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Status and distribution of the lynx (*Lynx lynx*) in the Swiss Alps 2005–2009

Status in razširjenost risa (*Lynx lynx*) v Švicarskih Alpah 2005–2009

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Abstract: We evaluated the status of lynx in the Swiss Alps for the period 2005–2009. Even though the number of lynx presence signs remained almost stable between the present (2,068 signs) and previous pentad (2,091), there was a 7.6% increase in the area occupied by the 5-km circular buffers around the confirmed lynx signs of presence over the five years period (12,637 km^2). The north-western Swiss Alps (VI) remained the compartment with the highest number of chance observations. It was followed by compartments central Switzerland west (III) and north-eastern Switzerland (II). These sub-populations acted as source in the current pentad, as signs of reproduction were reported almost every year. The translocation to north-eastern Switzerland is still the only significant contribution to the spatial increase of the lynx range in the last 10 years in the Swiss Alps. The small and vulnerable north-eastern Switzerland lynx sub-population plays an important role for the Alpine population. There is hope that in the future this sub-population could act as stepping stone to the eastern Alps and together with individuals dispersing from the central Switzerland west (III) sub-population would enable to found a new sub-population in central Switzerland east (IV). The status of the sub-population in the Valais (VII) is less clear. As only few signs of reproduction and mortalities were reported over the pentad, it acted more as sink than a source population. From the few signs of lynx presence reported in the remaining compartments (Grisons V, central Switzerland east IV and Ticino VIII) we concluded that only a few single lynx that did not yet establish the typical social organisation occur there. An occupancy-based population estimate from a parallel study resulted in about 111 (SE = 10) independent lynx for the period 2005–2009. This is higher than the 60–90 individuals estimated for the previous pentad.

Keywords: Alps, distribution, *Lynx lynx*, monitoring, status, Switzerland

Izvleček: Prispevek ocenjuje stanje risa v Švicarskih alpah za obdobje 2005–2009. Čeprav je številčnost znakov prisotnosti risa med sedanjim (2068) in prejšnjim (2091) pet-letnim obdobjem ostala stabilna, se je območje skupaj s 5-km pufersko cono povečalo za 7,6 %. SZ Švicarske alpe (IV) tako ostajajo območje z najvišjim številom opažanj. Sledita območji osrednje Z Švice (III) in SV Švice (II). Omenjene sub-populacije so bile vir opažanj za zadnje pet-letno obdobje, saj so bili znaki reprodukcije prisotni skoraj vsako leto. Širjenje na območje SV Švice je edino prostorsko povečanje areala v Švicarskih alpah v zadnjih 10 letih. Majhne in ranljive SV švicarske sub-populacije risa imajo pomembno vlogo za vzdrževanje risa v Švicarskih alpah. Ostaja upanje, da bo ta populacija odigrala vlogo odskočne deske do V Alp in skupaj s posameznimi osebki, ki prihajajo iz osrednje švicarske »sub-populacije (III)« in bo omogočila nastanek nove sub-populacije v osrednji V Švici (IV). Stanje sub-populacije na območju Valais (VII) je manj jasno. Ker je za zadnje pet-letno obdobje znanih le malo znakov reprodukcije in smrtnosti, predstavlja bolj ponor kot vir. Na podlagi znakov risove prisotnosti na ostalih območjih (Grisons (V), osrednja V Švica (IV) in Ticino (VIII)) smo zaključili, da se tam pojavljajo posamični osebki, ki se še niso povezali v populacijsko strukturo. Po ocenah modela zasedenosti prostora (occupancy models) iz vzporedne študije ocenjujejo 111 (SE = 10) neodvisnih osebkov za obdobje 2005–2009. To je precej več kot 60–90 osebkov ocenjenih za prejšnjo petletko.

Ključne besede: Alpe, razširjenost, *Lynx lynx*, monitoring, status, Švica

Introduction

Two lynx (*Lynx lynx*) populations are currently present in the Alps originating from the reintroduction done in the 1970s. One lies in the western Alps in Switzerland and one in the Slovenian Alps, expanding into Italy and Austria. Switzerland harbours the most vital sub-population (Molinari-Jobin et al. 2010) and thus has a great responsibility regarding the conservation of the Alpine lynx population which has still to be considered as endangered according to the IUCN Red List criteria.

Forty years after the first reintroduction, less than 20% of the whole suitable habitat in the Alps has been recolonized by the species, despite considerable efforts at the national and international level to expand the existing lynx areas. In Switzerland large parts of central Switzerland east, the Grisons, and Ticino are not yet colonized by lynx (Zimmermann et al. 2010a). Lynx experts from the Alps considered illegal killing, habitat fragmentation and anthropogenic accidents to be the main reasons for this slow expansion (Molinari-Jobin et al. 2010).

In Switzerland the main conflict is with hunters who compete with lynx for game, and who fear that high lynx densities diminish ungulate game (Breitenmoser et al. 2010). A side effect of this conflict is that the local authorities become reluctant to actively conserve lynx. A possible solution proposed by hunters' associations and wildlife managers, may be a controlled legal harvest to supress illegal killing. In parallel, this solution might increase the willingness of new cantons to actively reintroduce lynx as this new legislation would give them the rights to intervene under some circumstances. The Swiss Lynx Concept established in 2000 and updated in 2004 defines the general conservation and management goals, the co-operation between the FOEN and the cantons. Besides the removal of stock raiders and the translocation from high density areas to areas not yet colonized to foster the spatial expansion of the lynx population, the Swiss Lynx Concept foresees that lynx are reduced through controlled hunting, if the impact of the lynx predation on roe deer and chamois is considered too strong. However this needs a revision of the hunting ordinance. The consultation of the hunting ordinance ended in October 10th 2011. By mid-2012 the Federal Council will adopt the report of the consultation and the ordinance.

To counterbalance the slow expansion of the lynx population in Switzerland, six lynx were translocated in 2001 from the north-western Alps to north-eastern Switzerland. Another three from the Jura Mts. followed in 2003. All animals were fit with radio-collars in order to follow their movements, reproduction events and mortalities. In Switzerland the translocation of a total of 6 lynx to the north-east in 2001–2003 (Ryser et al. 2004) led to an increase of 7% of the lynx distribution range in the whole Alps (Molinari-Jobin et al. 2010). The monitoring conducted in winter 2005/06 in north-eastern Switzerland revealed that the lynx number was critically low (Ryser et al. 2006). Subsequently, in 2006 the north-eastern Swiss cantons and the FOEN based on recommendations from the program KORA decided to restock the north-eastern Switzerland lynx sub-population with additional 3–4 individuals that should mainly originate from the Jura Mts. to increase the chance of mixing up the genes of both meta-populations (Jura Mts. and Alps). In 2007, one male and one female lynx were translocated from the Jura Mts. and north-western Swiss Alps, respectively. Another female was translocated in 2008 from the Jura Mts. (KORA unpublished data). Similarly to the 2001 and 2003 translocations all individuals were fit with radio-collars to monitor the fate of individuals during the first years after their release. The translocation project ended in 2009 and was since then integrated into the national monitoring.

The purpose of this report is to evaluate the status of lynx in the Swiss Alps for the period 2005–2009.

Material and methods

For organizational purposes, Switzerland was divided into 8 large carnivore management compartments, taking into account natural and artificial barriers to natural spread of lynx as well as political borders (Fig. 1). We used a stratified approach to monitor the lynx population (Breitenmoser al. 2006) as financial resources are restricted. There is a stratification in space (national level, compartments and smaller reference areas within compartments), in time (e.g. chance observations are gathered year round whereas systematic camera-trapping, which is very labor intensive, is conducted every 2 to 3 years in smaller reference areas) and in the datasets according to the type of observation and their validity (e.g. SCALP criteria; Molinari-Jobin et al. in press). On the national level questionnaires are sent on yearly bases to all game wardens of Switzerland (Capt et al. 1998). These questionnaires provide basic information about the detection/non detection of lynx, mortality, and reproduction as well as a subjective assessment of the trend of the lynx "population" within each game warden's surveillance area over the whole Switzerland. Chance observations (sightings, tracks, wildlife killed) are gathered year round at the national and compartment level. Livestock killed by lynx need to be confirmed by trained people to be compensated, mainly game wardens. All damages to livestock reported are published online on our webpage. This allows an open review when permission for removal of an individual lynx as stockraider is issued by the cantons of the corresponding compartment and the FOEN. Opportunistic camera-trapping, where camera-traps are set on ideal occasions principally at fresh kills, is conducted at the compartment level. At a smaller scale in reference areas (680–1,601 km^2) within three large carnivore compartments (II, III and VI) we estimated the number of lynx using photographic capture-recapture models (e.g. Zimmermann et al. 2010b). These data are reported each year in our national large carnivore monitoring reports (e.g. Zimmermann et al. 2010a) to make this information available to the members of the lynx monitoring network, the decision makers, the NGOs and the general public.

On the national level, five sources of information on the presence of lynx are available: (1) reports of lynx killed or found dead, or young orphaned lynx caught and put into captivity; (2) opportunistic camera trapping where camera-traps are set for ideal occasion, mainly at fresh kills; (3) samples confirmed by means of genetic analysis; (4) records of livestock killed by lynx; and (5) chance observations of wild prey remains, tracks, scats, sightings, and vocalisations. Three levels of reliability were distinguished according to the possibility to verify an observation (Molinari-Jobin et al. in press): Category 1 (C1) represent the hard facts (i.e. direct signs), e.g. all reports of lynx killed, found dead or removed from the wild as young orphaned lynx and put into captivity, as well as opportunistic photographs of lynx. We also include all samples that were identified to be lynx by means of genetic analysis in this category. All lynx photographs of one or more individuals taken at a kill were counted as a single detection. Lynx photographs taken at a given site along a trail were counted as single detection for each night even though several lynx were pictured the same night (this happened only on rare occasions). Category 2 (C2) represent all records of livestock killed, wild prey remains and tracks confirmed by trained people, e.g. mainly game wardens. As all game wardens were instructed how to recognize signs of lynx presence, these records are mostly an objective proof of lynx presence, though both errors and even deception may occur. Category 3 (C3) represent chance observations of all wild prey remains and tracks reported by the public as well as all sightings, scats and vocalisations, e.g. mainly indirect signs that can hardly be verified. The information about reproduction came from three different data sets: chance observations of juvenile lynx, photographs of juvenile lynx during the opportunistic camera-trapping and juvenile lynx found dead or captured as orphans for removal from the wild.

To be able to compare the spatial range of the lynx population for the pentad 2005–2009 with those reported in previous status reports (Molinari-Jobin et al. 2006), we computed two different measures of the spatial range: (1) the minimum convex polygon (MCP) encompassing all signs of presence belonging to category 2; and (2) a circular buffer of 5-km around the C2 signs of presence, resulting in an area of about 80 km² around each confirmed sign of presence. This area corresponds roughly to an average female lynx home range size in the Alps (Breitenmoser-Würsten et al., 2001).

Category 1	2005	2006	2007	2008	2009	Total
Photo	22	23	41	42	48	176
Dead lynx	3	4	4	9	10	30
Genetic sample		2	1	2	1	6
Total	25	29	46	53	59	212
Category 2						
Livestock killed	31	28	47	21	28	155
Wild prey remains	136	119	148	170	228	801
Tracks	50	54	58	60	70	292
Total	217	201	253	251	326	1,248
Category 3						
Wild prey remains	6	11	15	9	13	54
Tracks	10	18	15	8	5	56
Sightings	82	87	87	97	113	466
Vocalisations	1	3	12	5	2	23
Scats	2	2	1	3	1	9
Total	101	121	130	122	134	608
Total all categories	**343**	**351**	**429**	**426**	**519**	**2,068**

Table 1: Number of lynx records collected per year and category from 2005–2009.

Tabela 1: Število zbranih podatkov o znakih prisotnosti risa po letih in kategoriji v obdobju 2005–2009.

Results

The number of signs of presence recorded in the Swiss Alps from 2005–2009 (2,068) remained stable compared to the previous pentad (2,091; Molinari-Jobin et al. 2006). Signs of presence (C1–C3) were reported from all compartments, the fewest in the compartment Ticino (VIII) with 8 and the most in the north-western Swiss Alps (VI) with 966 (Fig. 1). Intermediate values were found in the remaining compartments (345 in compartment II, 424 in III, 70 in IV, 68 in V, and 187 in VII).

A total of 155 damages to livestock were reported (Table 1), which is less than one fourth of the number reported for the previous pentad (543). On the other hand, the number of wild prey remains reported almost doubled (801 compared to 449 in the previous pentad).

With 30 the number of lynx found dead or removed from the wild remained almost stable compared to the previous pentad. Most losses occurred in the north-western Swiss Alps (16) and in central Switzerland west (11), followed by north-eastern Switzerland (2) and the Grisons (1).

The signs of reproduction showed almost the same pattern as the reported lynx mortalities (Fig. 2). The largest part of signs of reproduction came from compartments VI (32), II (32) and III (23). The remaining, all unconfirmed signs except one, came from the Valais (VII) with two, from central Switzerland east (IV) with one and from the Grisons with two of which one was a confirmed sign of reproduction, although it came from a juvenile lynx originating from north-eastern Switzerland (II) that died in Grisons during its dispersal.

As in the previous pentad, 71% of the signs of presence belong to the C1 and C2 category and thus have been confirmed. C1 signs of presence considerably increased in north-eastern and central Switzerland west

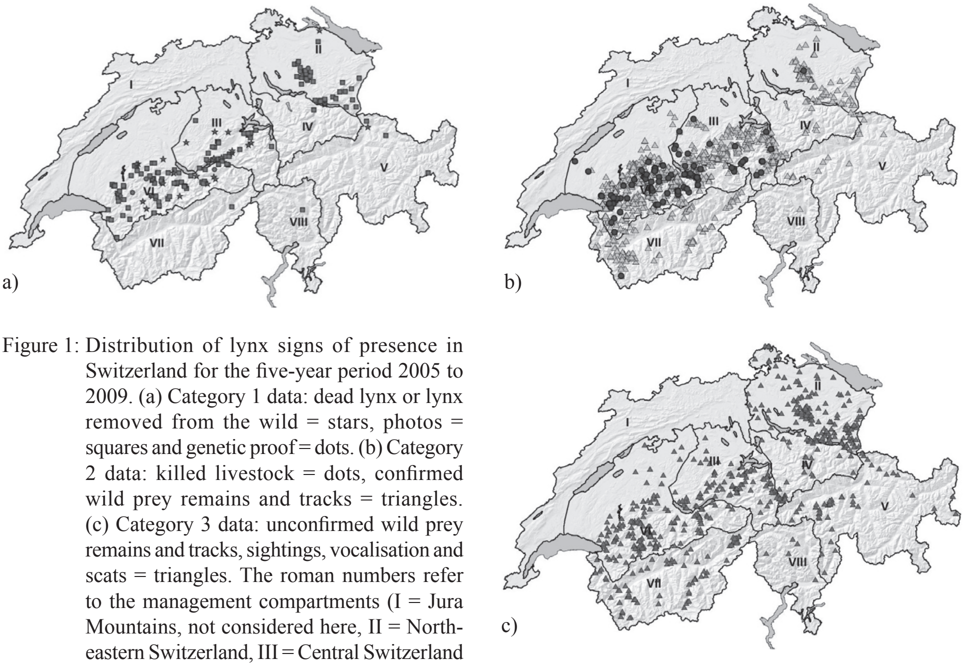

Figure 1: Distribution of lynx signs of presence in Switzerland for the five-year period 2005 to 2009. (a) Category 1 data: dead lynx or lynx removed from the wild = stars, photos = squares and genetic proof = dots. (b) Category 2 data: killed livestock = dots, confirmed wild prey remains and tracks = triangles. (c) Category 3 data: unconfirmed wild prey remains and tracks, sightings, vocalisation and scats = triangles. The roman numbers refer to the management compartments (I = Jura Mountains, not considered here, II = North-eastern Switzerland, III = Central Switzerland west, IV = Central Switzerland east, V = Grisons, VI = North-western Swiss Alps, VII = Valais and VIII = Ticino).

Slika 1: Razporeditev znakov prisotnosti risa v Švici za petletno obdobje 2005–2009. (a) Kategorija podatkov C1: mrtvi risi alirisi odvzeti iz narave = zvezde, fotografije = kvadrati in genetski dokazi = pike. (b) Kategorija podatkov C2: napadi na drobnico = pike, potrjeni ostanki naravnega plena in sledi = trikotniki. (c) Kategorija podatkov C3: ne potrjeni ostanki naravnega plena, sledi, opažanja, oglašanja in iztrebki risa = trikotniki. Rimske številke se nanašajo na upravljalske oddelke (I = Jura, tukaj ni obravnavano, II = severovzhodna Švica, III = osrednja Švica – zahod, IV = osrednja Švica – vzhod, V = Graubünden, VI = severozahodne švicarske Alpe, VII = Valais in VIII = Ticino).

compared to the previous pentad. C1 category data disappeared completely from western Grisons but in parallel some hard facts appeared for the first time in the northern part of the Grisons close to compartment II, where lynx were translocated. Category 2 signs of presence are more sparsely distributed in the western part of the Grisons compared to the previous pentad. For the first time in central Switzerland west (III) some confirmed signs of presence (C2) were recorded South to the Napf region.

The MCP encompassing all C2 signs of lynx presence increased from 20,166 km^2 in 2000–2004 to 27,487 km^2 in 2005–2009. The 5-km buffer around the C2 data resulted in a range estimate of 12,637 km^2 compared to 11,736 km^2 for the previous pentad (2000–2004).

Discussion

Development of lynx signs of presence

About 47% of lynx signs of presence that were reported for this pentad stem from the north-western Swiss Alps (VI) although this compartment contains only about 18% of the suitable lynx habitat in the Swiss Alps (based on 10x10-km cells containing ≥ 10% of suitable habitat fragment > 50 km^2; Zimmermann et al. in prep.). It is followed by compartments central Switzerland west and north-eastern Switzerland with 20.5% and 17%, respectively although the suitably habitat in these compartments makes up only 8% and 11.7% of the suitable lynx habitat, respectively. Each of the remaining compartments

Figure 2: Information about reproduction from three different sources: chance observations = triangles, dead lynx or lynx removed from the wild = stars and opportunistic camera-trapping = squares.

Slika 2: Informacije o reprodukciji iz treh različnih virov: naključna opažanja = trikotniki, mrtvi risi ali risi odvzeti iz narave = zvezde in oportunistični posnetki s foto-pastmi = kvadrati. Table captions.

(IV, V, VII and VIII) contained less than 10% of chance observations that were reported over the five year period although the suitable habitat within these compartments makes up 9% to 25% of the suitable lynx habitat.

In the previous pentad (2000–2004) signs of reproduction were mainly reported in compartments north-western Swiss Alps (VI) followed by central Switzerland west (III) and the Valais (VII) with very few signs. In north-eastern Switzerland (II), where lynx were translocated since 2001, signs of reproduction were only reported for the year 2003. In the current pentad (2005–2009) juvenile lynx were observed and reported every year in compartments north-western Swiss Alps (VI), north-eastern Switzerland (II) and central Switzerland west (III). In the Valais (VII) reproduction was only reported in 2006 and 2007. Even though a juvenile lynx was found dead in the Grisons in 2008, this lynx originated from north-eastern Switzerland (II) as revealed by genetic analyses (Breitenmoser-Würsten 2009). In 2009 for the first time an isolated sighting of a juvenile lynx (C3) was reported in the southern Grisons (V) close to the border with the canton of Ticino (VIII). This needs however to be confirmed in the next pentad. In 2003 compartment central Switzerland east (IV) faced immigration of female AIKA that was translocated to north-eastern Switzerland (Ryser et al. 2004). Even though female AIKA was still present in this compartment in 2009, when she was photographed by a camera-trap set along a trail, no signs of reproduction were documented from 2005 to 2009 in the area known to be occupied by this female from the radio-telemetry and camera-trapping studies indicating a lack of males in this area. The only sign of reproduction that was reported in 2009 is an unconfirmed sighting of a juvenile lynx that was located at the south-western corner of the compartment nearby the border with central Switzerland west (III).

Mortality showed almost the same spatial pattern as reproduction. In pentad 2000–2004 lynx found dead or removed from the population were reported every year only in compartment north-western Swiss Alps. In compartment north-eastern Switzerland they were reported in 2003 in 2004 and in the Valais only in 2004. In the current pentad, with the exception of the Valais from where no mortality was reported, mortality events were additionally reported in compartments central Switzerland west and the Grisons. Although the juvenile lynx found dead in the Grisons originated from the north-eastern Switzerland lynx sub-population (Breitenmoser-Würsten 2009).

The damages to livestock in the current pentad make only one fourth of those reported in the pentad 2000–2004 and were as in the previous pentad mainly located in the north-western Swiss Alps. The possible reasons for this decrease are twofold. First, efficient prevention measures were implemented in the hot spots where damages occurred regularly in the past in the north-western Swiss Alps. Second the roe deer numbers have increased in the north-western Swiss Alps in recent years according to the observations reported by game wardens. Therefore lynx do not need to switch to sheep as they find enough wild ungulates to prey on (Breitenmoser et al. 2010).

Even though the number of lynx presence signs slightly decreased between both pentads, the areas covered by the MCP encompassing all C2 data (27,487 km^2) and the 5-km circular buffer around the C2 data (12,637 km^2) increased by about 36% and 7.6%, respectively. The MCP of the C2 data is about two times larger than the 5-km buffered C2 lynx signs of presence. This discrepancy is due to the strong fragmentation of the Alps by both artificial and natural barriers. As a consequence the suitable lynx habitat in the Swiss Alps has a patchy distribution (Zimmermann 2004). The MCP approach is not suitable to measure the absolute spatial expansion of the lynx population in this fragmented mountain range as it contains large parts of unoccupied or unsuitable habitat that will never be occupied by lynx. Besides, our results highlighted that it is not suitable to measure the relative changes in the spatial distribution as well as it overestimated the rate of spatial change almost by a factor five. To get a more reliable estimation of the »real« area occupied by the lynx in the fragmented Alpine habitat we buffered the C2 data with a 5-km radius since the last status report (2000–2004; Molinari-Jobin et al. 2006). Although the area resulting from the buffered C2 data collected over a five years period is closer to the »real« spatial distribution of the Alpine lynx population compared to the MCP approach, it does neither take into account imperfect detection into the estimation of the area occupied by lynx nor any dynamic processes such as colonisation and extinction. To palliate these shortcomings we recently started to use a multiple season site occupancy approach to analyse our lynx presence data (Zimmermann et al. in prep.).

Synthesis

The north-western Swiss Alps is still the compartment with the highest number of reported lynx presence signs. As signs of reproduction and mortalities were reported every year we can conclude that the sub-population is functioning well. This compartment is followed by compartments central Switzerland west (III) and north-eastern Switzerland (II) where signs of reproduction and mortalities increased in the last pentad. All three lynx sub-populations acted as source in the current pentad. The translocation to north-eastern Switzerland is still the only significant contribution to the spatial increase of the lynx range in the last 10 years in the whole Alps (Molinari-Jobin et al. 2010). With about 8 independent lynx (KORA unpublished data), this small sub-population is however highly vulnerable. In the context of the Alpine population the north-eastern Switzerland sub-population is very important for the future expansion of the lynx, as it could act as stepping stone to the eastern Alps and could enable to fill the gap towards west (compartment IV). During the current pentad it was documented that at least two individuals already left the compartment: sub-adult male B132 showed the longest dispersal ever reported in the Alps and dispersed over more than 200 km to the Trentino (Haller 2009) and a juvenile lynx died while dispersing in the Grisons (V). However such spontaneous migrations are generally far too rare to allow the establishment of a population and these individuals, if they survive their dispersal, remain isolated for years. However when immigration from different directions is possible – as it is currently the case for compartment central Switzerland West (IV) – the chances that several individuals settle down in a lynx-empty area and start to establish the classical social structure and finally reproduce are improved (Zimmermann et al. 2007). The status of the sub-population in the Valais (VII) is less clear. As almost no signs of reproduction and mortalities were reported over the pentad it acted more as sink than a source. In the remaining compartments there are only a few single individuals that did not yet establish a social structure. An occupancy-based population estimate by Zimmermann et al. (in prep.) based on the ratio of population size estimated by means of photographic capture-recapture analyses and occupancy values of occupied range estimated that about 111 (SE=10) independent lynx lived in the Swiss Alps for the period 2005–2009. This is higher than the 60–90 individuals estimated for the previous period.

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