feeding started at the hind leg													
belly													
back													
shoulder													
Skin on limbs turned inside out													
Entire skin turned inside out (at the end head in “bag”)													
Carcass and hide in one piece													
Carcass and hide torn apart													
Parts of carcass removed													
Carcass consumed in 3-5 nights													
Carcass totally consumed in 1 night													
Long bones biten through													
Rumen consumed													
Handling													
Carcass covered													
Several animals killed (wild prey)													
Animal injured but still alive													
Total													

F = Frequency
- - criteria not applicable
- 0 never or seldom
- 1 occasionally to regularly
- 2 frequently to always

S = Specificity
- - not applicable
- 2 typcial to exlusiv
- 1 typical but not exclusiv
- 0 no to little validity
- -1 not very likely
- -2 impossible

4. Collecting, documenting and storing field observation and monitoring data

4.1. Dead lynx

Every dead lynx must go through pathological exam! Even if the cause of mortality is obvious (e.g. traffic accident), information on causes of mortality, occurrence of diseases and parasites are very valuable indicators for the health status of a population, and need to be considered for the conservation programme. All information must be collected and the mortality form must be filled in as completely as possible. The entire data must be compiled in a central database (see monitoring guidelines). Collect any information available additionally to the mortality form and note name/date/place on all additional documents, too.

For a pathological exam, a carcass needs to be as fresh as possible. A carcass should be cooled (only freeze it if it must be stored for several days or weeks). Never transport a carcass in a closed container or plastic bag before cooled down! If the body heat cannot escape, body and skin decomposition is accelerated and many examinations are no longer possible.

The following information needs to be collected regardless the status of the carcass and even if pathological exam is no longer possible. Even if only some bones remain it is worth to thoroughly document the case on the mortality form.

Date of death/Date of discovery: The date/time when the animal died is most often a guess, but the circumstances of the discovery may allow a better estimation of the time of death. The judgement of the finder is important.

Age: Adult = full grown mature animal, subadult = young animals after they leave their mother at the age of about 10 months until their sexual maturity (males usually three years, females two years), juvenile = young animals as long as they stay with their mothers (until March/April of the next year).

Photos of the dead animal: Make photos of the animal from left and right body size, the head and any obvious abnormalities (e.g. split claws, photo below).

Documentation of the discovery place: Photos of the place where the carcass was found are very important and can help identifying the cause of mortality. Take photos from different angles (see below) and different distances. Always note data/ place/author of the pictures. If photos are not possible or difficult, make a sketch drawing of the situation.

Circumstances of the discovery: Give detailed description of the place where the animal was found (e.g. "at the bottom of a rock face" – photo left – or "at roadside" – photo below), and observation in the environment (e.g. "fighting tracks in the snow" – photo at the bottom). Any additional information or observation on the animal is important, e.g. „the animal was observed several days near houses" or „ the animal was observed moving with great difficulties".

Caution: Lynx can occasionally be carrier of zoonoses (e.g. rabies) or parasites dangerous to humans (e.g. trichinas). Although the danger of infection from a dead lynx is small, cautious handling is crucial. Wear rubber/latex gloves, avoid any cutting/injury, wash/disinfect hands after work.

After documenting (description, photos) the place and circumstances of discovery of the dead lynx, the next steps are:

a) *in case of a pathological exam*:
- measure and weigh carcass (fill in morphology form)
- remove the entire skin carefully
- complete dissection according to pathology standards
- do not destroy skull (take brain samples through Foramen Magnum if needed)
- collect samples:
  - stomach (for diet analyses), stored in a deep freezer
  - scat from the rectum (diet analyses and parasites), stored in a deep freezer
  - diaphragm for parasites (trichinas)
  - spleen or muscle (genetic analyses), stored in alcohol or deep frozen
  - in the case of an adult female uterus (placenta scars for reproduction data)
  - different organs for bacteriology
  - brain samples (hippocampus, cerebellum, medulla) for rabies diagnosis if indicated
- safeguard skin and carcass remaining (skeleton) in museum

b) *in case **no** pathological exam is possible:*
- measure and weigh carcass (fill in morphology form; photo)
- bring carcass/skeleton to museum
- remove the skin (someone experienced should do this to conserve the hide as best as possible)
- collect samples:
  - stomach (for diet analyses), stored in a deep freezer
  - scat from the rectum (diet analyses and parasites), stored in a deep freezer
  - spleen or muscle (genetic analyses), stored in alcohol or deep frozen
- check lungs for worms

4.2. Tracks and other field signs

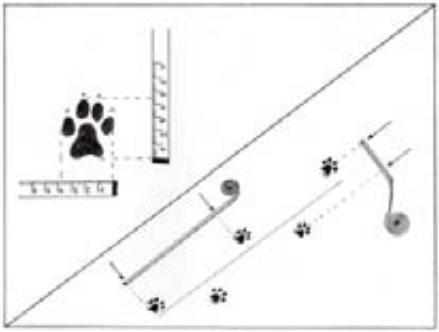
Many signs and observations in the field allow identifying the presence of a specific predator. Any sign and observation in the field must be carefully documented and material must be collected for further analyses. Fill in the **lynx form** in the field to assure to have checked all information and circumstances on the spot!

Footprint of an adult lynx in the snow.

Tracks

A single footprint is no secure confirmation of the presence of a lynx! Always several footprints should be looked at and the track should be followed if possible. Dimensions of prints and gait must be measured and documented as photos (with scale or object of known size such as pocket knife!) or drawings. Tracks and gaits can vary according to terrain and inclination of the slope. In lynx tracks, in soft underground and steep slopes, claw marks can often be seen in the tracks.

Footprint of a lynx in steep terrain. Note the fine claw marks.



Take the following measurements: Footprint: length (without claws) and width. Gait: distance between prints of the same foot (normally every second print), and width of the track.

A gait of only 60 cm is rather short for a lynx, but the animal was walking uphill on a slope with an inclination of 25°.

Hairs

Lynx leave hairs on barbed wires (photo), on scent posts (wood piles, little trees, rocks, corner of a house, etc.) or in the day bed (photo).

Collected hairs are stored in **paper** bags or envelopes (not in plastic bags!) to avoid electrostatic loading and reduce the risk of mildew.

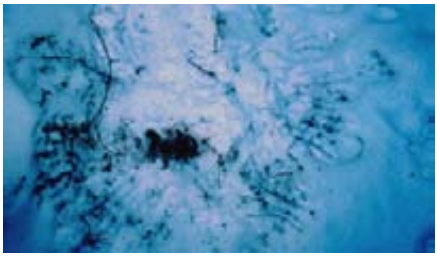
Caution: Predators such as red foxes eating mice can be infected with echinococcosis. The eggs of this parasite potentially dangerous to humans are in the scats. Do not directly sniff on scats and wear rubber/latex gloves to handle them!Wear rubber/latex gloves, avoid any cutting/injury, wash/disinfect hands

Scats

Collecting scats is only recommended if done systematically for the purpose of diet or genetic analyses.

- Fill in the scat form.
- Take a photo (with scale).
- Store them in a container suitable for later deep freezing. It is recommended to use biohazard bags suited for autoclaving the scats before analysis.

The identification of predator scats is difficult because of the big overlap in shape and size between different species. No scats should be accepted for diet analyses if the species was not identified by an independent method such as genetic analysis or hair identification! Lynx as all cat species wash themselves often and swallow their own hairs.



Lynx often cover their scats with earth, dead leaves or snow. Buried scats are often found in the vicinity of a kill.

4.3. Kills

It is difficult to identify the predator from one characteristic alone. Hence, to search, judge and document as many criteria as possible is very important, including the search for tracks and other associated signs in the vicinity of a kill. The principle approach is to search from "the outside" to "the inside", to avoid destroying important hints while searching for others:

1. Start with the surrounding of the kill,
2. look at the exterior of the carcass
3. remove it and cut it open.

a) *Examination of the surroundings of a dead prey animal* (note on the kill form).

Search the following features, describe and photograph them:

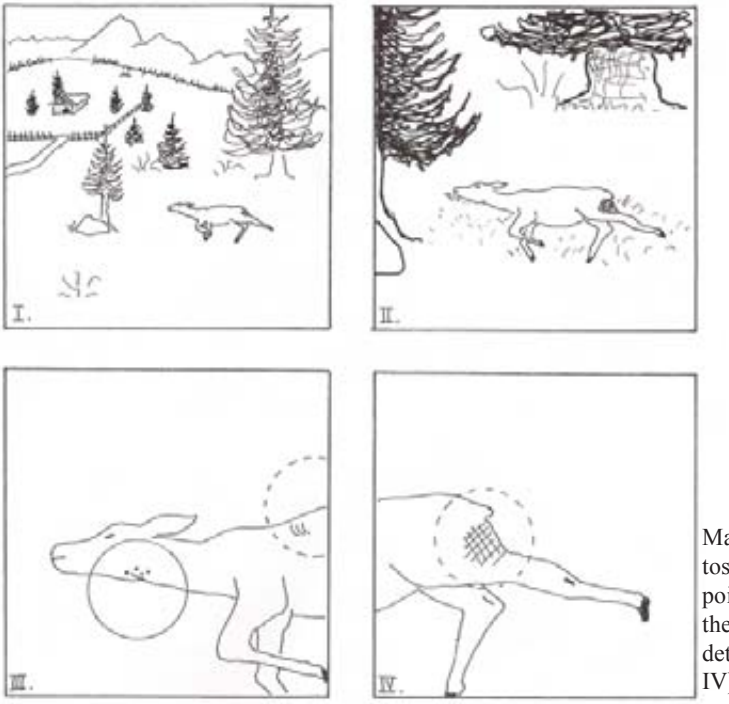
· Locality (coordinates, altitude, local name, etc.) and habitat (forest, pasture, distance to forest edge, etc.).

· Tracks, hairs and scats: see chapter 4.2., pages 55/56.

· Place where animal was killed/found (size of fighting area). If carcass was displaced, measure distance.

· Make sure that all collected material is properly labelled!

Photographic documentation:



Make several photos from different points of view, form the overview to the details (drawing I to IV).

For b and c see also checklist (p. 51)

b) *Analyses of the dead body from the outside* (**kill form**)

· Wear rubber/latex gloves to avoid any risk of a zoonoses!

· Weigh the carcass (photo).

Weighing a chamois killed by a lynx.

· Describe the carcass from the outside:

- Species, age and sex of the animal
- Body condition (well nourished, skinny, description of skin irritations, hoof abnormalities, former injuries and malformations – take photos! – etc.)

Hoof abnormality of a roe deer killed by a lynx.

- Freshness of the carcass (fresh to decomposition well advanced); in the warm season decomposition can go very fast. In summer, insect larvae can consume a considerable amount of a kill (photo).

Maggots consuming a chamois killed by a lynx.

• Was the animal covered? If yes (photo): with what material? What body parts are covered?

Lynx kill (roe deer) covered with snow.

• Was the body opened and consumed? Where?
• What body parts are missing? Consumed (photo)? Removed?
• Is the digestive tract on place (photo)? Was it opened/removed/covered?

The hind part of the roe deer killed by a lynx is consumed including the ribs on the left side. The digestive tract has been removed and is lying under the kill.

• Is the skin turned inside out?

The lynx started feeding at the back of a chamois and worked its way forward. By doing so it turned the hide inside out.

•Are injuries visible on the skin (claw marks, holes, bleeding – photo)?
• Are injuries visible that could have caused the death of the animal?
• Are other symptoms visible that could explain the death of the animal (diarrhoea, broken bones from a fall, parasites, etc.)?

Lynx bites visible on the throat of a roe deer.

c) *Analyses of the body after removing the hide*

The hide is removed very carefully. Avoid cutting through injuries! If the throat is bitten, cut the skin at the neck and remove the hide carefully to the throat.

· Are there (bleeding) holes in the skin? Note frequency (many, photo right top; few, photo right middle), distribution, form, diameter.

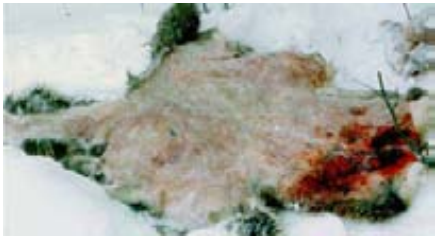
Caution: The distance between holes alone does not allow attributing a kill to a specific predator.

· Is there bleeding in the subcutis in conjunction with holes and claw marks on the skin (photo right middle and bottom)?
· Is bleeding in the muscles visible?
· Are there any broken bones?

Judgement of the status of organs must be done by experienced pathologist and often requires further laboratory analyses!

Many small holes are typical for the red fox.

Sometimes there is only bleeding around the holes where the animal was bitten while still living.



The skin of this red deer killed by a lynx has been entirely removed. The only bleeding is at the throat.

The sheep has been killed by a lynx, as indicated by the few holes of the teeth at the throat skin.

4.4. Chance and second-hand observations

Collecting and assessing chance observations on lynx presence (direct sightings, calls, tracks, and kills) is an important but difficult element of the surveillance. These observations are called “chance” observations because they are not generated through a systematic field project using transects, telemetry or camera trapping.

Chance and second-hand observations must be consequently recorded and if possible confirmed by all network members and compiled in a central data base.

Fill out the lynx form for lynx observations. Always carry enough forms with you. You might meet people while doing fieldwork who tell you about a lynx observation (photo).

Whenever possible, reported observations should be recorded by means of the observation form immediately.

Try to confirm the observation reported if possible. This is generally feasible when fresh tracks or kills are reported. Direct observations can only be confirmed if a photo is available or if tracks or any other indication of lynx presence can be found.

5. Field techniques and procedures

5.1. Snow tracking

Snow tracking is a straightforward way to confirm presence of lynx in an area. We distinguish a) opportunistic tracking and b) systematic tract transects with or without following lynx tracks. Systematic track transects require an accessible terrain and good snow tracking conditions lasting for long enough to fulfil the programme. This is mainly found in northern areas. The snow cover and weather conditions in the mountains of central and south Europe most often allow only opportunistic tracking, which however is still an excellent method to confirm lynx presence and can furthermore provide important ecological information.

a) Opportunistic tracking

Lynx tracks are searched for in a pre-selected study area when the snow conditions are good. Length, density and shape of the tracking routes depend on the goal of the survey, the size of the area and the number of trackers and the time available. The survey is done 2–3 days after new snowfall, when the animals had time to move, but tracks are still neat and easy to identify. Trackers follow forest roads or paths, which are also used by lynx and allow covering a large area. A track found is carefully identified and then followed first backwards, then forwards from the discovery point. Basic features of the track (number of lynx, size of prints, gait) are recorded each time the terrain or snow conditions change. The track is drawn in a map (scale 1:50,000 or better) or recorded by means of a GPS. Any special observation is indicated and documented: resting places, day beds, scats, scent marks, kills, hunting attempts, etc. A female with kittens sometimes follow each other in the tracks so that the number of animals can be defined only after following the track over a longer distance.

A lynx track (red lines) found on two different transects (brown lines). Active (smelling) lynx sent posts (blue dots) were found mainly along conspicuous landscape features as ridges or on outstanding objects (for example wood piles along roads). In the shown case, the lynx track lead to a lynx kill (triangle), where a camera trap was installed.

b) Track transects

The study area is defined as the total survey area. Transect routes are positioned in a more or less regular pattern (e.g. 10 km per 100 km²) according to the terrain and habitat distribution (forest). In rough terrain, transects are designed to assure a high probability of encountering lynx tracks, but still manageable and secure for the tracker. These requirements are best met when transects follow trails, ridges, forest roads, or natural travel corridors. A transect should be long enough to encounter tracks with a high probability. In mountains, transects normally start at the lower rim of the habitat (agricultural areas in the valley bottom) and go up to the ridge or the timberline (lynx usually do not move far above the forested areas), hence cross the entire band of lynx habitat. Density and distance of transect lines depend on the size of the area, the number of trackers and time available.

Transects can be done with or without following lynx tracks encountered. The methods require that all transects are finished within a given time. So trackers must first of all continue the transect line. Lynx tracks should however also be followed to see whether tracks found on neighbouring transects belong to the same animal. The lynx tracks can be followed after the transect (possibly only the next day) or through another person if enough trackers are available.

• *Recording*. All lynx tracks encountered on the transects – and of course also those found off the transects – are recorded and indicated in a map. Furthermore, tracks of lynx prey species (ungulates, hares, tetraonids) or other carnivores should be recorded as well.

• *Season*. The best season for track transects is the mating season (February/March/April), when lynx move more and the days are getting longer.

Example of a track transect study in eastern Switzerland. The transects were mainly laid out on forest roads, where lynx like to move in winter. They cover an area of 230 km² where 5-6 lynx were living. The total length of the transects was 305 km. Green = forest.

5.2. Camera trapping

Camera traps can be set for the following purposes:
1) to confirm the presence of a species in an area;
2) to identify the predator of a kill;
3) to distinguish a minimum number of lynx living in an area (extensive photo trapping in the Monitoring Guidelines);
4) to estimate the population in a study area (intensive camera trapping in the Monitoring Guidelines);
5) to conduct a survival analysis.

Camera trap at a kill (opportunistic setting)

- The camera is installed at a distance of 2-3 m, directed towards the kill.
- The terrain often allows anticipating where the lynx comes from. Camera traps are set that with a high probability the lynx is pictured from the side and not frontal. For the individual identification of a lynx, pictures of the fur pattern of the body side(s) are needed. Opposing camera traps allow taking pictures from both sides simultaneously. With only one camera trap available, it can be set on opposing sides of a kill in two consecutive nights.
- The camera must not be directed towards sunrise or sunset. Some triggers are sensitive to intensive light.
- A lynx may stay at a kill for a longer time or return to it several times during the night. To avoid taking all pictures within a few minutes (and hence to disturb the animal) the repeat rhythm of the camera trap should be set to a few minutes.
- Lynx normally return to a kill at dusk. Camera traps can therefore be programmed for the period just before sunset and just after sunrise.
- Use 400 ASA films.
- Only the negatives need to be developed – it safes money to produce prints only from the interesting photos.

Camera traps are set at a kill or on a trail either opportunistically (photos p. 64) or on trails in a pre-defined, systematic pattern (photos p. 65). Along trails, narrow places or attractive spots (scent mark sites) are preferably used. Most photo traps can be programmed (day/night, repeat frequency, etc.). Programming depends on the setting (trail, kill) and the question. Most cameras used for traps have a moderate wide-angle lens with a rather bad speed and a limited flashlight. An animal of the size of a lynx is most often pictured in a good size and well illuminated at a distance of 2–3 m.

The predator of the sheep is identified.

An individual lynx can be identified from its pelt pattern.

Camera trap at a trail

The camera is set (distance, vertical and horizontal angle) to get a good quality picture of the animal in a favourable position (sidewise).

a) Confirm species in an area (opportunistic setting)

- Trails or paths selected should be known to be used by lynx.
- One camera per site.
- Distance camera trap–animal (trail) 2–3 m.
- If distance is larger and/or surroundings are dark and dull, an additional flashlight is required.
- Firm fixation of the camera trap to a tree or a tripod, maybe secured with a chain and a security lock.
- Grass and branches, which could trigger the motion sensor or reflect the flashlight must be removed.
- Camera setting recommended: 15-20 sec (as short as possible) between photos, 1 hour before sunset to 1 hour after sunrise, 400 ASA film.

If correctly set, the animal walks in a right angle in front of the camera and the entire animal is taken in the centre of the picture.

Camera trap released too early and only part of the animal can be seen.

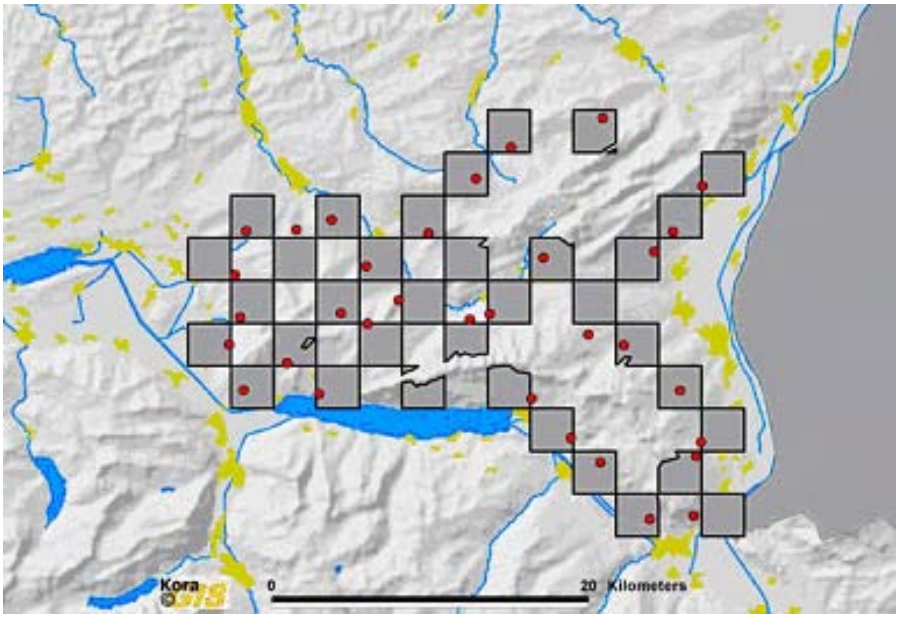
Lynx taken at the outer limit of the flashlight. The flash is too weak (additional flashlight needed) or the camera trap is set too far from the trail.

b) Population estimation

The best season for population estimation is the mating season (February to March/April) when lynx move a lot. The survey must last 40–60 days. To set 30–40 camera traps, an additional week is required.

The size of the study area is normally limited by practical means (manpower, number of camera traps), but it must encompass a significant part of the distribution area (for lynx in the Swiss Alps, this is at least 500 km²). The study area is defined on a map and the lynx habitat is divided into cells taking into consideration the size of a female home range (about 100 km²). As a rule of thumb, 5–7 camera traps are set per 100 km². In the Swiss Alps, the area is divided into a grid of 7.3 km² for each cell. A camera trap is set in half of the cells (granting a more or less regular distribution), always at the presumably "best" site within the cell.

If possible, two opposing cameras are set per site to get photos from both sides of the animal. A "cheap" solution is to use a fully programmable camera trap as a "master" and vis-à-vis a much simpler "slave" system with a camera triggered by the flash of the master system.



Example of the design of a camera trap survey in the Swiss Alps. The total study area is 538 km², the survey cells are 2.7 x 2.7 km. Within this area, a total of 66 cameras are set at 33 sites.

Camera setting as described above (p. 65). When setting two cameras facing each other at one site, make sure that the light sensor of the slave system "sees" the flashlight of the master.

A trail set with two cameras. In this case the grass was not removed, and triggered the cameras when moving in the wind.

Documentation

For each camera trap site, the **camera trap form** must be filled in. The first photo of each film is always used for the **film identification form**, allowing to identify the developed film later. A camera trapping session with many sets and many films requires a high degree of discipline to avoid confusion and loss of information! Each control of the camera trap set is entered in the camera trap form. Sets need to be controlled every 5–7 days and after each snowfall to avoid that cameras are snowed in. Exposed films must be developed immediately to detect malfunctioning or poor framing of certain camera sets (photo).

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7. Appendices

7.1. Checklist field material

Dead lynx
- mortality form
- camera, film, flash
- container to transport carcass
- map
- field notebook, pencil
- rubber gloves

Kills
- kill form
- field notebook and pencil
- map
- camera, film, flash
- rubber gloves
- measuring tape (for tracks, footprints, and characteristics on the kill)
- scale to weigh the kill
- plastic bags of different size
- bio-hazzard bags to collect scats
- paper envelopes to collect hairs
- labelling material
- sharp knife

Track transects and snow tracking
- track transect form
- map (with pre-defined transect)
- field notebook and pencil
- GPS
- camera, films, flash
- measuring tape
- bio-hazzard bags for scats
- paper envelopes for hairs
- rubber gloves
- plastic bags
- labelling material
- sharp knife
- flashlight

Camera trapping

- film identification form
- camera trap form
- camera trap (functioning tested before)
- accumulator (loaded) or batteries
- films
- material to fix the trap (tripod, angle and screws to fix on a tree)
- ball point
- key to open the camera
- hammer
- adhesive tape
- rope/chain to secure the trap
- security lock
- field notebook, pencil
- cleaning cloth
- cleaning alcohol
- installation checklist
- flashlight
- replacement camera trap

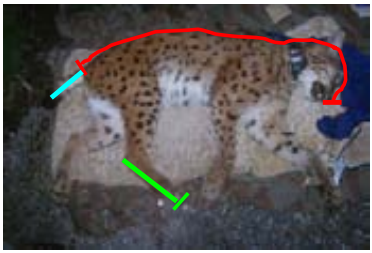
7.2. Report forms

How to measure a lynx

Total length:
From tip of the nose to the root of the tail (red line);

Tail length:
Root of the tail to tip of the tail (last bone, not hair tip, blue line);

Hindfoot length:
Heel bone to end of the ball of the toe (without claws, green line);

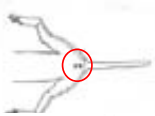


Ear length (international standard)
Inner earlength from ear canal to tip of the ear (without hairs);

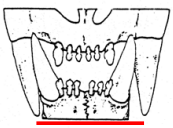
Ear length (KORA)
Inner earlength from Anthelix (see red arrow in drawing) to the tip of the ear (without hairs);

Ear tuft
Tip of the ear to tip of the tuft

Distance between anus and genital aperature
measure from centre to centre of the holes



Distance between canini
Measure tip to tip



Lynx morphology

Send form to:

Running ID _____

Date and Location of Mortality

Date:_____Coordinates:X_____ /Y_____

Name of locality: _____ Altitude:_____m

Community/District:_____

Animal information

☐ male ☐ female age (juvenile, subadult, adult):_____

Cause of mortality:_____

Pathology exam.: ☐ yes ☐ no if yes, where _____

Biometry

Weight:_____kg

Total length (tip of the nose to root of the tail): :____ cm

Tail length :___ mm

Shoulder height: :_____ mm

Hindfoot length	left: :_____ mm	right: :_____ mm
Ear (internationl standard)	left: :_____ mm	right: :_____ mm
Ear (KORA):	left: :_____ mm	right: :_____ mm
Ear tufts:	left: :_____ mm	right: :_____ mm
Distance between canini	upper: :_____ mm	lower: :_____ mm

Distance between anus and genital aperture: :_____ mm

Lynx mortality

Send form to:

Finder

Name, First Name:_____Phone:_____

Address, Zip Code, Town: _____

Email:_____

I am a : ☐ game warden ☐ hunter ☐ naturalist

Who else did observe the dead animal? _____

Form filled out by: ☐ finder ☐ other person: _____

Date and Location of Mortality

Date found:_____Coordinates:X _____/Y_____ Altitude _____m

Date animal died: _____ known: ☐ estimated: ☐

Name of locality:_____Community/District: _____

Description of the locality: _____

(forest, clearing, distance to forest, village, etc.)

Animal information

☐ male ☐ female weight:_____kg age (juvenile, subadult, adult): _____

Freshness: carcass ☐ very fresh ☐ medium fresh ☐ autolytic

Body condition (injuries, nutrition status, reproduction, etc.): _____

Pathology exam.: ☐ yes ☐ no if yes, where _____

Remainings

☐ Skull Conserved with (what museum or private person):_____

☐ Skeleton Conserved with (what museum or private person):_____

☐ Skin Conserved with (what museum or private person):_____

Sample collected for genetic analyses

☐ muscle in alcohol (90%)

☐ dry skin in paper envelop

☐ other _____

sample(s) stored where_____

Mortality form (back side)

Description of the discovery of the mortality and further remarks:

Locality and date: _____ Signature: _____

Did you make one of the following or did you collect anything?:

☐ Photos ☐ Video ☐ collected the carcass
if yes, brought where _____

Attachments:

☐ Photos
others:

Scat form

Running ID:_____

Finder

Name, First Name:_____

Address, Zip Code, Town:_____

Email:_____ Phone:_____

I am a: ☐ game warden ☐ hunter ☐ naturalist ☐ network member

Form filled out by: ☐ finder ☐ other person:_____

Date and Location of Scat

Date:_____Coordinates:X_____/Y_____

Name of locality: _____Altitude_____m

Community/District:_____

Description of the locality:_____

Scat Information

scat found ☐ near daybed ☐ near kill ☐ at scent marking

☐ on track ☐ other_____

If near kill, species_____ estimated date of kill_____

To what percentage was kill used when scat was found _____%

☐ scat not covered scat covered with ☐ grass ☐ leaves ☐ snow ☐ moss

☐ earth ☐ other_____

☐ scat fresh ☐ scat not fresh ☐ scat old

☐ scat firm consistence; number of nods_____

☐ scat no firm consistence (liquid)

Scat collection

☐ scat collected ☐ scat stored at _____

☐ scat photographed

☐ scat analysed by_____

Documentation of lynx kills (wild animals and livestock)

Running ID Nr.:_____

Expert controlling the kill (game warden / project expert / etc):

Name: _____First name:_____

Phone Nr(s): _____

Mobile Phone Nr.:_____eMail: _____

Person who found the animal:

Name:_____ First name: _____

Address: _____

Zip code:_____ Town: _____Country:_____Phone Nr.: _____

Owner of the animal in case of domestic livestock:

Name:_____ First name: _____

Address: _____

Zip code:_____ Town: _____Country:_____Phone Nr.: _____

Locality and date of discovery of the kill

Country:_____District/community:_____local name: _____

Coordinates X:_____/Y:_____Altitude (m) _____

Date found: Day: _____Month:_____Year: _____

Date announced: Day: _____Month:_____Year: _____

History:

Livestock:

Animals in the area: ☐ sheep ☐ goat ☐ cattle ☐ horse ☐ others:_____

Number:_____ ☐ flock fenced ☐ free ranging

flock: ☐ guarded ☐ 1 control/day ☐ 1 control/week ☐ 1 - 2 controls/month

Predators / stray dogs observed in the area (potential killer):

Observed in the area: species:_____How many:_____ Date:_____

Locality:_____Altitude: _____ m

Predator/stray dogs observed at the kill:

Species:_____ How many: _____Date:_____

Findings in the field: (Hint on the predator species):

☐ trail ☐ track species:_____ ☐ Findings sure ☐ Findings unsure

Underground: ☐ snow ☐ soft earth ☐ sand

☐ scat ☐ hair: species:_____ ☐ Findings sure ☐ Findings unsure

Collected material: _____

Photos of what and by whom: _____

Findings on the animal:

Species:_____ Breed (livestock): _____

Sex:_____ Age: _____ Weight: _____

Examination in the field: ☐ Animal opened ☐ Judgement only from the outside

Remarks: _____

_____

Description of the kill

Body condition: ☐ good ☐ poor Freshness: ☐ good ☐ poor

Animal moved: ☐ yes ☐ no Animal covered (grass, leaves, snow) ☐ yes ☐ no

Missing body parts: _____

Skin: ☐ scratching signs; where: _____

☐ perforations; where: _____

Subcutis: ☐ bleeding; where: _____

Muscles: ☐ bleeding; where: _____

☐ missing muscle parts; where: _____

Bones: ☐ broken bones; what bones: _____

Drawings of the observed injuries:

Fig. A: Head and neck

Fig. B: Head and throat

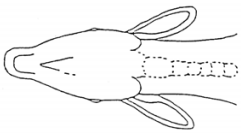
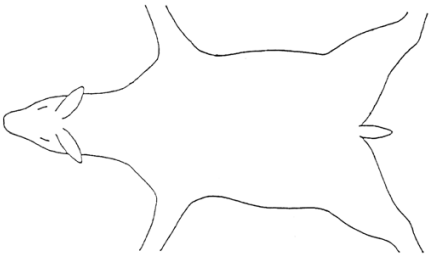


Fig. C: Skin from the inside (laid out)



Legend for Fig A, B, C: bite-tacks claws / scratching feeding signs bleeding

Use of the kill by other species: ☐ fox ☐ birds other: _____

☐ Supposed kill cannot be found

Remarks: _____

_____

_____

_____

Questionnaire Lynx

Year concerned _____

1. Did you have during this year lynx presence in your area?

☐ no ☐ yes ☐ only unconfirmed signs of presence

2. Number of lynx signs in your area during this year:

☐ none ☐ 1 – 2 ☐ 3 – 5 ☐ 5 – 10 ☐ more than 10

3. Typ of observation(s)

☐ Direct observation of a single lynx
☐ Direct observation of several lynx
☐ Signs of reproduction (direct observation, tracks, etc.)
☐ Lynx tracks (single tracks, trails, scats, hairs)
☐ Lynx kill found
☐ Dead lynx found

4. Is the lynx occurrence/observation in your area:

☐ increasing ☐ stable at high density ☐ stable at low density ☐ decreasing

---

Details on the observations

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Region: _____

Reporter: ☐ game warden ☐ network member

Name, First name:_____Phone: _____

Address, Zip code, Town: _____

Country: _____Email: _____

Locality and date: _____

Signature: _____

Send to:

Lynx observation

Send form to:

Running ID _____

Observer

Name, First name:_____ Phone: _____

Address, Zip code, City, Country _____

Email: _____

Personal Information: ☐ game warden ☐ hunter ☐ network member ☐ other_____

Who else has made the observation? _____

Form filled out by: ☐ observer ☐ other person: _____

Date and locality of observation

Date:_____Coordinates X:_____/Y_____ Altitude _____ m

Locality: _____

Community:_____District:_____

Description of the observation location: _____

(forest, clearing, distance to forest, to town, etc.)

☐ **Lynx observed**

Number:_____ Time: observed from _____ to _____ at a distance of:_____m

Observation by: ☐ eye ☐ binoculars ☐ telescope

Weather and observation conditions: _____

☐ **Lynx tracks found**

☐ single footprint ☐ track ☐ scat ☐ hairs ☐ other: _____

Underground (snow, soft ground, mud, etc.): _____

If track followed, please note details at the end of the form

☐ **Lynx prey found**

Species:_____ ☐ male ☐ female age (if possible): _____

What happened to the kill (left on the spot, taken away, etc.)?

Special form filled out ☐

☐ **Lynx mortality discovered**

☐ male ☐ female age (juvenile, subadult, adult):_____ special form filled out ☐

Description of the observation and further remarks:

Locality and date:_____Signature: _____

Did you do or collect any of the following things?:

☐ Photos ☐ Photos on CD ☐ Video ☐ Drawings ☐ Hairs ☐ Scat

☐ Plaster cast of a footprint ☐ Collect carcass

Annex:

☐ Photos ☐ CD ☐ Drawings ☐ Video

others: _____

Track survey form

Please fill out a complete form for each lynx track set you encounter and a form for each unsuccessful survey.

Date, Location & Conditions

Date:_____Coordinates: X_____ /Y_____

Name of locality: _____ Altitude:_____m

Community/District:_____

Survey person or team:_____

Estimated trail distance covered:_____kilometres

Weather:_____

Time/day of last snow fall:_____

Snow condition: ☐ dry/fluffy ☐ compact/dry

☐ wet ☐ surface crust

Snow depth: _____cm

Track location habitat: ☐ forest ☐ shrub ☐ open ☐ other

Describe location habitat:_____

Track description

Number of lynx: ☐ 1 ☐ 2 ☐ 3 other_____ ☐ uncertain

Behaviour: ☐ walking ☐ trotting ☐ bounding other:_____

Estimated track age: ☐ <1day ☐ <1week ☐ >1week ☐ uncertain

Track condition: ☐ distinct outline ☐ indistinct outline ☐ melted
Toe-nail imprints: ☐ absent ☐ present ☐ uncertain

Track size

Pad Length: _____cm Width: _____cm
Stride distance between tracks: greatest _____cm / least _____cm
Straddle With _____cm
Track Photo: ☐ no ☐ yes, digital ☐ yes, conventional

Remarks

(scat, other sign?)_____

Film identification and camera trap control form (on the back) for intensive camera trapping sessions

This front page filled in with the necessary information is **always** the first photo on the film

Locality number	
Number of camera	
Locality name	
Coordinates (X/Y)	
Habitat	□ forest road □ wildlife passage □ hiking trail □ other_____
Film Sensitivity	400 ASA □ other sensitivity_____
Film size	36 pictures □ other size_____
Functioning time	from_____ to_____
Remarks	

Slave

make a big cross in the square besides if the camera is a slave

Month (01-12) Day (01-31) Camera number

Person controlling	Date	Time	Number of photos taken	Remarks (sabotage, lynx tracks, etc...)

Per action only one form Film ID _____

Extensive camera trap action form

Person _____

Camera trap number _____

Date when put in the field _____

Date when removed from the field _____

Aim

☐ Survey of kill species _____

Survey of wildlife passage: ☐ forest road ☐ hiking trail

Locality

Name _____

Community _____ District _____

Coordinates X_____/Y_____ Map Nr. _____

Photos

Number of potos taken _____

	Lynx	Red fox	Badger	Bird	Domestic cat	Humans	dark
Number							

Remarks

_____

_____