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Survey of the *Lynx lynx* distribution in the French Alps: 2005–2009 update

Spremljanje razširjenosti risa v francoskih Alpah: 2005–2009

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Abstract: As part of the survey of the pan-alpine population of Eurasian Lynx, the French national network of large carnivores experts collected N = 301 data, out of which 159 (n_1 = 2 C1, n_2 = 62 C2, n_3 = 95 C3) were regarded robust enough from a technical point of view to evidence the presence of lynx (compared to 224 data in the previous pentad). Such a rejection rate (46%) significantly differed from that (24%) observed elsewhere in the Lynx area during the same period, but not from that during the previous pentad in the Alps (43%). The rejection rate was dependent on data type: hair and faeces samples were significantly more often rejected than other presence signs (78% vs. 41%). Among other presence signs, prints were more often rejected (55%) than expected, and sightings were less rejected (35%) than expected. Preys were rejected according to expectations given sample sizes. As noted during the previous pentad, a north-south gradient was evidenced in presence signs collected: C1+C2 were more often encountered north to Grenoble than in the southern part of the lynx area, contrary to C3. Using a modelling approach of the trend in the presence area detected, area with regular presence was increasing then stable, whereas a declining trend was noticed in the area newly colonized during the last years.

Keywords*:* *Lynx lynx*, France, Alps, presence signs, population trend.

Izvleček: V okviru spremljanja pan-alpske popoulacije evrazijskega risa je Francoska nacionalna mreža strokovnjakov za velike zveri zbrala N = 301 podatek o znakih prisotnosti risa, od tega je bilo 159 (n1 = 2 C1, C2 n2 = 62, N3 = 95 C3) podatkov dovolj zanesljivih s tehničnega vidika, da smo jih lahko vključili v analize (primerjalno; v prejšnji pentadi so zbrali 224 podatkov). Takšna zavrnitvena stopnja (46 %) se bistveno razlikuje od (24 %) stopnje v drugih državah na območju prisotnosti risa v istem obdobju, ne pa tudi od pretekle pentade v francoskih Alpah (43 %). Zavrnitvena stopnja je bila odvisna od vrste podatkov: vzorci dlake in iztrebkov so bili precej pogosteje zavrnjeni kot drugi znaki prisotnosti (78 % proti 41 %). Med drugimi znaki prisotnosti, so bile sledi pogosteje zavrnjene (55 %) kot je bilo pričakovano, neposredna opažanja pa so bila zavrnjena redkeje (35 %) kot je bilo pričakovano. Zavrnitvena stopnja pri ostankih plena je bila v skladu s pričakovanji glede na dano velikost vzorca. Kot je navedeno v poročilu za prejšnjo pentado je tudi za to pentado značilen gradient pogostosti znakov sever-jug, kar je razvidno iz zbranih znakov prisotnosti: C1 + C2 so se pogosteje pojavljali severno od Grenobla kot v južnem delu območja prisotnosti risa, v nasprotju s C3, ki so bili pogostejši na jugu. Z modeliranjem trendov spreminjanja območja prisotnosti risa se je pokazalo, da je trend velikosti območja z redno prisotnostjo risa naraščal nato pa je bil stabilen, medtem ko je bil trend upadanja opazen v na novo koloniziranih območjih v zadnjih letih.

Ključne beside: *Lynx lynx*, Francija, Alpe, znaki prisotnosti, populacijski trend

Introduction

Most of the European large carnivore populations are by nature transboundary and should be monitored as such (Linnell et al. 2008). The alpine Lynx metapopulation is periodically evaluated based on standardized and common protocols as a follow-up of implementing the pan-alpine conservation strategy for the Lynx (Molinari-Jobin et al. 2001, 2003). The present work details how the "French" sub-unit has been changing during the last pentad (2005–2009), providing some insights in the data at hand, and showing how trends in the distribution area could be modelled.

Methods

Data collection

Presence signs are gathered by a national network of field lynx-experts (ca. 1000 people), who have been trained to collect them and describe their technical characteristics according to a standardized protocol and corresponding forms. Signs are further evaluated to check for their robustness and rejected where needed according to methods in Vandel and Stahl (2005). The validated signs were further converted to SCALP criteria (C1, C2, C3) following Molinari-Jobin et al. (in press).

Data analysis

Validation / rejection rates according to data type or period were compared using Chi-square statistics. Validated data were converted into presence area based on Vandel and Stahl (2005). Trends in the area were modelled using log-linear Poisson regression implemented in TRIM (Pannekoek and Van Strien 1998). The method provides trend estimates together with a Goodness-of-Fit test (deviance, DEV) that can be used into an information-theoretic approach, based on Akaike Information Criteria (AIC = DEV + 2 np; see Anderson and Burnham 2002, for a review). AIC has been elaborated to help choosing among candidate models the one best supported by data at hand (e.g. no trend vs. linear trend vs. break points and changing trend). DEV is a measure of the discrepancy between data and the model; the larger the number of parameters (np) in the model, the better it fits to the data, but variance in estimated parameters will be large. Basically one has to solve a bias-variance trade-off, e.g. by selecting the model(s) with the lowest AIC value(s) to balance errors of over- vs. under-fitting.

Results

Data collected

During the 2005–2009 pentad, N = 301 data were collected, out of which 159 (n_1 = 2 C1, n_2 = 62 C2, n_3 = 95 C3) were validated from a technical point of view (compared to 224 data in the previous pentad, Table 1). Such a rejection rate (46%) significantly differed from that (24%) observed elsewhere in the Lynx area during the same period (χ^2 = 67.0, 1 d.f., $p < 0.01$), but not from that during the previous pentad in the Alps (43%, χ^2 = 1.1, 1 d.f., p = 0.31). The rejection rate was dependent on data type: hair and faeces samples were significantly more often rejected than other presence signs (78% vs. 41%, χ^2 = 27.1, 3 d.f., $p < 0.01$). Among other presence signs, tracks were more often rejected (55%) than expected, and sightings were less rejected (35%) than expected (χ^2 = 5.9, 2 d.f., p = 0.05). Wild ungulate kills were rejected according to expectations given sample sizes.

Because the colonizing process of the French Alps seems orientated north to south (Marboutin et al. 2006), data collected north to Grenoble were compared to those collected south to this area (Figure 1, Table 2). The most robust presence

Table 1: Numbers of lynx presence signs, according to SCALP categories, validated over the French Alps.
Tabela 1: Številčnost ovrednotenih znakov prisotnosti risa po SCALP kategorijah v francoskih Alpah.

Categories	1990–94	1995–99	2000–04	2005–09	Total
C1	2	0	3	2	7
C2	5	7	92	62	166
C3	24	62	128	95	309
Total	31	69	224	159	483

Table 2: Unbalanced numbers of lynx presence data, according to SCALP categories (C1+C2 versus C3) and geographical location.
Tabela 2: Neuravnovešena številčnost znakov prisotnosti risa po SCALP kategorijah (C1+C2 proti C3) in prostorski razporeditvi.

Categories	North to Grenoble	South to Grenoble
C1+C2	55	9
C3	65	30

signs (C1 + C2) were significantly encountered more frequently in the northern range of the species contrary to C3 ($\chi^2 = 6.3$, 1 d.f., $p = 0.01$).

Trend in the distribution area

Different trends were noticed in the area with regular presence of lynx, and in the area newly colonized (Fig. 2). Three different models were fitted to these data: model 1 assumed no trend in the data; model 2 assumed a linear trend; model 3 assumed changing points and related trends (Table 3). Based on minimum AIC, model 3 with one changing point and two slopes best described the data at hand regarding both changes in the area with regular detection of lynx and in area newly colonized. The area with regular presence has been first increasing (1993–2007) then stabilizing (2008–2010); the area newly colonized increased (1993–2004), and then decreased (2005–2010).

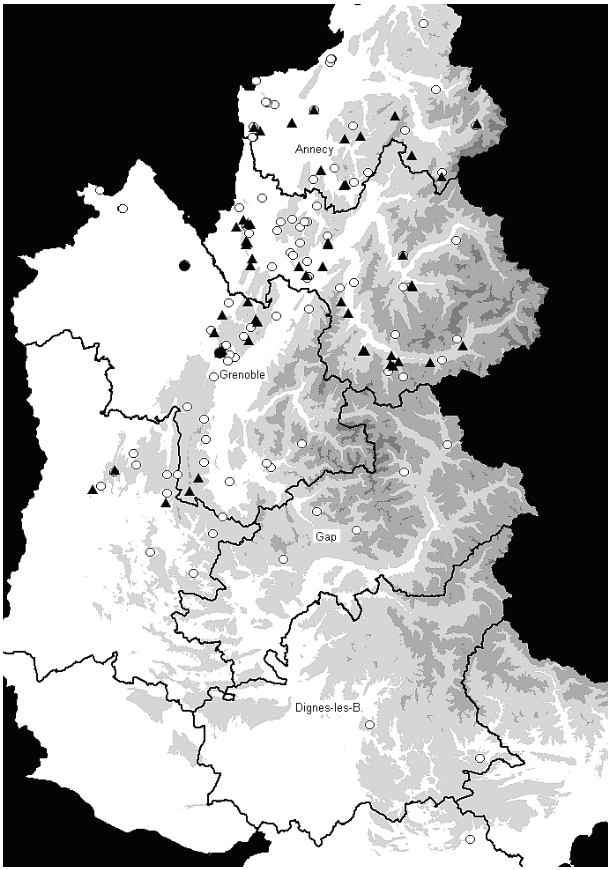


Figure 1: Distribution of validated lynx signs (● = C1, ▲ = C2, ○ = C3) collected from 2005 to 2009 in the French Alps; shaded areas represent altitudinal patterns (the darker, the higher).
Slika 1: Razporeditev ovrednotenih znakov prisotnosti risa (● = C1, ▲ = C2, ○ = C3) zbranih od 2005 do 2009 v francoskih Alpah; senčena območja predstavljajo višinske pasove (temnejše je višje).

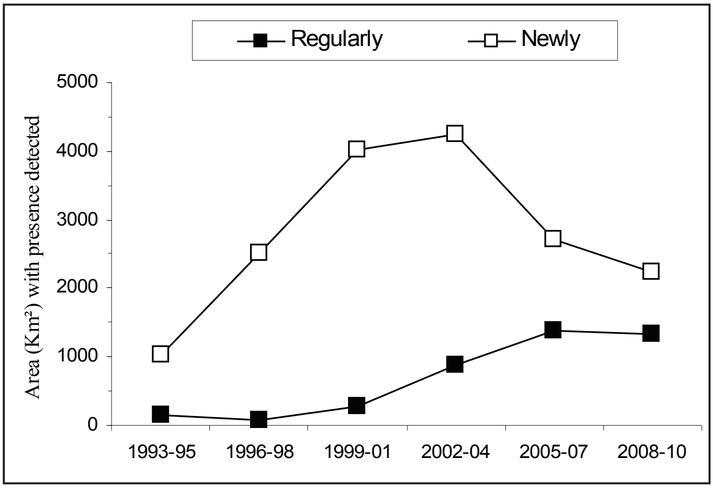
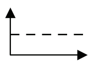
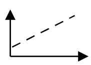
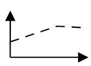
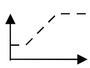
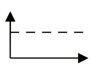
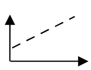
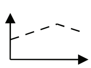


Figure 2: Trend in the area with lynx presence detected regularly vs. newly during the corresponding 3-year periods.
Slika 2: Trend v velikosti območij kjer je prisotnost risa zaznana redno proti območjem kjer se je ris pojavljal na novo v posameznih triletnih obdobjih.

Table 3: Modelling of trends in the detected population range using TRIM software.
Tabela 3: Modeliranje trendov zaznanega prostorskega obsega populacije z uporabo programa TRIM.

Area with Presence detected	Model structure	Slope estimates	A.I.C.
	 no time effect	0.00	304.7
	 linear trend 1 slope	0.49	41.0
regularly			**13.1**
	 1 changing point 2 slopes	0.69 –0.07	27.2
	 2 changing points 3 slopes	0.00 0.96 0.13	
	 no time effect	0.00	296.3
newly	 linear trend 1 slope	0.07	271.3
	 1 changing point 2 slopes	0.38 –0.42	**51.4**

Discussion

Despite a strong rejection rate of presence signs collected, which suggests that most spurious data may have been discarded, a strange geographical pattern still occurred in validated data. Robust lynx presence signs (C1+C2) were still located mostly north to Grenoble, as already mentioned in Marboutin et al. (2006). The southernmost robust presence signs were collected in the Chartreuse and Vercors massif, and in the Maurienne valley. Many places in the whole area of the Alps are actively monitored for wolf presence too, using systematic surveys of e.g. tracks in winter; an unknown – but possibly large – part of C3 may therefore correspond to "phantom" lynx (sensu Molinari et al. in press), specially in those places where only C3 are obtained. Based on trends observed in the detected presence area, the French Alpine lynx sub-population is likely stabilizing. Overall, the estimated regular population range covers less than 1350 km², which may hardly correspond to more than 10 – 15 resident adults. The area newly colonized may be a mixture of actual dispersers and phantom lynx (wrong positive detection of the species). This suggests a conservative approach is needed, i.e. not considering such areas in the population status assessment as long as they do not turn to regular presence areas. Combining an analysis of the spatial recurrence in species detection, together with an analysis of the influence of species misidentification (Molinari-Jobin et al. in press), may help reaching the right balance between the risks of under- versus over-estimating the changes in population range.

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