ANNEX to
Methodology on identification and designation of Ecological corridors of transboundary interest for *Open Borders for Wildlife in the Carpathians (OBWIC) project*

Regarding Section 2.3. Collecting data on the umbrella species occurrence via field survey

PROTOCOL FOR TARGET SPECIES FIELD SURVEY

Version 1.0

Compiled by: Milan Janák, Jerguš Tesák, Nuno Guimaraes, Tereza Thompson, Lukáš Holásek

Field surveys of target species in the project area shall serve two purposes:

- renewal or updating of the distribution data for the target species in the project area as well as filling in data gaps and mapping of actual / potential habitats of the target species including threats and pressures,
- verification and detailing of core areas, ecological corridors and bottleneck areas identified in the project area by modelling – i.e. verification of functional connectivity (functioning of the ecological corridor).

While field surveys oriented on improving the distribution data on the target species could be performed in any phase of the project, verification of the functional connectivity is dependent on the results of connectivity modelling, i.e. it shall target the specific parts of the project area identified by connectivity model as core areas, corridors or bottlenecks. With the respects to project needs, the project phase and spatial focus of the survey, we hereby distinguish field surveys of target species to be part of opportunistic sampling, systematic surveys or continuous monitoring. In this way, the collection of data on target umbrella species will be organised in three stages.

Field surveys shall cover both target species of the project – brown bear, grey wolf and Eurasian lynx as well as two additional (auxiliary) species – golden jackal and red deer, which we expect to fill in possible deficiency of data on large carnivores in particular parts of the project area.

1. Opportunistic sampling in the project area

The main purpose of the opportunistic sampling is collection of evidence on the presence of the target species (such as tracks, droppings, coat etc.) in the project area as well as collection of data on the quality of actual or potential habitats of the target species. The intention is also to make first reconnaissance of the area to enable detailed designing of systematic survey (e.g. determination of locations for camera traps installation). This will allow collection of first field data about the real use of the area by target species, including location of movement corridors or bottlenecks.

Opportunistic sampling may target any part of the project area, however it is advisable to focus on expected corridors and specific bottlenecks. In this respect, ecotone habitats represent best habitat to target by the sampling. Other areas may be chosen according to their location, spatial importance or because of special interest (e.g. border areas). In case there are too many optional sites with the same priority, the choice can be random.

Ground tracking surveys

Method and design of survey

Ground tracking surveys will represent regular and repeated **tracking on predefined transects** to confirm presence of target umbrella species and determine assumed migration / dispersion routes throughout the year, but especially during migration periods. Tracks and other presence signs such as droppings, pickings, temporary shelters etc. are to be recorded. The advised length of transect is 10-15 km, which is a distance that could cover quite large territory and is feasible to be surveyed within one day.

Migration / dispersion routes will be surveyed especially in the open landscape as forested landscapes usually represent suitable breeding habitats with no migration barriers (with exclusion of fenced areas, such as game enclosures, etc.).

Animal routes (e.g. those of red deer) are most visible on the forest ecotone, where game enters open agricultural landscape. Animal trail leading from the forest to the open landscape is strongly trampled and evident at the beginning but gradually becomes less visible until it disappears (especially in case of ungulates, which disperse while grazing, looking for nutritious food). Coming to a target habitat, animals concentrate again in flocks and create a distinct path of similar width it had on its beginning.

Due to the different behaviour of the target species and considering the difficulty to find animal evidences in open landscapes, survey should start in areas with more probability of target species presence. We use such areas as a starting point for transects continuing then further into the open land. These can be the following:

- forest edge, especially forest ecotone with dense shrub layer
- crossing point of (forest) habitat and surface linear infrastructure (road, power line, etc.)
- riparian vegetation (vegetation growing along the watercourse)
- linear tree stands, such as hedges, alleys, wind barriers
- connection to the artificial feeding spot
- locations suggested by local experts, e.g. hunters

Ideally, ground tracking shall cover entire area of interest. However, priority shall be given to expected corridors and specific bottlenecks or areas with data gaps in target species presence. In any case, the same methodological approach has to be used all over the surveyed area. As majority of transects will be first defined based on the maps, aerial images or partial knowledge of the surveyed area, it is expected the location/route of the transects is redefined after the first visit, e.g. to avoid obstacles (fences, unpassable water courses) and best suit to survey objectives.

The exact timing of field visits need not to be harmonised throughout the entire surveyed area. It is advised to visit each particular transect repeatedly in different periods of the year, ideally in spring and / or autumn. In case of repetition in different years, the deviation in visit date should not be larger than 2 weeks.

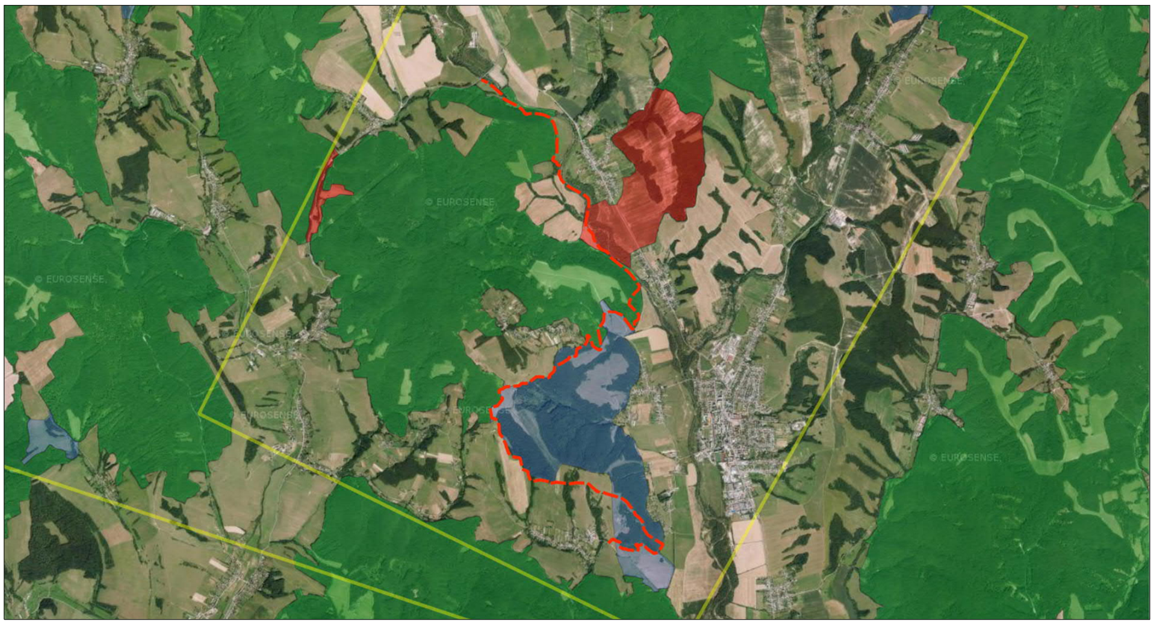

Fig. 1: Example of monitoring transect location for ground tracking surveys. Blues polygon represents expected ecological corridor habitat, red polygon is an assumed bottleneck.

Determination of target and auxiliary species presence

Brown bear (*Ursus arctos*)

The spatial behaviour of Brown bear is typical for its using of large areas consisting of a variety of natural and semi-natural habitats. Migration is a significant part of bear behaviour connected with some specific activities. Ecological corridors in this case play an important role, because they connect landscape as such or are part of bear core area. Main drivers for migration of bear specimen may be food search, reproduction or dispersion of subadults. In the springtime, when bears start to move to farther areas after the winter sleep they usually cross the existing ecological corridors. The individuals in the age of 3-6 years, which start to discover new unoccupied areas, usually pass longer distances. It is a typical form of dispersal behaviour, searching and occupying new areas. In autumn time individuals move back into their dens from a larger area. Genetic surveys and telemetry results suggest (Paule 2016, Barton et al. 2019) the movement activity of bears is significant. All those behavioural patterns point out on a necessity of permeable landscape with functioning ecological corridors.

Optimal season for tracking of bears is spring or autumn when we can track bears also in ecological corridors. During the monitoring and tracking it is important to focus on typical signs of bear presence in the surveyed area (transects).

The following signs of the species presence shall be noticed:

a) **bear tracks -** they are distinct from other animals. Front tracks consist of an oval and wide pad with five toes. Generally, claws are present in the track varying from one individual to another in the distance from the toe prints. The hind tracks have an additional circular pad (heel) in the posterior edge of the track and can resemble human footprint. The width of the pad of the front track ranges: +/- 8cm of a 1st year cub to +/- 18 cm in an adult individual. The length of the hind track ranges from 12 cm (cub in its first year) to 30 cm (adult individual).

Fig. 2: Bear track – from left to right - hind pad & front pad

b) **droppings -** the size of bear droppings ranges from 3 to 8 cm (diameter) on average, depending on the size, sex and age of the individual. As an omnivorous species, the appearance of bear droppings depends on the diet, which varies according to season and food availability. In the springtime, the colour of the droppings usually varies from dark green to black, due to the higher content of plant food (grasses). In the summer, pips of various berries can be visible in the droppings (e.g. raspberry, strawberry). In the autumn, pips as well as undigested bits of seeds (rose hip, rowanberry, blueberry, acorns, etc.) are contained in the droppings. In the winter, the bear droppings are rare. The remains of digested meat in the feaces are usually brown, containing also hairs of the prey. Anthropogenic food remnants can also be found in bear droppings, such as agriculture crops, or the food from artificial feeding places for wild ungulates.

Fig. 3: Variety of bear scats 1. - rosehip scat, 2. beechmast, 3. artificial feeding scat

c) **marking activities** - marking trees are an important communication node as a territorial mark within bear’s territory but also a source of food. Marking trees are usually characteristic with the presence of bites, claw scratch and hairs from body scratch. Generally, when bears feed from the tree the tree bark is damaged or peeled off by the animal. Coniferous trees are generally the preferred trees for territory marking while forage trees vary in species depending on availability and season. The coat of individual bears, which scratched themselves against the tree can be found at the damaged places. This type of behaviour has been observed most frequently in male individuals and it points out higher activity of bears in the area. Marking trees decrease the possibility of undesirable meetings with other individuals, notify others about the marking animal's social status, and promotes meetings of sexual partners during the rut season (Flerov, 1929, Seton, 1937, Pazhetnov, 1979, Pazhetnov, 1990, Rukovsky, 1987, Puchkovsky, 1991).

Fig. 4: Two types of typical bear forage trees appearance

d) Coats/Fur – coat of the bears can be found most likely on the marking and forage trees. The colour of the coat varies from dark brown to light brown.

Eurasian lynx (*Lynx lynx*)

Lynx migration is connected strictly to its diurnal behaviour. Lynxes have huge home ranges (100 - 350 km^2) that occupy a variety of landscapes. In many cases, anthropogenic infrastructure can be present inside the lynx territory. Lynx movements represent migration related to reproduction, taking place from January to March, when male individuals search for fertile female individuals. Lynx migrates at longer distances and leaves its stable territory. Many times the individuals cross over the entire mountain ranges and their routes cross several road and rail infrastructure. Permeable corridors are thus very important for the species and can affect the gene flow in the population. Dispersal migration is typical for young subadult individuals of both sexes, which are in search for a new territory. Within this migration pattern, both regional and supraregional corridors can be used. For monitoring of lynx migration corridors the optimal season is winter (December – March) with preparatory actions (such as the opportunistic monitoring) to be performed during the autumn months (October – November), when the marking and movement activity of the species is increasing.

Detection of presence is the best in the winter and early springtime when lynx leave tracks in snow or mud. During the summer, detection of lynx is much more difficult. To record the lynx presence out of winter season the most efficient is using of camera traps.

The tracking of lynx shall focus on the following signs of the species presence:

a) **tracks** - The footprint is typical feline-type with a width very close to the length, with large and rounded anterior part, with prints of the lateral fingers positioned quite ahead (asymmetric position of the 3rd and 4th toes), with relatively small surface of the fingers cushions' part as well as with pointed (in some cases) finger's cushions, but without separate traces of claws (which is the main difference between the lynx and dog paw prints), unless made in the jump, or if the imprint is in the soft mud or snow). The size of the print ranges from 6.5 to 10 cm.

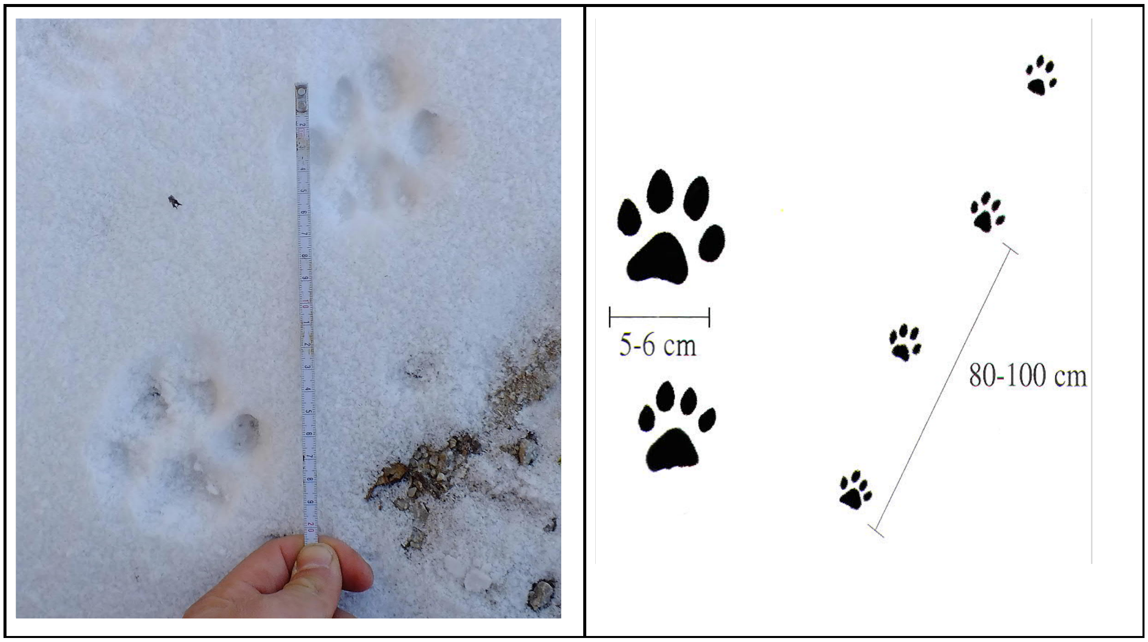

Fig. 5: Lynx tracks in the snow.

b) **way of walking** - lynx usually walks (wolf usually trots) and therefore each track is independently placed (front paw placed in front of the back paw). If the lynx traces something, he often changes the direction of the walk, scratches itself against the tree stumps and marks the tree stumps and twigs. During trotting the lynx places its back paw into the print of its front paw. The stride/trail width is 40 to 50 cm. Specific movements of the tracked animal can be recorded in comments section of the field mapping form.

c) **marking** - lynx marking spots are generally very difficult to find, nevertheless individual lynx tend to choose specific places which it visits periodically. On the lynx marking spots it is possible to record the presence of coats/fur and claw marks from scratching.

d) **droppings and urine** - in some marking spots it is also possible to determine the presence of urine and less commonly the presence of droppings. Although urine samples are the most difficult sample to record, their location might be of crucial importance within is the animal's trails. Lynx droppings are difficult to record except for snow cover conditions.

e) **prey** - dominant prey for the lynx is roe deer, but he can also prey on hares, subadult red deers or other ungulates. Characteristic sign of lynx presence is that lynx hides its prey from other predators using surrounding natural material (leafs, branches, etc.). The prey usually remains on the spot for several days (3-8). Registering of such presence sing is however very rare.

Fig. 6: (Left) Hiding of droppings under the snow or soil is very typical sign of lynx presence. (Right) Roe deer female covered in beech leaves.

Fig. 7: Lynx droppings.

Grey wolf (*Canis lupus*)

Wolves are social animals that live in packs, occupying a determined home range. Wolf dispersion happens when one individual leaves its pack in search for a new territory or in cases when packs are disrupted e.g. by an anthropogenic impact (especially when alpha individuals are killed; intentionally or by accident). Wolves use various types of habitats from forest to pastures. Food availability determines the territory use.

Spatial behaviour of wolves depends on the season and the life cycle. In spring and summer, wolves are more bound to their dens (in case the reproduction was successful and wolf female has brood). Later in the year, the pack moves to the rendezvous sites. The female stays with cubs while the alpha male and other members of the pack leave for a hunt. They hunt individually or in small groups. During this time, when they bring the food to the female and the cubs, the hunting wolves do not move as far away as in the rest of the year. The summer-time home range of the male wolf, which was monitored by telemetry in the north of Tatra Mountains, was 85 km^2, which is about half the size of its wintertime territory.

During autumn and winter, the cubs grow up and the whole pack is able to move at farther distances. They are not bound to the surroundings of the den, but they are still visiting their rendezvous sites. They keep meeting up within their territory and in searching for food they move at 22-28 (45) km long distances on average.

Migration or long-distance movements are characteristic for this species. Subadults use to leave the pack in search for their own territory. This dispersal happens at larger distances (sometimes-even hundreds of kilometres) and wolves can use supra-regional or regional ecological corridors during these movements. For daily movements wolves often use artificial passages to cross transport infrastructure, which lays within their territory. Wintertime is a best season for tracking of wolves as wolf track can be well recognised on snow. But there are also other presence signs which enable to register presence of the species.

The following signs of the species presence can be recorded during monitoring:

a) **tracks -** wolf's tracks are normally determined by its size and the position of toes. When a group of tracks is found, it is also possible to determine the species by the size of the stride, trail width and type of gait. However, it can be confused with a dog track due to some similarities. Normally based on a group of tracks we can determine the species with a higher certainty as dog movements are different from that of the wolf. Track of wolf consists of 4 toe prints (slightly oval), a pad (with differences in front & hind pad) and the claws. There are four claws visible in the wolf's paw print. Compared to dog's paw print, wolf's paw print is usually longer, as two front finger balls are more in front and thus the paw print seems to be elongated in comparison to that of dog, which seem to be more rounded. The size of wolf's paw print ranges from 8 to 10 cm. When walking, wolf places its back leg paw into the print of the front leg paw, which results in a regular line pattern. When walking in a group, wolves usually walk in one track (especially in the snow), which may create uncertainty in the number of individuals which were present. Location of observed wolf paw prints also needs to be taken into consideration.

Near to human settlements, the risk of mistaken dog tracks is much higher. In such case, single tracks should not be considered as relevant sign of species presence unless there is a strong (photographic and metric) evidence or other evidences where found in near locations (e.g. record from camera trap, prey carcass, and other).

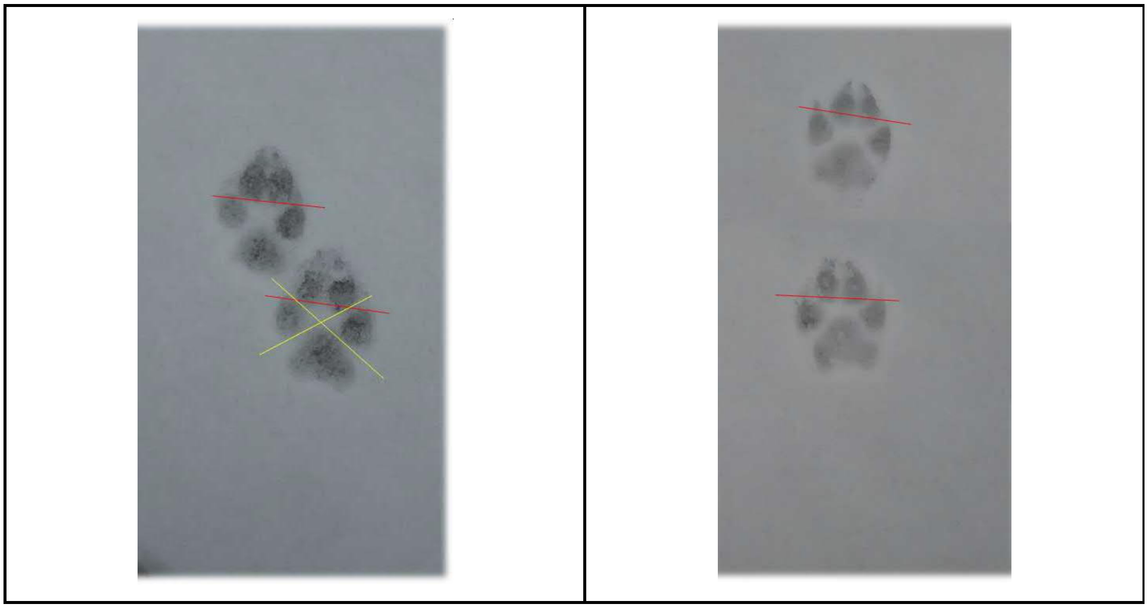

Fig. 8: Difference between the wolf (left) and dog (right) tracks in snow.

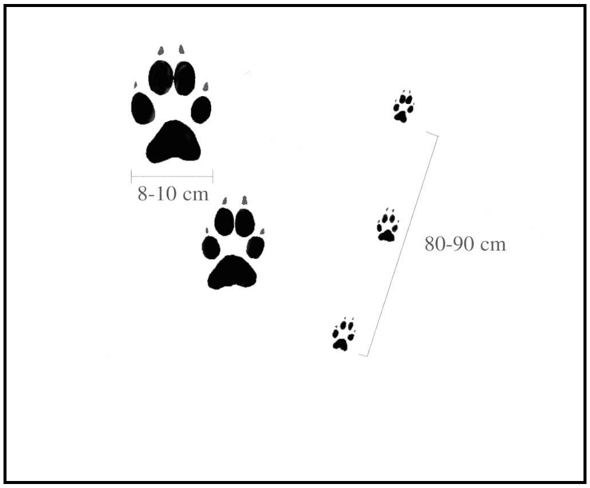

Fig. 9: Wolf prints.

b) **droppings** - droppings of wolf usually contain hair from the prey and in most of the cases the hair is not carrying evidence of being chewed. Most common is the hair of cervides or wild boar. Droppings are usually of dark brown colour and distinct odour.

They often contain remains of bones. Older droppings are white with a lot of hair content. Wolves use droppings to mark their territories or important communication nodes.

Fig. 10: Wolf droppings are usually 2-5 cm in diameter.

c) **marking activities** - can be found at important points of the wolf territory. Most often, it can be the border of the territory, which is being marked by urine or dug soil. Digging helps to disperse the smell. Urine is most often found during the winter, when snow is present and it can be well visible.

Fig. 11: Dug soil on a wolf marking spot.

d) **prey -** important, but less common is finding of a wolf prey. The most common wolf prey is red deer or wild boar, less common is roe deer, fallow deer or mouflon. If wolves live in areas with sheep farms, sheep can become part of their diet. Wolves usually eat the most of their prey, often leaving only a spine, a head or less often legs. The prey carcasses are often found in long valleys with a river course. In case the carnivore prey is found it is important to identify if it is that of wolf, what is possible only in initial phase of the consumptions. When the carcass is older, mostly composed of bald bones, it is difficult to determine if it was a wolf prey.

Fig. 12: Red deer female as a wolf prey. Wolf tracks around the prey are well recognizable.

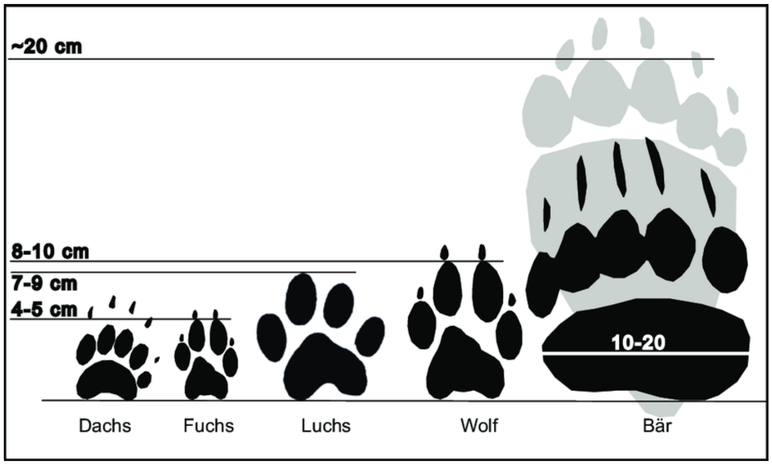

Fig. 13: Comparison of different carnivore species tracks.

Golden Jackal (*Canis aureus*)

Jackals are mesocarnivores, which most usually live in pairs, but they can also form bigger groups. These groups are usually formed by members of the family (descendants of the main pair) but also by non-relative individuals. Home range size of pairs can be as small as 5km^2. Golden jackals have a great ability of dispersing and are recently present all over the Europe. Recent dispersion in Slovakia places the Golden Jackal in a vast area of the country and in a large variety of habitats all due to the adaptability and generalist behaviour of the species.

a) **prey** – jackal is a mesocarnivore, omnivorous and generalist species. The trophic ecology of the species can vary from large prey (normally scavenged), small mammals, birds (including eggs of ground nesting birds) and insects. In settled areas the diet also includes food waste (from dumping sites).

b) **marking activities** – jackals do not leave specific markings distinguishable from other canids. Marking activities of the Golden Jackal are similar to wolves and foxes and in general these are used for communication (marking of the territory) and orientation, such as using specific corridors in wetlands.
c) **droppings** – droppings of jackals can be misinterpreted due to the close appearance to fox droppings. Although the length of the droppings can be larger than the one of the fox having a total length of 14 cm, to be considered as a valid evidence it should be always supported by other presence signs such as coat samples (hair) or tracks.
d) **tracks** – jackals have normally a much specific track as the toes 3 and 4 are connected in the posterior part of the print of both toes. The distribution of the fingers and the shape of the fingers can help to distinguish from fox and dogs in case the connection between fingers is not clear. Some dogs in a very small number also present the connection between toes so it is important to relate evidence in order to avoid bias.

Red deer (*Cervus elaphus*)

Red deer is known for several types of migration movements. During seasonal migration red deer avoids winter landscape by moving into lower areas with lesser snow cover and frosted soil. In summer, they again move into higher altitude areas in search of food and peace needed for reproduction. During mating season, both male and female individuals pass over large distances. Females can do 4 - 6 km, males up to 25 km long movements.

Other movements relate to search for optimal food sources available in the landscape, such as moving to a cornfield, etc. During this type of movement, older, reproducing individuals use experience and knowledge gained at a younger age, as at that age their learning ability is high. Older deer do not have the ability to learn about new migration routes.

Young individuals perform most distant dispersal movements. This way they get to know their future territories. A deer, which has already entered reproduction, uses only a territory he knows from its young age. Getting its genetic material to a new territory is important for the health and good condition of the population. Dispersal distances depend on the population density.

The following signs of the species presence are to be observed:

a) **pounce/hoof track**

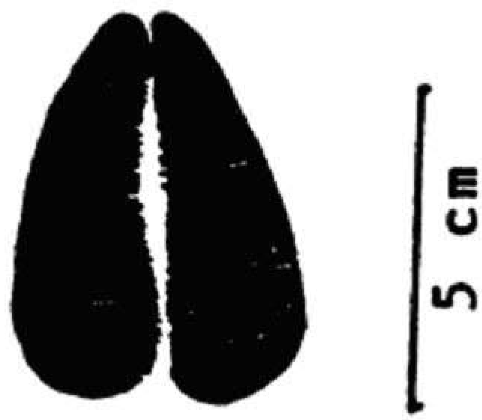

Fig. 14: Red deer track.

Front leg hoofs are more robust, longer and wider in comparison to back leg hoofs, which are shorter and sleeker. The hoof tracks of old deers (more than 7 years old) measure 7.5-9 cm in length and 6-7 cm in width. The hoof tracks of middle age deers (3-6 years old) measure 6.5 - 7 cm in length and 5-6 cm in width. The hoof tracks of young deers measure 4-5.5 cm in length and 3.5-5 cm in width. The hoof tracks of an adult doe measure 6-6.5 cm in length and 4.5-5.5

cm in width. Their hoof tracks are thinner and grow gradually sharper towards the front of the hoof. Stag hoof prints are rounder and the pounce top is round as well.

In comparison to roe deer, the red deer hoof print is distinguishable by longer step and larger hoof track, wider crotch and bigger angle of swerving. In comparison to fallow deer, the red deer hoof track differs in size, in case of same sized-individuals it differs in size of edger block/footing. Fallow deer edger block/footing covers the full back half of the pounce and the outer pounce is not that significantly longer as that of the red deer.

b) **track pattern**

If the animal walks, only the tip of the hoof track pointing out of the track will be printed. Older deers are typical for wider “swerving” and wider steps. Back leg tracks are placed in the front leg tracks and a variety of double prints occur. If the animal runs, the back legs get in front of the front legs and the tracks are positioned as pairs of front and back leg tracks. If the animal jumps, the spacing is wider, back legs reach further to the front and they are positioned next to each other at a small angle. Front legs tracks at an angle one after another.

Hoof track pattern of a doe is typical by tracks being almost parallel with movement centreline. In case of a stag, the tracks swerve out of the line, more so with higher age of the stag.

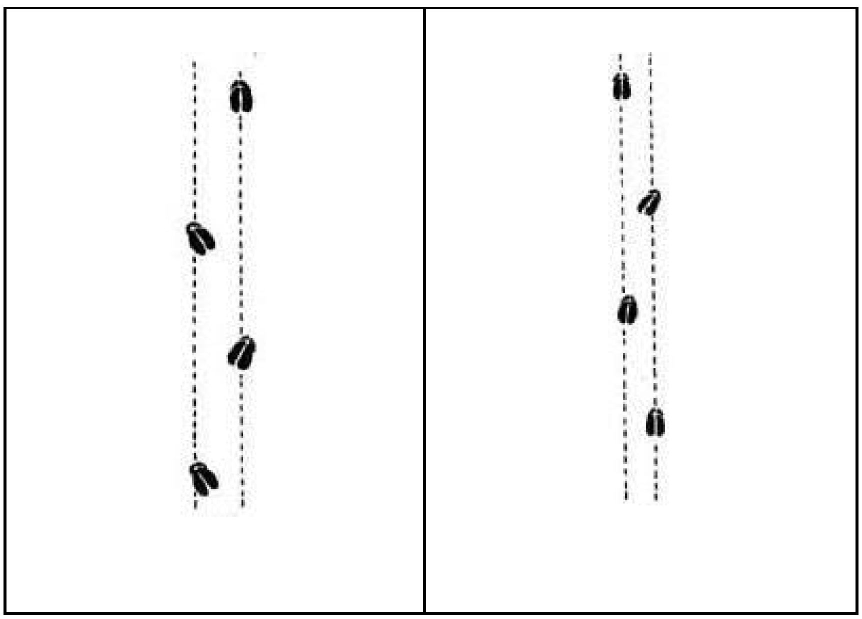

Fig. 15: Red deer track pattern – stag (left) and doe (right).

c) **droppings**

Fig. 16: Red deer droppings – winter type.

Deer droppings can be most often found at places where deers come out to feed or mate, or at their pathways. Deer droppings are cylindric, one end is sharp, other usually slightly deepened. A doe leaves dropping which are elongated and cylindric in shape, with both ends sharp or rounded. The scat of cervid animals is dark coloured and if fresh, glossy. Droppings of an adult animal are 20-25 mm long and 13-18 mm wide. The scat is thinner in the summer and individual droppings usually stick together into larger lumps. During the transition period from winter dry food to fresh food, the droppings are of mushy consistency.

d) bark peeling

Red deers often peel tree and shrub bark in times of food scarcity or in order to replenish acids helping digestion of food. Stags also often damage tree bark when scratching antlers. However, in such cases there are no distinguishable marks of teeth visible on the wood trunks.

Fig. 17: Peeling of the bark by red deer in summer (left) and during wintertime (right).

Recording data in the field

Tracks and other presence signs of target and auxiliary species such as droppings, pickings, temporary shelters etc. are to be recorded when moving on the mapping transect. Each spotted presence (sign, location) needs to be recorded separately as a point occurrence locality. However, there may be cases the species occurrence is better recorded as line or polygon locality. For example, above we described how to track wolf and that for its safe determination it is advised to follow the track line and check more than a single footprint. In such cases, when we want to record an animal trail, it is more efficient to record it as a line locality indicating its length and width. Alternatively, it can be recorded as a point occurrence with information about the path length and width recorded in notes section of the record. Example of occurrence, which can be recorded as a polygon locality, is temporary resting place of ungulates, which may cover tens to hundreds of square meters.
The below list includes the minimum required data fields (information) which has to be recorded for every occurrence record. Filling all information in the following steps is mandatory, except those under point 7, 8 and 9.

1. **Name of mapper** – name of person mapping the transect. In case more persons participated on making the record, input all names. Person responsible for particular record shall be indicated in the first place.
2. **Date** – date the survey was conducted in format dd.mm.yyyy; eg. 08.04.2009. In case survey is planned for several days, this is the date the actual record was made.
3. **Time** – time when the record was made.
4. **Transect number** – indicate transect number using predefined codes
5. **Locality** – such as local name of the area, cadaster of the closest village plus number, etc.
6. **X, Y coordinates** (+ altitude) – geographical coordinates of the record position in decimal degrees (e.g. 33.2514) according to GPS. If possible, record also altitude (may be an important information for some species, such as lynx). In case, the record is made as a line locality record starting and terminating point of the line. In case of polygon locality, measure approximate centroid (if possible) or position of borderline points.
7. **Area** **only for locality recorded as polygon** – estimate the area (in m^2 or ha) of the species locality. This information is mandatory if the species occurrence locality is recorded as a polygon.
8. **Length** and **Width** **only for locality recorded as line** – Record the length and width (in m) of the mapped species locality. This information is mandatory if the locality is recorded as a line.
9. **Note** – place for any notes and comments. Alternatively, here can be recorded information about area, length and width of polygon or line occurrence locality if recorded as a point record.
10. **Taxon** – name of the species (genus or at least family in case of doubts) choosing from the list of target and auxiliary animal species: Brown bear, Grey wolf, Eurasian lynx, Golden jackal, Red deer. At least one taxon should be recorded on each recorded locality. Other species than those listed above (e.g. wild boar) can be recorded too, but it is not mandatory.
11. **Abundance** – indicate abundance for each species recorded. There are three options how to provide information on species abundance ranging from more to less precise. Use as precise abundance estimation as possible:
    A. Number of individuals: Estimate, if possible, absolute number of individuals. If possible indicate separate abundance numbers according to sex (males Vs females) or age (juveniles, subadults, adults). You can also use suffix (i) for individuals or (p) for (breeding) pairs.
    B. Abundance range: Use the following ranges: 1-5, 6-10, 11-50, 51-100, 101-250, 251-500, 501-1000, 1001-10.000, > 10.000.
    C. Relative abundance: C - common, R – rare, V – very rare.
12. **Character of occurrence** – Indicate the character of occurrence for each species using one of the categories below:

BOJ – adult males fight – Observation of adult male individuals fighting for territory.
GRAVID – pregnant female – Observation of a gravid female individual.
HIBERNACIA – hibernation, winter sleep – Finding of a hibernating individual.
HLAS – voice / call – voice display.
M_MV – migration or presence out of breeding period. Not to be used for winter, for that use category HIBERNATION instead.

MUMIA – mummy – Finding of a dead mummified body. Usually a skeleton covered by skin, with mild smell, time of death is uncertain. In case of finding a fresh dead or decaying carcass, use category UHYN.
NEGAT – negative result of planned check - Negative result of checking the occurrence of the given species. In such a case, recorded abundance of the given species should be zero. However, during field tracking surveys, we do not expect using of this occurrence cathegory.
NOCOVISKO – night roosting place – Gathering of larger number of individuals at night roosting place.
PARENIE – mating – Observation of mating.
POBYTOVE ZNAKY – presence signs of species in case of its direct absence – Indirect proofs of occurrence – such as finding of food remnants, scratched trunks, scratched soil, mud, urine or other marks, hair, etc. based on which the species can be identified.
PRECHODNY UKRYT – temporary shelter – Finding of individuals in a temporary (not permanent) shelter.
STAVBA – structures created by animals – Finding of an animal-made structure, such as nest, den, burrow, etc.
STOPA – footprint / track – Indirect proof of occurrence – finding of tracks in the snow, soil or sand, based on which the species could be identified.
TRUS – droppings – Finding of droppings, based on which species can be identified.
UHYN – dead specimen – Finding of a fresh or decaying carcass (it may not originate on the place of finding, may be transported by watercourse etc.).
UHYN NA CESTE – animal killed on the road – Animal killed or injured on the road, the cause of death or injury is a collision with transport vehicle.
UKRYT – animal in/at its shelter – Visual observation of an animal in the shelter or in its proximity. The shelter itself (if without the animal) can be recoded as STAVBA (construction, such as den, burrow…). Check also PRECHODNY UKRYT (temporary shelter).
VIZUAL – visual observation – Direct visual observation of live individual in its natural environment without direct contact or a capture of the animal, e.g. individuals occurring at unreachable places.
ZASTREL – killed with firearm – Finding of an individual killed by a firearm. This category is of a different value than the category UHYN.
ZHOD – shed antlers – Finding of the antlers. In case of finding of a dead individual with the antlers, use the category UHYN, UHYN NA CESTE or ZASTREL.
ZIMOVANIE – wintering – Wintering individuals, individuals in timeperiod between 1 December to 15 February. For individuals in “winter sleep” use category HIBERNATION.

Field equipment

The following field equipment is necessary for the ground tracking survey:

- Topographical map in 1:25 000 scale or higher or high resolution aerial photos
- Clip board, notebook
- Pencil(s)
- GPS
- Digital camera
- Meter

The last two items can be substituted by smartphone equipped with GPS module and digital camera. Additional equipment include binocular and sample tubes for collection of droppings or urine samples (in case analysis of samples is foreseen).

Data digitalisation and collection of data from mappers

The data obtained during the field inventory in both analogue (hard copy maps and field notes) or digital format (database) have to be handed over to the coordinator of field inventory in digital format. For data digitalisation, a special database module in Aves Symfony online database of BirdLife Slovakia will be used. The information required under chapter *Recording data in the field* reflect the structure of fields of the Aves Symfony database. The database is also equipped with an integrated GIS module, which allows to digitalise the localities from the hard copy maps into the GIS, directly in the database environment.

Camera trapping (testing locations)

Camera traps can also be used for opportunistic surveys. Aim is to gain supporting background data on the presence (or absence) of target and auxiliary species in the study area, to test locations for camera traps stations established for systematic monitoring or already to establish such camera trap stations. It will be performed preferentially in assumed bottleneck areas (as suggested by structural connectivity modelling) or in other important localities based on expert considerations. Appropriate locations for camera traps (CT) shall be determined during the ground tracking surveys. The actual placement of CTs shall be on the mapping transect for ground tracking surveys or in their direct proximity (app. 50-100 m) to maximise time effectiveness of the field visits. Optimization of proper CT positions for systematic monitoring is crucial, therefore it is expected that some CTs can be relocated after some time to get best possible location.

Method and design of survey

CTs will be set in localities where we identified presence signs of focal species (paths, tracks, droppings, hair, etc.) or on locations suggested by trustful local experts.
Most suitable places for installation of CT include:

- significant animal walkways / intersections and places where these walkways connect
- places with observed track lines
- places where there is the greatest chance that the animal will pass just in front of the camera trap
- places sufficing the assumption "where there is prey, there is also a predator" (the routes of herbivores will be followed by large carnivores, too)
- the safest possible place from the viewpoint of possible theft of the camera trap

Tips for camera trap installation:

- We ALWAYS install CT together with the protective box.
- We try to screw the protective box directly to the tree.
- In principle, we do NOT place CT at the height of the human eye. Optimal installation height is 60 - 90 cm. In case of risk of stealing CT can be placed on a tree at up to 3-4 m height in the correct angle.

- We use natural material from the immediate vicinity of the installation for the camouflage (less is sometimes more)
- If the environment allows, we prefer trees with coarse bark and various optical defects, instead of trees with smooth and clean trunks
- We think of possible changes in the environment during the monitoring (snow cover, tall grass, etc.)
- We place CT at the correct distance from the observed object
- If possible, we prefer longitudinal monitoring of animal walkways over frontal observation
- If possible, we try to orient CT to the north (due to the incident sunlight)
- In the settings we prefer Video or Photo + Video function
- Before we initiate CT, we ALWAYS make a control record to verify it is functioning properly in a given place (the height, size and ability to catch movement of a particular species).

The start and end date of the sampling period is not set as binding, but it is important to perform opportunistic camera trapping before the start of the systematic monitoring on camera trap stations. It is therefore suggested that first installation of CTs on testing locations is performed during opportunistic ground tracking survey. At places where presence of target species was confirmed by CT records, the CTs are left for systematic monitoring to represent camera trap stations, while from locations proven unsuitable the CTs are relocated to different places.

Field equipment

Apart from CT and necessary equipment, such as spare batteries and SD card to replenish used ones, it is recommended to document potential corridors and barriers with digital camera. It is also required to record coordinates and altitude of every CT. Optimal is to use smartphone with GPS or GPS navigator with camera.

Data digitalisation and collection of data from mappers

Every CT will have its own ID. Field controls of CT will be performed min. 2x/month when data should be transferred on external hard drive and empty batteries changed to fully charged. Minimum installation time of CT is 1 month/location. For the purpose of data records each CT location is dealt as a separate locality. Therefore check part *Recording data in the field* if the ground tracking survey and deliver data from CTs in the same structure.
Collected data will be exported in harmonized format (with ID of concrete CT) and sent to the field work coordinator.

Fig. 18: Protective box for the camera trap and camouflaged camera trap.

Fig. 19: Example of installed camera trap location.

2. Systematic monitoring in potential corridor and bottleneck areas

After the first habitat modelling is ready (draft), with the identified corridors and bottlenecks, it will be worthy to start the systematic field surveys and the collection of evidence on the presence of the target species in the assumed corridor and bottleneck habitats. It is necessary to verify the results from the modelling, which means to verify functional connectivity of the corridors and bottlenecks. There is also the probability that the model will reveal large number of potential areas for field verification. As models are sensitive to certain parameters it will be necessary to choose the ones where monitoring is possible and feasible given the duration of the project.

Systematic monitoring shall therefore consider the following:

- The purpose is to analyse thoroughly the use of the pre-selected corridors/bottlenecks by the target species, in order to verify the first identification and designation of ecological corridors of transboundary interest.
- Subject of the monitoring in this stage is to determine (reveal) the real functionality of corridors (functional connectivity), confirm and characterise the presence of target species. At the same time, it will be possible to identify bottlenecks/limitations of use of the corridors.
- Target areas for systematic monitoring will be determined according to the results obtained from mathematical modelling. The intention is to validate the results of the model, where the use of possible corridors can be defined as true or false.
- Monitoring will target areas which the model indicates as corridors and specific bottlenecks.
- In case the number of results is too many, the choice will be made randomly or monitoring orients to areas with a special interest (transboundary areas).

Method and design of survey

The systematic monitoring will use the same monitoring methods as described in the opportunistic sampling:

- Ground tracking surveys, incl. transect mapping and winter tracking on snow
- Camera trapping on camera trap stations

The systematic ground tracking surveys will include repeated visits on the predefined transects set up during opportunistic sampling as well as new transects set to cover potential ecological corridors and bottleneck habitats identified by mathematical modelling.
The systematic use of camera traps serves to gain data for statistical processing and evaluation. The background are data provided by previous opportunistic sampling, which preliminarily identified potential spots for further systematic monitoring. Systematic survey has to be performed for an exact time period in exact - predefined locations. In this survey all relevant data about the presence or absence of focal species in identified core areas, corridors and bottlenecks have to be systematically collected.

Instructions and details on methods and design of survey, field equipment, recording data in the field, data digitalisation and collection of data from mappers are the same as described for opportunistic sampling (see previous chapter) with additions described below.

Ground tracking surveys

Winter tracking on snow is a variation of transect tracking method and will be used to complement systematic ground tracking on transects. The aim is to cover larger territories or specific habitats not only on corridor habitats but also in core areas of species distribution – source and target areas (forested areas). It shall also provide better estimation of target species abundance than the more dispersed transect tracking enables. Although the actual field visits during the winter snow tracking are performed in similar manner as those of the transect tracking, the work is organised in a different manner. Aim is to cover larger compact territories (e.g. mountain ranges) with a survey executed by larger number of mappers within a short time, e.g. 1-2 days, which allows estimate of target species abundance, location of home ranges (territories) of particular animals or packs, etc.

Timing of the winter tracking depends on the presence of fresh snow cover followed by days with no snow precipitation. Due to more difficult weather and lower accessibility of remote places during winter period as well as due to safety reasons it is advised to design mapping transects for winter tracking on a maximum length of 5 km. For the same reason, it is also advised mappers will do field surveys in pairs, not as single person.

Camera trapping (camera trap stations)

Data processing

Collected data will be exported in a harmonized format (with ID of concrete CT) and sent to the field work coordinator. For each camera station, a relative abundance index (C) will be calculated as the total number of animals recorded for each species, divided by the total sampling effort:

$Ci = xi/ni$
Ci = index of species visitation at camera station i
xi = total number of animals of a species photographed at camera station i
ni = number of nights that camera was operative at camera station i
i = camera trap with specific ID

3. Continuous monitoring

The purpose of the continuous monitoring is to ensure that management and mitigation measures aimed to maintain / improve the functionality of the corridors (particularly in bottleneck areas) can be sustainable. It represents a continuous evaluation of the use of the corridors, to understand if there is some seasonality in its use by the target species.
Subject of the survey is to increase the knowledge on the use of the corridors by the target species in order to increase the success of the project outcomes (identification and designation of ecological corridors of transboundary interest) and ensure not only structural but also functional connectivity of the landscape in the project target area.
Selection of area targeted by the continuous monitoring depends on the previous stage results. These results will much probably allow the determination of the corridors, which permit the connectivity between habitats, and/or the possible bottlenecks.

The continuous monitoring will be mainly include ground tracking surveys and camera trapping although other different methods described below can be considered too. From a technical point of view, continuous monitoring will be performed in the same way as the systematic monitoring.

From a methodological point of view the main purpose of continuous monitoring is to gather data on a longer period to record the trends in functionality of wildlife corridors (with/without, after/before the measures have been implemented). Especially when the identified corridor is threatened by some development plan (e.g. building of road infrastructure) or after implementing of some mitigating measures.

Additional field methods for the continuous monitoring:

Observation stations

Corresponds to sit and wait sessions to gather data from key areas by visual contact of individuals or groups of wild animals, in order to evaluate the use of these areas. Aim of this method is to support the records of the use of the corridors collected with other methods. Observation will be realized 1 to 2 times per month in open landscapes (e.g. meadows, crop fields) within the key and determined based on the results of both opportunistic and systematic surveys. This will allow to maximize the chance of confirmation of the use of the areas in question. Observations can be done during the day as optional but they should be programmed 2 to 4 hours within the sunset and sunrise times, when wildlife activity is higher.

- All presences will be recorded in: numbers, approximate age and sex, time of the day and description of the behaviour of the animal(s).
- For the observation process, observer should be equipped with a telescope (20-60X), binoculars (7X42 - 10x50), a digital camera or smartphone, a video camera with high optical zoom.
- Field researchers should be discreet during the travel to the site and during the time on the observation station in order to minimize the impact on the presence of the animals.

Bioacoustic stations

Bioacoustic stations target just one species, the golden jackal. This method comprehends a series of simulated howls reproduced with a megaphone, in order to confirm the presence of the species. The use of bioacoustic is the most used for surveying golden jackals within the species range and will increase the probability of recording his presence within the key areas. Bioacoustic sessions will be realized to enlarge the space monitored and it is intended to determine the localization of pairs or groups and the estimation of minimum number of animals. In order to decrease the chances of double counting animals, two bioacoustic stations should not distance less than 2.5 km from each other.

Within the bioacoustic monitoring, researcher should be equipped with a megaphone, a dictaphone, binoculars, flashlight, photographic and video camera (with long distance).

The procedures to realize the method are as follow:

- After arriving to the bioacoustic station proceed with 10 to 15 minutes of silence (quiet and motionless).
- Start recording with the Dictaphone.
- Proceed with a 5 series of howling reproduction, with 2-3 minutes between them (a search with the flashlight should be done.

- When series are finished, researcher should wait 10-15 minutes in silence. All records should be recorded in howling table.

Appendix

FIELD FORM ON THE UMBRELLA SPECIES OCCURRENCE

No.______

Date and hour of observation: _ _ /_ _ / 202_; start ___:___ end: ___:___
(day/month/year) (hour/minute) (hour/minute)

Name of the observer:...

Locality/Location of observation: ....**Toponym:**

Transect number: ....

GPS coordinates (X,Y):

Altitude (m):

Meteo conditions:

Sky		Rainfall		Wind	
clear weather (cloudless)		rain		windlessness	
somewhat cloudy (mostly without clouds)		rain scud		light breeze (moves tree leaves)	
half cloudy (app. 50% of the sky with clouds)		storm		moderate wind (moves tree branches)	
mostly cloudy (more than 50% covered by clouds)		distant storm		strong wind (moves with entire tree and is able to broke branches)	
cloudy (completely covered by clouds)		drizzling		Windstorm (able to broke large tree branches or uproot trees)	
fog (low inverse cloudiness)		snow scud			
		snowing			
		snow storm			

Temperature			
time	exact temp.	subjectively estimated temp.	
		very cold (below 15 ˚C)	
		cold (15-20 ˚C)	
		warm (20-30 ˚C)	
		hot (above 30 ˚C)	

Notes on locality:

Habitat:

Taxon information:

Species	**Abundance**	**Sex** (M-male, F-female, U-unknown)	**Age** (A-adult, S-subadult, J-juvenile)	**Character of occurence**	**Notes on species occurence** (details on presence signs, size of prints; size, colour, consistency and freshness of droppings, etc.)

Additional information:

Photos (to be attached)

Instructions for filling in the Field Form:

1. **Name of mapper** – name of person mapping the transect. In case more persons participated on making the record, input all names. Person responsible for particular record shall be indicated in the first place.
2. **Date** – date the survey was conducted in format dd.mm.yyyy; eg. 08.04.2009. In case survey is planned for several days, this is the date the actual record was made.
3. **Time –** time when the record was made.
4. **Transect number** – indicate transect number using predefined codes
5. **Locality –** such as local name of the area, cadaster of the closest village plus number, etc.
6. **X, Y coordinates** (+ altitude) – geographical coordinates of the record position in decimal degrees (e.g. 33.2514) according to GPS. If possible, record also altitude (may be an important information for some species, such as lynx). In case, the record is made as a line locality record starting and terminating point of the line. In case of polygon locality, measure approximate centroid (if possible) or position of borderline points.
7. **Area** **only for locality recorded as polygon** **–** estimate the area (in m^2 or ha) of the species locality. This information is mandatory if the species occurrence locality is recorded as a polygon.
8. **Length** and **Width** **only for locality recorded as line** – Record the length and width (in m) of the mapped species locality. This information is mandatory if the locality is recorded as a line.
9. **Note –** place for any notes and comments. Alternatively, here can be recorded information about area, length and width of polygon or line occurrence locality if recorded as a point record.
10. **Taxon –** name of the species (genus or at least family in case of doubts) choosing from the list of target and auxiliary animal species: Brown bear, Grey wolf, Eurasian lynx, Golden jackal, Red deer. At least one taxon should be recorded on each recorded locality. Other species than those listed above (e.g. wild boar) can be recorded too, but it is not mandatory.
11. **Abundance** – indicate abundance for each species recorded. There are three options how to provide information on species abundance ranging from more to less precise. Use as precise abundance estimation as possible:

    A. Number of individuals: Estimate, if possible, absolute number of individuals. If possible indicate separate abundance numbers according to sex (Males, females) or age (juveniles, subadults, adults). You can also use suffix (i) for individuals or (p) for (breeding) pairs.

    B. Abundance range: Use the following ranges: 1-5, 6-10, 11-50, 51-100, 101-250, 251-500, 501-1000, 1001-10.000, > 10.000.

    C. Relative abundance: C - common, R – rare, V – very rare.
12. **Character of occurrence** – Indicate the character of occurrence for each species using one of the categories below:

BOJ – adult males fight – Observation of adult male individuals fighting for territory.

GRAVID – pregnant female – Observation of a gravid female individual.
HIBERNACIA – hibernation, winter sleep – Finding of a hibernating individual.
HLAS – voice / call – voice display.
M_MV – migration or presence out of breeding period. Not to be used for winter, for that use category HIBERNATION instead.
MUMIA – mummy – Finding of a dead mummified body. Usually a skeleton covered by skin, with mild smell, time of death is uncertain. In case of finding a fresh dead or decaying carcass, use category UHYN.
NEGAT – negative result of planned check - Negative result of checking the occurrence of the given species. In such a case, recorded abundance of the given species should be zero. However, during field tracking surveys, we do not expect using of this occurrence category.
NOCOVISKO – night roosting place – Gathering of larger number of individuals at night roosting place.
PARENIE – mating – Observation of mating.
POBYTOVE ZNAKY – presence signs of species in case of its direct absence – Indirect proofs of occurrence – such as finding of food remnants, scratched trunks, scratched soil, mud, urine or other marks, hair, etc. based on which the species can be identified.
PRECHODNY UKRYT – temporary shelter – Finding of individuals in a temporary (not permanent) shelter.
STAVBA – structures created by animals – Finding of an animal-made structure, such as nest, den, burrow, etc.
STOPA – footprint / track – Indirect proof of occurrence – finding of tracks in the snow, soil or sand, based on which the species could be identified.
TRUS – droppings – Finding of droppings, based on which species can be identified.
UHYN – dead specimen – Finding of a fresh or decaying carcass (it may not originate on the place of finding, may be transported by watercourse etc.).
UHYN NA CESTE – animal killed on the road – Animal killed or injured on the road, the cause of death or injury is a collision with transport vehicle.
UKRYT – animal in/at its shelter – Visual observation of an animal in the shelter or in its proximity. The shelter itself (if without the animal) can be recoded as STAVBA (construction, such as den, burrow…). Check also PRECHODNY UKRYT (temporary shelter).
VIZUAL – visual observation – Direct visual observation of live individual in its natural environment without direct contact or a capture of the animal, e.g. individuals occurring at unreachable places.
ZASTREL – killed with firearm – Finding of an individual killed by a firearm. This category is of a different value than the category UHYN.
ZHOD – shed antlers – Finding of the antlers. In case of finding of a dead individual with the antlers, use the category UHYN, UHYN NA CESTE or ZASTREL.
ZIMOVANIE – wintering – Wintering individuals, individuals in time period between
1 December to 15 February. For individuals in “winter sleep” use category HIBERNATION.