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The Eurasian lynx in Continental Europe

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Cover Photo: Camera trap picture of two Eurasian lynx kittens in north-eastern Switzerland. 11 December 2014 (Photo KORA).

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SCALP: Monitoring the Eurasian lynx in the Alps and beyond

The project Status and Conservation of the Alpine Lynx Population SCALP is an ongoing programme aiming to coordinate the Eurasian lynx *Lynx lynx* monitoring, conservation and management activities in the Alps, but the monitoring approach has recently been expanded to the neighbouring Dinaric and Jura Mountains. The long-term goal of the SCALP is to help the still small and isolated reintroduced populations to expand and to recover in co-existence with people. The process is advanced and supervised by the SCALP Expert Group, which also prepares yearly distribution maps.

Since the foundation of the SCALP Group in the early 1990s, we have gained considerable experience with monitoring of this elusive species. In the context of species distributions, false-positive observations arise when a species is recorded erroneously at a place where it does not occur, most often because another species is mistaken for the focus species. To identify the potential cases of false-positive observations, we developed the so-called "SCALP Criteria" where each sign of lynx presence is categorised based on the possibility to verify and confirm the reported observation. With lynx, the following categories are used (Molinari-Jobin et al. 2012):

C1 – Confirmed hard facts, verified and undisputable records of lynx presence with material evidence, such as (1) dead lynx, (2) captured lynx, (3) georeferenced lynx photos, and (4) samples (e.g. excrements, hair) attributed to lynx by means of a scientifically reliable analysis (e.g. genetics).

C2 – Records confirmed by a lynx expert (i.e. trained member of the network) such as (1) livestock or (2) wild prey killed by a lynx, (3) lynx tracks or other assessable signs of presence.

C3 – Unconfirmed records, chance findings (kills, tracks and other field signs too old or badly documented, where however the description conforms to a lynx sign) and all observations such as direct sightings and calls, which by their nature cannot be verified.

We used site-occupancy modelling to estimate lynx distribution and showed that the inferred distribution is highly sensitive to presence category, where C3 data had a much wider distribution than C1 and C2 data (Molinari-Jobin et al. 2012). We recommend rigorous discrimination between fully reliable and un- or only partly reliable data in monitoring datasets. However, despite containing potentially false-positive observations, "soft" data (C3) are not discarded: They increase the precision of parameter estimates in dynamic occupancy models (Louvrier et al. 2018) and are valuable to indicate expansion or regions where the monitoring needs to be improved.

Although this type of categorisation needs to be adapted to the focal species, a distinction between "hard" and "soft" data can help to raise awareness about the fact that false species identification may exist in the monitoring dataset, and thus facilitate the adjustment of the survey and hence the population status assessment. We have further improved the lynx distribution maps by differentiating between 10x10-km presence cells with and without reproduction classified according to the SCALP criteria (Fig. 1).

It is not only important to consider false positive data. Lynx detection probability varies in space and time. Therefore, we also have explored methods considering imperfect detection when producing distribution maps (Molinari-Jobin et al. 2018). Site occupancy models jointly estimate occurrence and detection probability (MacKenzie et al. 2002, 2003) and are able to correct for improvements in monitoring efficiency. In the Alps, improvements in monitoring over the past 25 years were achieved both through better training and advanced experience of monitoring network members as well as the increased and nowadays widespread use of camera traps. Lynx distribution and detection probability varied by year, country, forest cover, elevation and distance to the nearest lynx release site (Molinari-Jobin et al. 2018). Occupancy of neighbouring cells had a strong positive effect on colonisation and persistence rates. Our analyses demonstrated the importance of accounting for imperfect detection: The raw data underestimated

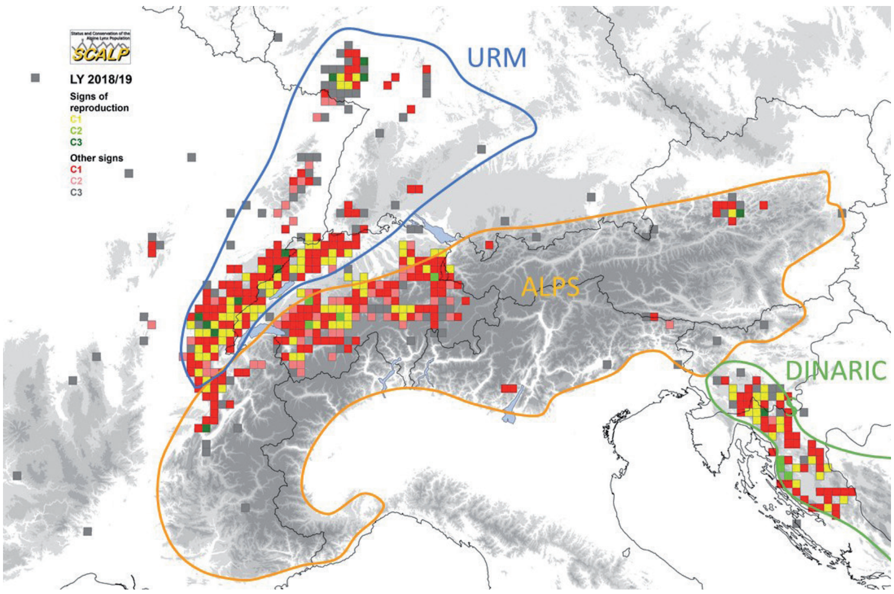

Fig. 1. Lynx distribution in 2018 in the Upper Rhine Metapopulation (blue), the Alps (orange) and the Dinaric Mountains (green) based on the SCALP criteria where hard data (C1) is separated from confirmed data (C2) and data not verified (C3). Presence signs of reproduction are also distinguished. The squares represent 10x10 km cells of the European Terrestrial Reference System 1989.

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the lynx range by 55% on average, depending on country and winter. We recommend calibrating the naive distribution at least once in a generation time using site occupancy models.

We have considerably advanced our knowledge of the species' distribution, but have only just started to address the "how many" question. Although at local scale spatial capture-recapture modelling gives excellent results (Zimmermann et al. 2013, Zimmermann & Foresti 2016), the extrapolation to the large scale, e.g. population level, remains a challenge. Similar to distributional data, it is desirable to standardise also the interpretation of abundance estimates, which presently range from expert guestimates, minimum counts through camera trapping to robust estimates based on capture-recapture methods, which themselves require standardisations. At present, we are in the process of developing SCALP criteria for abundance estimates.

Since the start of the SCALP cooperation in the early 1990s, the experts (Fig. 2) have emphasised that connecting the isolated lynx populations is vital for lynx conservation. The basis for a recovery strategy is the Pan-Alpine Conservation Strategy for lynx (PACS; Molinari-Jobin et al. 2003), produced by the SCALP expert group and adopted by the Standing Committee of the Council of Europe's Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) in 2001. Over the past 20 years, the Alpine lynx range has expanded at an average rate of 4% per year, which was mainly the result of translocation projects (Molinari-Jobin et al. 2018): 12 lynx were translocated from the north-western Swiss Alps and Jura Mountains to north-eastern Switzerland from 2001–2008, five lynx from the north-western Swiss Alps and Jura Mountains to Upper Austria between 2011–2017, two lynx from the Jura Mountains to north-eastern Italy in 2014 and another five lynx were captured in the Carpathians and relased in the Julian Alps of Slovenia in 2021. Lynx have so far recolonised less than 20% of the Alps (Fig. 1). The translocation projects all base on the "stepping-stone idea" (Molinari et al. 2021) that has been adapted to lynx conservation in the frame of the SCALP project.

Assessments published since the year 2000 largely agree on main threats to the lynx populations in the Alps (Molinari-Jobin et al. 2003, Molinari-Jobin et al. 2010, Schnidrig et al. 2016) and in Europe in general (Breitenmoser et al. 2000, von Arx et al. 2004, Council of Europe 2012, Kaczensky et al. 2013, Boitani et al. 2015). They consist mainly of illegal persecution, accidental mortality (vehicle collisions), habitat deterioration due to infrastructure development. Low acceptance due to conflicts with hunters, combined with the intrinsic limited dispersal capability of the species add to the slow expansion of the Alpine lynx population. The more recent assessments also identified inbreeding as an important threat for some of the lynx populations (Schnidrig et al. 2016). Additionally, Boitani et al. (2015) list poor management structures as a factor impeding lynx conservation in Europe. Based on these threat assessments, as well as social and political considerations, management scenarios for advancing the recovery of the Alpine lynx population were developed on behalf of the Alpine Convention (Schnidrig et al. 2016).

Fig. 2. Scalp expert group members regularly meet to discuss progress and challenges, e.g. members from Slovenia, Italy, Austria, Germany, Switzerland, France and Fürstentum Liechtenstein met in Berchtesgaden, Germany, in September 2018.

Although the Alpine lynx population is still far from being (genetically) viable, it is the only mountain range in Western and Central Europe that could host an isolated viable population considering its potential extent. The Alps are hence a future stronghold for the species and also crucial with regard to connecting with neighbouring populations, e.g. the Dinaric, Bohemian-Bavarian-Austrian, Black Forest and Jura Mountains populations (von Arx et al. 2021). The overall goal is to build up a large Central European meta-population (Bonn Lynx Expert Group 2021). The connection between the eastern and western Alps is decisive, but will in due time only be achieved through active management, as the extant lynx sub-populations are spreading very slowly. Moreover, the Alpine population has a very low genetic variability as a consequence of a very small founder group, and needs genetic management (Breitenmoser-Würsten & Obexer-Ruff 2003; Reiners et al. 2021). Therefore, further translocations and reinforcements will be necessary, such as current efforts taking place in Slovenia and Croatia as part of the LIFE Lynx project (Fležar et al. 2021). To foster the population spread and assure the demographic and genetic rehabilitation, a coordinated approach with a step-wise improvement in all small subpopulations is recommended (Fig. 3). In the frame of the SCALP project, we have developed widely recognised best practice approaches for monitoring and management that were applied also for several other conservation projects in the Alps and beyond.

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Fig. 3. Translocations are an efficient tool for improving the outlook of small populations (Photo R. Pontarini).

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