2.5 Post-release monitoring and management interventions for Eurasian lynx in reintroduction or reinforcement projects

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Monitoring is an essential element of any reintroduction and, with a somewhat different focus, reinforcement project. Translocation management is an adaptive, cyclical process (IUCN/SSC 2013; Fig. 2.5.1) and any adjustment to the plans and protocols after the first releases will be based on information gained in the frame of a specifically designed Monitoring Programme. Considering the limited availability of suitable Eurasian lynx, any kind of release project will likely start with a minimum of specimens, and reaching the short- and long-term objectives of the project may hence require the release of additional animals over a considerable amount of time. Besides, reintroducing a large carnivore in the anthropogenic landscapes of continental Europe may affect the human use of these habitats and require management interventions, which again should be based on sound monitoring data.

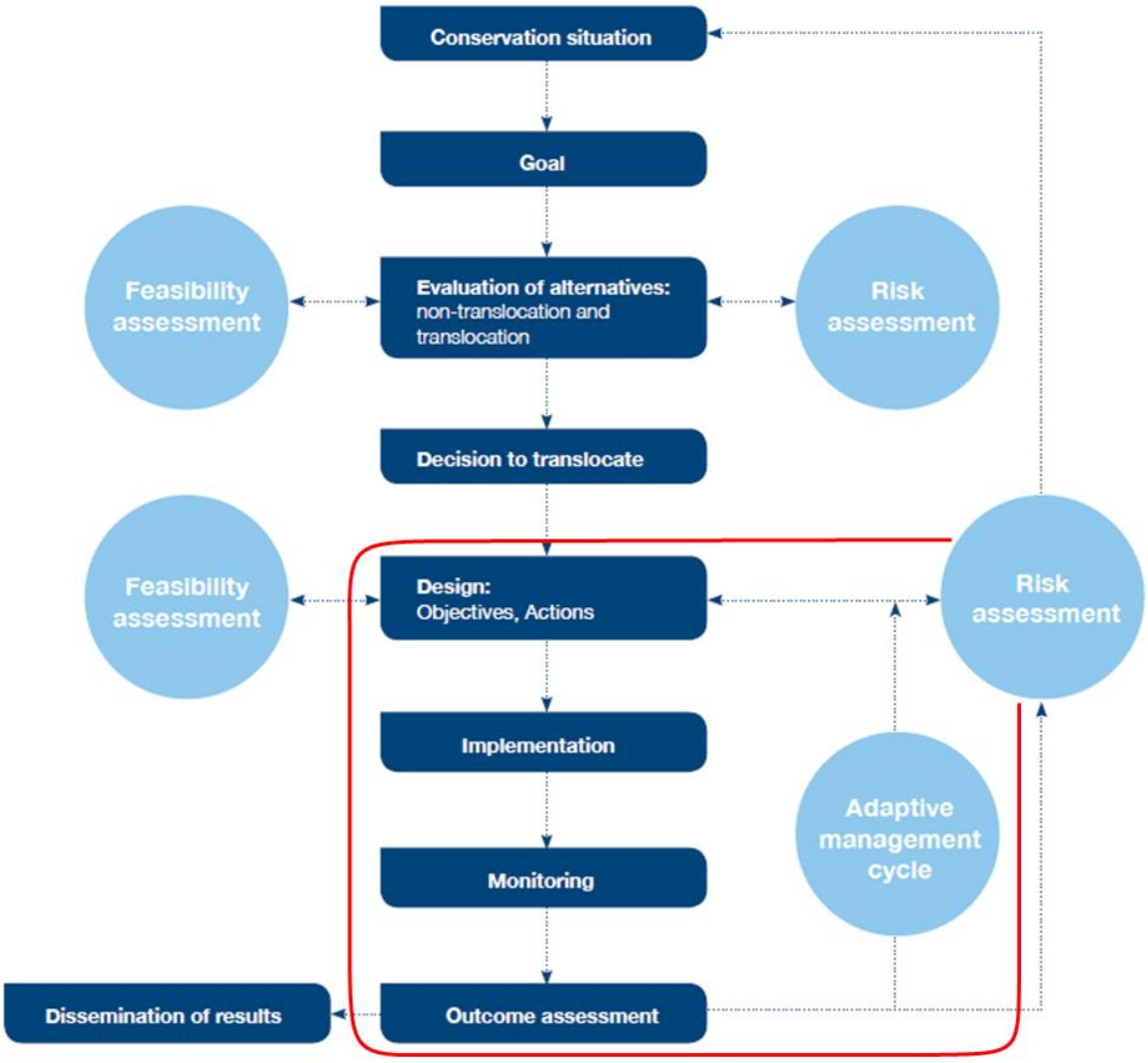

Fig. 2.5.1. The conservation translocation cycle from IUCN/SSC (2013). The adaptive part of the cycle (red polygon) requires decisions that must be based on the results from the monitoring programme.

Monitoring is not only essential for the sensible adjustment of the release programme, but also for the communication with (local) people and stakeholder groups in order to inform them and to prevent or mitigate possible conflicts of interest. Eurasian lynx are predators of small ungulates – both wild and domestic – and sooner or later, arising conflicts with human land users may have to be managed. Any management interventions should be justified by adequate robust information. However, monitoring results should not only be scientifically robust, they must also be shared in a credible and understandable form with all stakeholders and the public. Indeed, monitoring results generated in cooperation with stakeholder groups are a great way to build trust among interest groups.

2.5.1 Elements and parameters of a monitoring programme

Annex 8 to the *Guidelines for Reintroductions and Other Conservation Translocations* (IUCN/SSC 2013) provides a checklist for the development of a Monitoring Plan. A specific and detailed Monitoring Plan should be an integral part of any reintroduction project. Such a plan must be adjusted to the explicit goals and objectives of the project as well as to the local preconditions and requirements. The purpose of our document is not to provide a detailed guideline on how to monitor, but rather to provide guidance on what to monitor and outline a more specific monitoring programme in the context of a Eurasian lynx reintroduction project (Fig. 2.5.2).

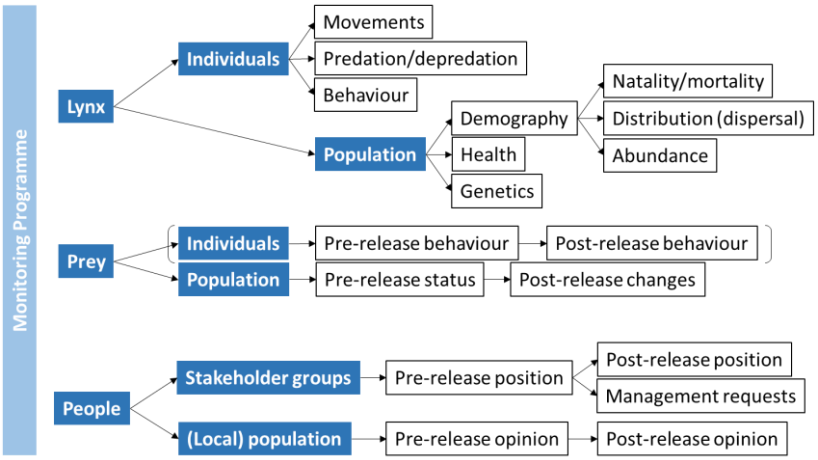

Fig. 2.5.2. Elements of a Monitoring Plan for a lynx reintroduction project. The blue boxes represent the monitoring entities, the white boxes the parameters/features to be monitored.

The goal of a reintroduction project is to create a demographically and genetically viable population in coexistence with local people. The definition of "viability" (targeted population size and genetic variability) depends on the long-term status of the population, whether it will be an isolated, self-sustaining population, a subpopulation of a larger metapopulation, or a mere "stepping stone population" facilitating the connectivity of larger units. "Coexistence with people" implies that the reintroduction of lynx may impact the habits of land users such as hunters or livestock breeders, foremost through predation on wild ungulates (mainly roe deer, locally on chamois and red deer) and occasional depredation on domestic animals such as sheep and goats or farmed game species such as fallow deer or red deer. Furthermore, a possible negative impact of lynx reintroduction on other threatened wildlife species like wildcat or capercaillie was often feared, although never confirmed. Reliable compiled and recurrently disseminated monitoring data will ease the solution of possible conflicts.

2.5.2 Monitoring aims and principles

The release phase of a reintroduction project for Eurasian lynx typically runs for 3–5 years in a predefined region that was identified as suitable for hosting a lynx population. It is not likely that all lynx released, or their offspring will stay within the project perimeter, and it is even less likely that a "viable population" establishes within the project's lifespan. The **geographic scale** of the monitoring plan should therefore be flexible, allowing also the surveillance of lynx that migrate or disperse from the study area (e.g., permissions for field work, information of adjacent administrative units and people), and the **time scale** of the monitoring should be set according to the short- and long-term objectives of the project. Obviously, monitoring of demographic and genetic parameters of the emerging population should be ongoing after the reintroduction phase has been completed.

2.5.2.1 Observation of released lynx

- All information on the released lynx including material for genetic analyses need to be safely stored (see protocols *2.4 Capture & transport* and *3.5 Quarantine*).
- All animals released should be equipped with radio-collars allowing their telemetric survey. Such systems nowadays are typically based on GPS location technique (e.g., with GSM, satellite telephone, Argos, or LoRaWan download) and have an additional VHF transmitter permitting homing-in in the field as needed (see protocol *3.4 Rewilding orphans and zoo born lynx*).
- Telemetry survey of the animals allows tracking the individuals' movements. Important stages after the release are successful hunting of wild prey (or, less desirable, killing of domestic animals), establishing of a permanent home-range (or, less desirable, homing or emigration), and first reproduction. Collars should be programmed to cover at least the first reproduction period after the release. Besides movements, habitat use, and hunting, telemetric survey allows assessing the released animals' behaviour in relation to people and anthropogenic facilities. This might be of special concern with animals bred in captivity or having spent some time in captivity (orphans). Moreover, spacing of the released animals may not totally fit the predictions from habitat modelling, and tracking of the first released individuals will allow adjusting further releasing according to the land tenure system of the lynx.
- Fate and behaviour of released lynx are furthermore documented by means of systematically collecting chance observations from the public and especially from specific groups such as hunters, foresters, or small ruminant farmers. Surveillance of kills is best documented by means of automatic camera or video devices (camera traps).
- Long-term survival and reproductive success of females should be documented by means of camera traps and genetic monitoring (see protocol *2.2 Genetic monitoring*). Camera trap monitoring can already be started in parallel to telemetry survey. Information about the movement behaviour of radio-collared lynx helps to optimise camera trapping sites. Once in place, camera traps help to monitor the fate of released animals in case of collar failure and can be used to involve stakeholder groups in the monitoring at an early stage.

2.5.2.2. Monitoring of the source population(s) and the emerging reintroduced population

- If lynx to be translocated come from a (limited) free-living population, it must be ensured that the removal of animals is not detrimental to the source population, which therefore needs to be monitored. So far, lynx from the north-western Alps, Jura and Slovak and Romanian Carpathian Mountains have been used in translocation projects. The LIFE Lynx reinforcement project for the

Dinaric–south-eastern Alpine lynx population used specimens from the Carpathian Mountains; specific protocols were developed for the monitoring of the source populations in Slovakia (Kubala et al. 2018) and Romania (Gazzola et al. 2018).

- Although data on demography, genetics, and health will be collected at the level of individuals, the combined information allows assessing the status of the population. Protocols and infrastructure (including physical and electronic storage) and trained personnel for compiling, treating and analysing the data must be prepared before the first animal is set free.
- Distribution and abundance are the two most important parameters describing a population. Distribution is derived from all reported lynx observations according to the SCALP categorisation (Molinari-Jobin et al. 2021), e.g., through an occupancy analysis (e.g., Molinari-Jobin et al. 2018). Abundance is, in an early stage of a reintroduction project, the result of a "total count" based on the telemetric survey of the released animals. As the population grows and only part or no animals are radio-collared, abundance (or density) will be the result of a robust field study such as capture-recapture estimation by means of camera trapping (e.g., Zimmermann & Foresti 2016, Stergar & Slijepčević 2017). When performing a camera trapping study, the essential data to be collected in order to obtain sensible parameters and enable harmonisation between study areas are i) data about lynx events (date, time, lynx ID, site ID), ii) data about lynx individuals (individual lynx ID, sex, first recognition (lynx year), first recognition status (juvenile/adult)), and iii) data about effort (array size, number of camera traps and coordinates per site, camera trap spacing, deployment data). [ESSENTIAL DATA IS UNDER DISCUSSION WITHIN THE LINKING LYNX MONITORING WORKING GROUP]
- Information on predation on wild prey and attacks on domestic animals must be consistently generated not only to reveal the hunting behaviour and diet of the reintroduced lynx, but also to understand a possible impact on prey populations and mitigate conflicts that may emerge from such impact (see below). Diet and predation are studied in field work by means of telemetry (e.g., Vogt et al. 2018), through scat analyses and snow tracking, or – for specific situations – by means of opportunistic camera trapping. Cases of depredation are generally reported[1]. Livestock breeders, game wardens, hunters, policemen, etc. must be instructed on the reporting channels and specific personnel must be trained for the identification of lynx kills.
- Natality data are compiled from targeted field work with radio-collared females, additional information on reproduction comes from camera trapping (opportunistic e.g., at kills or from deterministic sessions when juvenile lynx are observed, or genotyping from genetic samples collected at kills) or from the compilation of chance observations. Mortality data are derived from telemetry work or from any direct or indirect hint on lynx casualties. All carcasses must be collected and properly examined (see below). In order to ensure the (timely) reporting of a lynx found dead, important target groups (hunters, game wardens, police, road maintenance service, foresters, etc.) must be informed in advance.
- The survey of the health status of the population is mainly based on comprehensive post-mortem examinations of dead lynx, but also from live lynx e.g., caught in field projects, both based on elaborated veterinary protocols (e.g., Ryser-Degiorgis et al. 2021, LIFELynx 2018a, b; see also protocols *2.4 Capture & transport, 3.5 Quarantine*). Precautionary examinations are im-

[1] Most projects or authorities in charge establish a reporting system, either a hotline (e.g. the "Large Carnivore Hotline" for the LIFE LUCHS in the Palatinate Forest) or reporting forms to be downloaded (e.g. the collection of forms of the Federal Office for the Environment, Switzerland).

portant with regard to future threats such as genetic deterioration of the population or newly emerging pathogens, for example as a consequence of climate change.

- The genetic profile of all released lynx must be known, and materials of any live-caught (blood samples) and dead lynx (tissue samples) must be stored for future analyses (see protocol *2.2 Genetic monitoring*). The pedigree of the growing reintroduced population should be traced based on direct observations (mother–offspring relationship from telemetry field work and camera trapping) or based on molecular parental analyses. Loss of genetic diversity is an inherent risk of any reintroduced population, and hence genetic drift and inbreeding must be monitored to propose adequate management interventions in time (see protocol *2.2 Genetic monitoring*). Utmost attention must be given to the consistent and correct storage of ample materials for future genetic analyses; molecular-genetic technology and methods are still advancing fast, and future retrospective analyses might enable insights that are presently not yet possible.

2.5.2.3 Prey

- Objective discussions on the predation impact of (reintroduced) lynx and hence the mitigation of conflicts (see below) often fail because factual data on prey are missing. It is hence highly advisable to generate data allowing to assess the perceived or factual changes on the major prey species (e.g., roe deer, locally chamois). After the return of the lynx, hunters often complain about more vigilant behaviour of deer, decreasing abundance and/or changes in their distribution. Lynx can indeed impact all of these factors (e.g., Gehr et al. 2017), but studying them goes beyond a monitoring plan realistically being implemented in the frame of a reintroduction project. However, it is advisable to at least generate some data on the distribution and abundance of the staple prey (most likely roe deer) before and after the release. Post-release monitoring of prey should indeed be continued in synchrony with and compatible to lynx monitoring, as fluctuations of populations (e.g., related to meteorological conditions) might affect the predator-prey relationship long-term.
- Another important, but even more complex question is the cascading effect of the return of the lynx on browsing impact on and rejuvenation of forests. During the reintroduction of lynx in north-eastern Switzerland from 2001–2008, the relationship lynx-roe deer-forest was specifically addressed in related monitoring projects, but the conclusions remained vague, also because the resources for and duration of the surveys were insufficient (Stiftung KORA 2021). Parallel to the lynx reintroduction in the Palatinate Forest, the Forschungsanstalt für Waldökologie und Forstwirtschaft (FAWF) conducted a still-ongoing long-term monitoring project on roe deer (Tröger et al. 2021).

2.5.2.4 People

- The most serious conflicts related to lynx reintroduction projects are with regard to the impact of this “new” predator on its wild prey species (e.g., Breitenmoser et al. 2010), and these conflicts can be a considerable threat to the population (Červený et al. 2019). Communication with and involvement of stakeholder groups at any time of the reintroduction project is therefore of utmost importance (Stiftung KORA 2021). Qualitative and quantitative comprehension of the opinion, concerns, and claims of interest groups before and after the releases are crucial for mutual information and objective discussions.

- Wildlife managers and decision-making or advisory bodies for wildlife management should be specifically informed about the monitoring results, as the return of a top-ranking predator such as the lynx might require adaptations in the wildlife management or hunting regime.
- An excellent example for an assessment of public attitudes in relation to a lynx reinforcement project was provided by the LIFELynx project in the northern Dinarids and South-eastern Alps (Majić Skrbinšek et al. 2020). The LIFE LUCHS Project in the Palatinate Forest established and maintained a transboundary "Lynx Parliament" to facilitate the public involvement and the exchange and discussion between interest groups including related authorities, which was also involved in the development of the lynx management plan for Rhineland-Palatinate.

2.5.2.5 Dissemination of monitoring results

Dissemination of (monitoring) results is a crucial component of any reintroduction project (see Annex 9 of the Guidelines; IUCN/SSC 2013). The scientific community should be informed through peer-reviewed publications. But regular dissemination of monitoring results is also a public service and helps building trust with and between interest groups. It is therefore important to release monitoring results regularly in popularized form and local language(s). Important stakeholder groups should be informed in regular personal contacts, e.g., update presentations. Dissemination of monitoring results should be included into the communication plan of any reintroduction/reinforcement project.

2.5.3 Management interventions

If the monitoring results reveal that the goal/objectives of a reintroduction or reinforcement project are not achieved, the releases might have to continue. On the other hand, if the monitoring indicates that individuals or the emerging population have undesirable impacts, management intervention may have to be implemented to control or remove individuals or the population (see Annex 8.3 of the Guidelines; IUCN/SSC 2013). In the case of a lynx reintroduction, the monitoring could indicate that the demographic or genetic viability of the population is not secured and reinforcement is needed. This could happen during the initial phase of the population establishment or many years later. An example for an intervention to mitigate genetic problems decades after the initial reintroduction is the LIFE Lynx Project *Preventing the Extinction of the Dinaric-SE Alpine Lynx Population Through Reinforcement and Long-term Conservation*.

On the other hand, lynx released (or their offspring) may not behave as expected. Management interventions to restrict or remove individual lynx could be related to lynx being too familiar with people or to attacks on livestock. Again, the evidence must come from monitoring or individual surveillance, respectively, but possible management interventions should be considered proactively to facilitate decision-making. Possible interventions could range from scaring the lynx off, protecting a herd, translocation, and, worst-case, lethal removal of the lynx. It goes without saying that radical solutions must be in conformity with national legislation, but under certain circumstances, lethal removal is more acceptable than confining a free-born lynx for the rest of its life.

Management measures or interventions at population level may be needed at a certain point, e.g., to mitigate conflicts with hunting (see above). But such management interventions generally go beyond the scope of a reintroduction project and should be addressed by a national or population-level management plan (see e.g., Linnell et al. 2008).

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