TRANSNATIONAL TOOLBOX FOR POPULATION-LEVEL LYNX MONITORING

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1. INTRODUCTION

1.1 DEFINITION OF MONITORING

With the word “monitoring” we refer to a series of surveys which compile qualitative or quantitative data by means of standardized procedures in order to define a status. The results of the surveys are continuously compared with a desired objective, for example the recovery of an endangered population to a viable status. This distinguishes monitoring from single surveys or surveillances (Breitenmoser et al. 2006).

1.2 AIMS OF THIS TOOLBOX

The main aim of this toolbox is to describe the principal existing methods available for lynx monitoring and evaluate their usefulness in terms of participatory approaches, also based on the direct experiences that each project partner has already earned so far.

Depending on the available means and on the specific aim of the monitoring, different methods can be used to monitor lynx. Each method has its own advantages and disadvantages, and very often different methods are combined into a monitoring scheme, integrating each other. Therefore, this toolbox was compiled to help identifying the best combination of methods to be used under different conditions and to achieve answers to different questions.

2. POSSIBLE METHODS FOR LYNX MONITORING

2.1 CAMERA TRAPPING

Method description

Camera traps are placed in the field, ideally on less frequented forest roads, game paths or hiking trails (these are often used by lynx to move more easily through their territories), or at (confirmed or potential) scent-marking places along roads, trails or in rocky terrain.

When placing cameras on forest roads/game paths/hiking trails, if possible, two camera traps with white flash and fast trigger speed should be installed, one on each side of the given road/path/trail, with the aim of taking high quality pictures from both lynx flanks and therefore obtain individual identification (based on coat pattern). At scent-marking places, camera traps with the possibility to record HD-videos and with infra-red or black flash are to be preferred. The installation of one camera should be enough. If precise information on lynx presence (e.g. by tracks or telemetry locations) is not available, camera trap sites should be chosen according to expert knowledge on lynx habitat and spatial use. Camera trapping sites should be distributed in the study area according to a grid in order to space the sites evenly.

Camera trapping can be done using extensive (opportunistic) or intensive (systematic) design, depending on the resources available and on the question that the camera trapping study is focussed on. In extensive camera trapping studies, the number of camera traps should be at least 2 per resident lynx, i.e. 2 traps in a 10km x 10km grid (assuming an approximate density of 1 independent lynx/100 km^2). The sites should be placed more densely in areas with known reproduction, where the number should be at least 4-6 camera trap sites per resident female (i.e. 4-6 traps per 10km x 10km grid) in order to obtain more detailed information about the presence and survival of kittens. Also, fresh lynx kills are a good opportunity to install camera traps and to record a lynx family. Data from extensive camera trapping can at least provide information about the presence of lynx in a given area and (if a sufficiently large area is covered) about the minimum number of individuals belonging to the studied population. In intensive camera trapping studies, camera trap sites should cover the area more densely (e.g., a 2.7km x 2.7km grid has been used in Switzerland and in the Bohemian-Bavarian border region) and the aim is generally to apply capture-recapture methods and estimate abundance and population density.

Main advantages

-It provides hard fact data on lynx presence.

-If performed in a sufficiently large area and with a proper underlying grid scheme, camera trapping allows the monitoring of a whole population and (for species whose individuals can be reliably recognized, like the lynx) the minimum number of lynx present in the area.

-If performed selecting the intensive camera trapping study design, it allows capture-recapture analyses and obtaining good estimations of abundance and population density.

-If performed for a sufficiently long time span, camera trapping allows collection of crucial information about the survival of single individuals and about migration, dispersal distances, and the establishment of home ranges by subadults.

-If performed continuously and with sufficient intensity, it allows documentation of reproduction and kitten survival throughout the year

-It is an attractive method to enhance the involvement of stakeholders (especially foresters and hunters, who also work with camera traps for other purposes).

Main disadvantages

-(Ideally) it requires expert knowledge about lynx habitat and spatial use. Furthermore, camera trap sites need to be evaluated for some time in order to set up a sufficiently successful net of camera trap sites

-It has relatively elevated costs, especially when the aim of the study is higher than confirming lynx presence in a given area, because clear, good quality pictures are required for lynx identification and this is only ensured by using cameras of good quality (and therefore more expensive).

-Relatively high risk of thefts or sabotage sometimes influences the choice of camera trapping sites, impedes installation of cameras in otherwise ideal sites, and can lead to gaps in the data series (when a camera is stolen together with its data content). This is especially true when cameras with white flash (which is currently the only possibility to obtain a clear picture of a moving lynx) are placed at forest roads/paths/trails, because the presence of white flash strongly increases the probability that the camera will be detected. On the other hand, the risk of thefts or sabotage could, to a certain extent, be reduced by attaching a note on cameras about the reason why they are installed (Clarin et al., 2014).

-Probably a less effective method for the monitoring of lynx populations with a prevailing “spotless” coat pattern, as defined by Thueler (2002)’s classification (e.g. Scandinavian lynx population)

-Agreement from landowner/hunter associations for camera trap installation on their property is sometimes difficult to get. This can cause gaps in the monitoring net.

Usefulness in terms of participatory approach

Very useful. Camera traps placed to monitor lynx can also document the presence of other animal species, some of which are also of great interest for stakeholders that may more likely get into conflict with lynx (e.g., photos of wild game can be of interest to hunters and foresters). Then, as a first step, presenting the results of camera trapping as a whole makes the results more interesting for all stakeholders and this ensures larger participation in the discussion about lynx conservation and management. In addition, researchers can “offer” to identify individual lynx and share the knowledge about the individual’s life history, which can motivate other stakeholders to share their own data about lynx presence and keep in contact with researchers. In the best cases, this can also lead to other stakeholders becoming an active part of the monitoring team.

Previous experience of project partners using this method for lynx monitoring

-SUNAP: since 2009, in about 2/3 of the National Park area, intensive camera trapping design, minimally 100 days/year.

-ALKA: since 2013, extensive camera trapping especially in the outskirts of the BBA lynx population distribution.

-NCA CR: extensive use of camera traps in some Protected Landscape Areas, especially in Blanský les PLA.

-LfU in cooperation with Lynx Project Bavaria: since 2007 at a scale of 800 – 3500 km^2, intensive and extensive use of camera trapping method.

-PLI: since 2004 with varying partners and efforts.

-GHE: since 2011 within Lynx Project Austria Northwest; up to now about 30 grid cells being monitored (varying efforts and partners).

-SloFS: since 2017 in State Hunting Grounds, which are managed by the Slovenia Forest Service.

2.2 SNOW TRACKING

Method description

In the presence of good snow conditions (ideally 48 hours after fresh snowfall), several pre-defined transects in the study area are walked contemporarily by different people, who record all lynx tracks detected and follow them (backwards) for as long as possible. Snow tracking allows collection of specific information about spatial use, reproduction, number of kittens, or marking animals. In addition, it helps to find fresh lynx scats or lynx kills, where saliva samples can be collected or camera traps installed to identify the lynx or lynx family which made the kill. Thus, it can be used as a complementary method to camera trapping in a given area, or even to identify good camera trapping sites (as snow tracking data show which trails are actually used by lynx). Furthermore, it can be performed locally and occasionally with the aim of collecting samples for genetic monitoring (see below). In Scandinavia, this method has also been used for large-scale population censuses (e.g. Andrén et al., 2002) and to estimate the number of reproductive units (family groups) within a given area (Linnell et al., 2007). However, in Central European conditions, with less persistent and less continuous snow cover, and with a larger percentage of lynx individuals that are easily recognizable based on their coat pattern, snow tracking is not used anymore to obtain these kind of data, which can be better gained by, for example, camera trapping.

Main advantages

-This method does not require purchasing expensive equipment.

-It allows the involvement of stakeholders (often volunteers from the general public), who however need experience in both field work and the identification of lynx signs.

Main disadvantages

-It can only be widely applied as a standard method in areas where snow cover persists for long time periods on relatively large areas (e.g. Scandinavia).

-Although with ideal weather/climate/snow conditions it is possible to plan snow tracking sessions so that the risk of "double counting" is minimized, this risk cannot be completely eliminated (at least under Central European climatic conditions).

-It can provide data for a relatively limited part of the year.

-In order to walk as many transects as possible at the same time, a relatively large number of people have to join a single snow tracking session. Therefore, high organizational efforts are required to coordinate such large groups of people in a short time. In addition, tracks from other animal species may be confused with lynx tracks by volunteers who are not experienced enough, and thus introduce bias into the results. However, this risk can be reduced by training people joining a snow tracking session to properly document their findings in the field, so that expert staff can then validate their results.

Usefulness in terms of participatory approach

Limited. The involvement of volunteers in snow tracking means that they have to be trained to identify and document lynx signs. This is a good opportunity to educate and inform people about lynx behaviour. However, volunteers who join snow-tracking sessions generally belong to stakeholders that are likely to have a positive attitude towards lynx (e.g. nature conservationists, students, general public).

<u>Previous experience of project partners using this method for lynx monitoring</u>

-SUNAP: the method was used in the past, until 2009-2010, also in a systematic way. In recent years no attempt was made, also due to worse snow conditions. In the future, opportunistic attempts are planned, mainly with the aim of collecting genetic samples.

-ALKA: snow tracking sessions organized locally during the TransLynx project.

-NCA CR: during TransLynx in the BBA lynx population area; once a year organized snow tracking in other regions (Beskydy, Jeseníky Mts.).

-PLI: systematically used snow-tracking in the 1990s, and also opportunistically later on, with the aim of collecting genetic samples.

-SloFS: occasional snow-tracking, no systematic approach.

2.3 GENETIC MONITORING

Method description

Samples of lynx scat, hair, urine, saliva, blood, or tissue are collected in the field and sent to a specialized lab that extracts DNA from them. Such samples can be collected during field surveys specifically organized for this purpose, or can be found by chance (see below). Lynx scats and urine are most often found during snow tracking, at marking places or while monitoring lynx by telemetry; lynx hair can be collected at marking places, or using specifically built “hair traps” (that can be installed in combination with camera traps); lynx saliva can generally be collected at fresh killed prey items (that can be found by chance or using telemetry data); lynx blood or tissues can be collected when catching and collaring an animal for telemetry (small amount), or when a dead lynx is found.

Extracted DNA samples can then be analyzed in different ways depending on the aim of the analysis, for example they can be used to determine the genetic variability of the population (and its level/degree of inbreeding). In this case, ideally samples from the whole area of distribution of the population and from a limited time span should be used. Furthermore, they can be used to determine the most probable father and mother of a given lynx, or the population of origin of poached individuals or stuffed lynx.

Main advantages

-It allows an estimation of the population’s genetic variability to be obtained, which is one of the most important parameters necessary to estimate the population’s long-term viability.

-If combined with camera trapping data, it allows completion of the information from pictures and videos about given individuals.

Main disadvantages

-While the collection and storage of samples from the field can be considered relatively cheap, genetic analyses performed in specialized labs are generally expensive

-Especially if sample collection is not done by well-trained people, samples from other species can be sent for analyses, which increases the costs. At least in the case of lynx hair samples, this risk can be reduced by verifying the supposed species identification via macroscopical and microscopical view (e.g. following Teerink, 2003).

-Especially when samples are not really fresh (or if samples are not properly stored), the rate of success in DNA extraction can become very low, which increases the costs.

-Results obtained from different labs can only be compared if they perform the analyses following exactly the same protocols.

Usefulness in terms of participatory approach

Limited. Assuming they are trained to properly collect genetic samples, stakeholders can be involved in genetic monitoring. However, in general the samples are mainly collected and sent by stakeholders who have a positive attitude towards lynx (e.g. nature conservation students, general public, volunteers).

Previous experience of project partners using this method for lynx monitoring

-SUNAP: occasional collection of genetic samples and preliminary analysis within a previous project, but the results are still unavailable.

-ALKA: occasional collection of genetic samples.

-NCA CR: occasional collection of genetic samples.

-SLOFS: non-systematic collection of genetic samples.

-LfU: occasional collection of genetic samples, but no systematic genetic monitoring.

-PLI: occasional collection of genetic samples.

-GHE: occasional collection of genetic samples, mainly hair.

2.4 COLLECTION OF CHANCE DATA

Method description

Information about signs of lynx presence found by chance (i.e., tracks (defined as more than 3 footprints following one another), scats, hairs, scratchings, killed prey, dead individuals) or chance lynx observations (either accompanied by a photo or not) are saved into the monitoring team database. For each record, the name of the observer and the time and place of observation are noted as precisely as possible.

Chance signs of presence are generally classified based on a standard for interpretation of monitoring data described by the SCALP expert group (Molinari-Jobin et al., 2012) and refined for large carnivore monitoring in Germany. The classification is based on the verifiability of records and thus implicates that records which had been verified and confirmed are more reliable and misidentification is less probable.

Three categories are distinguished: category “C1” represents ‘hard fact’ data (e.g. dead lynx, georeferenced lynx photos, genetic proof); category “C2” includes confirmed data (e.g. killed prey items, tracks verified by a lynx expert with several year of field experience); category “C3” summarizes unconfirmed data (e.g. direct visual observation and calls; killed prey items or tracks which are not sufficiently documented but seem probable).

The collection of chance observation also needs to be organised in areas that are more intensively monitored (e.g. through camera trapping, snow tracking) in order to allow the calibration of data.

Main advantages

-It is a quite cheap method applicable over a very large area (e.g. at national, population scale).

-Often this is the first source of information for those areas that are not permanently occupied by lynx or are not permanently/systematically monitored.

-Chance data (often obtained from external sources) often provide hints about a new area to be monitored with camera traps or hair traps for lynx camera trapping or genetic monitoring respectively.

Main disadvantages

-Especially when data collection is not done by well-trained people, the risk of species misidentification is high.

-If not properly documented (C3 data), even signs of presence that actually belonged to lynx cannot be confirmed.

-Chance data can only provide quite rough information about for example lynx presence and distribution but not about abundance and density.

Usefulness in terms of participatory approach

Relatively useful. People having at least a basic knowledge of lynx signs and spending some time in the field are likely to record such signs of presence when they encounter them. Stakeholders such as hunters or foresters are generally experienced in species recognition based on signs of presence. An invitation by the monitoring team to help in collecting chance data, together with the offer to share overall information coming from such data (e.g. distribution maps), can intensify the communication between researchers and other stakeholders.

<u>Previous experience of project partners using this method for lynx monitoring</u>

-SUNAP: since the 1990s/since lynx reintroduction.

-ALKA, NCA CR: possibility to enter observation by public into online accessible database BioLog - http://biolog.nature.cz/cz/Maps#1 (or send via mobile application).

-SLOFS: collecting chance data within State Hunting Grounds, managed by the Slovenia Forest Service, and occasional data from local hunting clubs.

-LfU: method used since the 1990s, ongoing.

PLI: since 1990s.

GHE: since 1990; classification in C1, C2, C3 as in Germany.

2.5 TELEMETRY

Method description

Both VFH and GPS telemetry studies are based on the concept that animals are captured and they are given a collar, which either sends a “radio” (VHF) signal on a specific frequency, or communicates with satellites and collects precise GPS positions of the collared animal (or can be equipped with both technologies combined). In this way, the movements and activity patterns of collared individuals can then be studied remotely without having to approach (and disturb) the animal again. VHF-telemetry is the oldest type of telemetry. The signal from this type of collar is captured by a directional antenna and a radio-receiver and animals are located with the “triangulation method”; the direction from which the signal is strongest is identified from three different locations and drawn onto a map using a compass (the animal’s location is then the point where the three lines drawn on the map meet). VHF collars can also include a basic activity sensor that makes the type of signal change according to the activity the collared animal is performing. GPS-telemetry is a more recent technology. GPS collars communicate with satellites and automatically save the precise location of the collared animal at a given time. Such GPS positions may then be stored in the collar (store on board collar types), that has to be retrieved from the field to obtain them, or can be sent by the collar, for example by SMS (GPS-GSM collar types). GPS collars generally also include a much more precise activity sensor that can record data about the activity of collared animals almost continuously and much more precisely compared to VHF collars.

Main advantages

-This is probably the most efficient method allowing the collection of detailed data on the biology and ecology of lynx in the field.

-If data are collected intensively and long enough, telemetry allows the collection of information about reproduction, litter size, and kitten survival.

-If a telemetry study and monitoring based on other methods take place at the same time in the same study area, the detailed information of the telemetry study helps to design a monitoring programme and to calibrate its results.

-This method was believed to work as a deterrent for poaching (collars are generally visible on the animal), but in more recent years its effectiveness has proven controversial.

-After capture, animals can generally be studied without being disturbed at all.

Main disadvantages

-It requires purchasing quite expensive equipment/technology (especially valid in the case of GPS telemetry).

-Battery weight (mostly in the case of GPS telemetry) or "available staff power" (in the case of VHF telemetry) limit the number of locations that can be obtained by each collar.

-Only a limited number of individuals belonging to a population at a (relatively) small spatial scale can be studied with this method (it is impossible to collar a whole lynx population).

-Collars generally work for a limited time span (typically one year, up to a few years in the case of VHF); recapturing an animal for re-collaring is not easy.

-Capturing and tranquilizing animals is required to equip them with a collar; these procedures are always linked with a certain degree of risk, which also implies that special permissions are required (probably state-specific).

-Minimally until recent years, collaring subadult animals that are still growing in size was considered risky, leading to a prevalence of adult animals among collared individuals. Thus, telemetry studies are more likely to provide information about resident lynx.

-Due to high battery weight, most GPS collars are not appropriate for subadult lynx.

Usefulness in terms of participatory approach

Good. Involvement of stakeholders in locating collared lynx is a good approach to enlightening stakeholders about spatial and habitat use, as well as the high mobility of lynx. Furthermore, telemetry data gathered at lynx kills gives detailed insights about lynx predation impact on game species.

Previous experience of project partners using this method for lynx monitoring

-SUNAP: VHF telemetry since the 1990s in cooperation with the Bavarian Forest Nature Park, GPS telemetry since 2005 in cooperation with the Bavarian Forest National Park.

-PLI: GPS/GSM telemetry since 2011.

-NCA CR: during the Monitoring of Large Carnivores project in Beskydy Site of Community Importance (2011-2014), outside of the BBA area.

-GHE: not until now; if orphaned lynx are re-released or lynx are translocated in the future, GPS telemetry would be used for these individuals.

- SloFS: this method was used during the Dinaris project (2006-2009) and will be used again within the LIFE Lynx project.

3. CONCLUSIONS

As mentioned in the first part of this toolbox, there is no “absolute” best method to be used for lynx monitoring, but different methods best suit different study aims.

Based on our descriptions and analyses, camera trapping seems to be the most suitable method for effective, long-term, population-level monitoring. Furthermore, this method has also proved quite effective in ensuring participatory approaches, which is one of the main aims of the 3Lynx project. However, all the other described methods can be used to collect complementary information about lynx occurrence, ecological requirements, and population viability status.

4. LITERATURE CITED

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