

PRESENT STATUS AND DISTRIBUTION OF THE LYNX IN THE SWISS ALPS

ANJA MOLINARI-JOBIN*, FRIDOLIN ZIMMERMANN^o,
CHRISTINE BREITENMOSER-WÜRSTEN**^{*},
SIMON CAPT*^o AND URS BREITENMOSER**

* *Oberdorfstrasse 274, 3852 Ringgenberg, Switzerland*

^o *Kornmattgasse 1A, 3700 Spiez, Switzerland*

** *KORA, Thunstrasse 31, 3074 Muri, Switzerland*

*^o *CSCF, 2000 Neuchâtel, Switzerland*

ABSTRACT - To evaluate the population trend of lynx in the Swiss Alps, we analysed the spatial and numerical development of signs of presence found from 1995 to 1999 and compared them with previous years. Three sources of information on the presence of lynx are available: (1) reports of lynx killed or found dead; (2) records of livestock killed by lynx; (3) records of wild prey remains, tracks, scats, sightings, and vocalisations. We distinguished three levels of reliability: Quality 1 represent the hard facts, e.g. all reports of lynx killed or found dead, photographs of lynx as well as young orphaned lynx caught in the wild and taken into captivity. Quality 2 include all records of livestock killed, wild prey remains, tracks and scats reported by people who have attended special courses, e.g. mainly game wardens. Quality 3 are all wild prey remains and tracks reported by the general public as well as all sightings, scats and vocalisations, e.g. signs that cannot be verified. More than 1600 signs of presence were recorded in the Swiss Alps in this 5-year-period. A high number of quality 1 and 2 records showed that (1) the lynx population in the north-western Swiss Alps increased from 1994 to 1999, that (2) there is a moderate presence of the species in the central and south-western parts and (3) none or hardly any lynx are found in the eastern Alps of Switzerland. Based on a radio-telemetry study and the number of quality 2 data, we were able to estimate the number of lynx in the Swiss Alps at 70 individuals. To counterpart the uneven distribution of lynx in Switzerland, lynx are being translocated from the north-western Alps to the eastern Swiss Alps, as the expansion of the Swiss lynx population is crucial for the conservation of the lynx in the whole Alps.

Key words: *Lynx lynx*, monitoring, distribution, Alps, Switzerland

INTRODUCTION

Lynx were re-introduced in the Swiss Alps from 1971-1980 (Breitenmoser *et al.*, 1998). After a swift expansion over part of the potential range in the first decade, Breitenmoser and coauthors (1998) reported a stagnation of the lynx population in the Swiss Alps from 1985-1994, although there was still suitable habitat in the east and in the south. The reason for this is unclear, but most likely, it was due to the natural and artificial barriers that hindered individual lynx dispersal, and, maybe more importantly, illegal killings destroyed

the population pressure needed for an expansion. Nevertheless, the population in the Swiss Alps was judged to be one of the most vital of all lynx occurrences in the Alps.

Since about 1993/94, a second increase of the lynx population in the north-western Swiss Alps has been observed, leading again to another controversy about the return of the lynx. Not only hunters and sheep-breeders, but also the authorities of the respective cantons have demanded that the lynx population in this area be reduced. To respond to this situation, a research project was started in the



Figure 1 - Potential lynx habitat (grey) and division of Switzerland into 9 management compartments (black outlines).

north-western Swiss Alps. From 1997 to 1999, 40 individual lynx were radio-collared. This allowed us to directly estimate the number of lynx in the north-western Swiss Alps.

To evaluate the population trend of lynx in the Swiss Alps in the late 1990's, we first analysed the development in the number of signs of presence found from 1995 to 1999 and compared them with previous years. Secondly we analysed the spatial trend of the population and estimated the number of lynx in the Swiss Alps.

METHODS

From 1992 onwards, the network of game wardens in Switzerland was used to survey the development of lynx in Switzerland. Annual questionnaires have been sent out to all game wardens in order to obtain a systematic monitoring (Capt *et al.*, 1998). To instruct game wardens how to recognise signs of presence of lynx, special courses were organised and instructive material was produced (e.g.

Molinari *et al.*, 2000). Three 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) records of livestock killed by lynx; and (3) records of wild prey remains, tracks, scats, sightings, and vocalisations. The best evidence of lynx presence is a lynx found dead or a lynx captured. The reliability of all other records varies greatly. We distinguished three levels of reliability according to the possibility to verify an observation: Quality 1 (Q1) represent the hard facts, e.g. all reports of lynx killed, found dead or captured, photographs of lynx as well as young orphaned lynx caught in the wild and put into captivity. Quality 2 (Q2) represent all records of livestock killed, wild prey remains, tracks and scats confirmed by people who attended special courses, e.g. mainly game wardens. As all game wardens were instructed how to recognise lynx signs of presence, these records are mostly an objective proof of lynx pres-

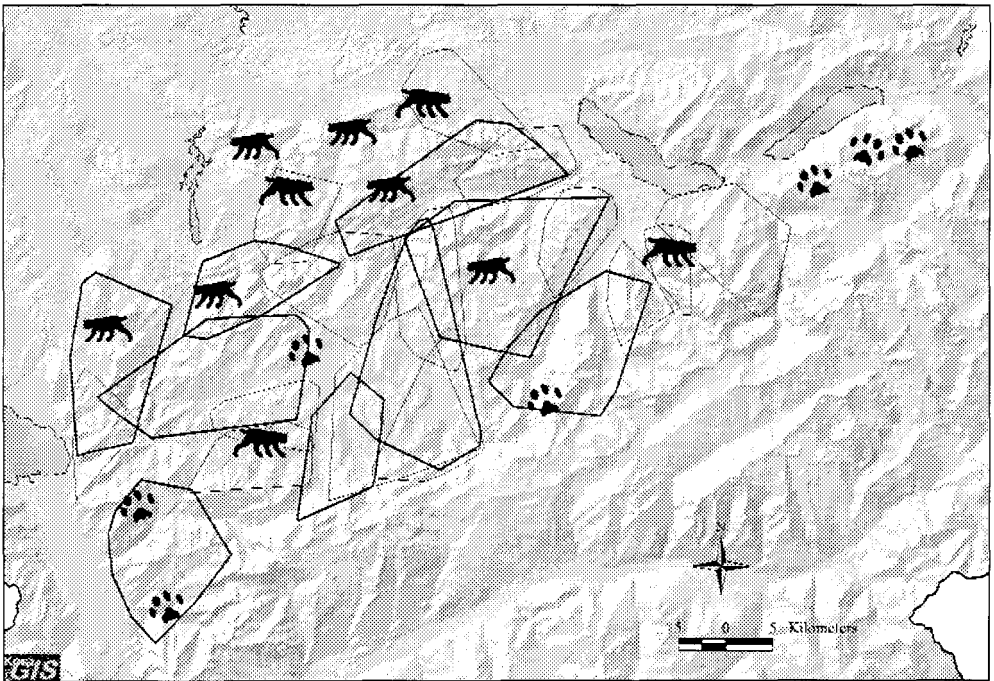


Figure 2 - Home ranges (100% convex polygons) of radio-tagged male (thick line) and female (thin line) lynx and confirmed presence (lynx symbol) of untagged lynx in the north-western Swiss Alps (compartment VI). Suspected presence of lynx is shown with the lynx print symbol. Symbols facing right stand for male lynx, symbols facing left for female lynx.

ence, though both errors and even deception may occur. Quality 3 (Q3) represent all wild prey remains and tracks reported by the general public as well as all sightings, scats and vocalisations, e.g. mainly signs that cannot be verified. When studying distribution, isolated data of Q3 are of reduced significance. However, their repeated occurrence in the same areas may attract attention to the possible presence of the species.

Subsequently, Switzerland was divided into 9 geographical compartments according to habitat connectivity and administration units (Fig. 1). To estimate the potential lynx habitat within each compartment, we used squares with the probability of ≥ 0.5 of a previously modelled suitability map (Breitenmoser *et al.*, 1999; Zimmermann, pers. comm.) computed with Biomapper (Hirzel *et al.*, 1999).

Lynx numbers in the north-western Alps were estimated by means of radio-telemetry and

confirmed presence of unmarked lynx (Fig. 2; Breitenmoser-Würsten *et al.*, 2001). We then compared the number of Q2 data reported from this compartment with known lynx density and number of lynx present and extrapolated to all other compartments where only the number of Q2 data reported was available. Thus, we used Q2 data recorded as an index of lynx abundance and the findings from the radio-tracking to calibrate the data.

LEGAL SITUATION

Switzerland has signed and enforced both the Washington convention (CITES, in 1975) and the Bern Convention (in 1982), which require the conservation of lynx population. Lynx are protected year-round by the *Federal Law on the Hunting and Protection of Free Living Mammals and Birds* (JSG). The according ordinance to this law defines that all domestic animals killed by lynx are reimbursed by the

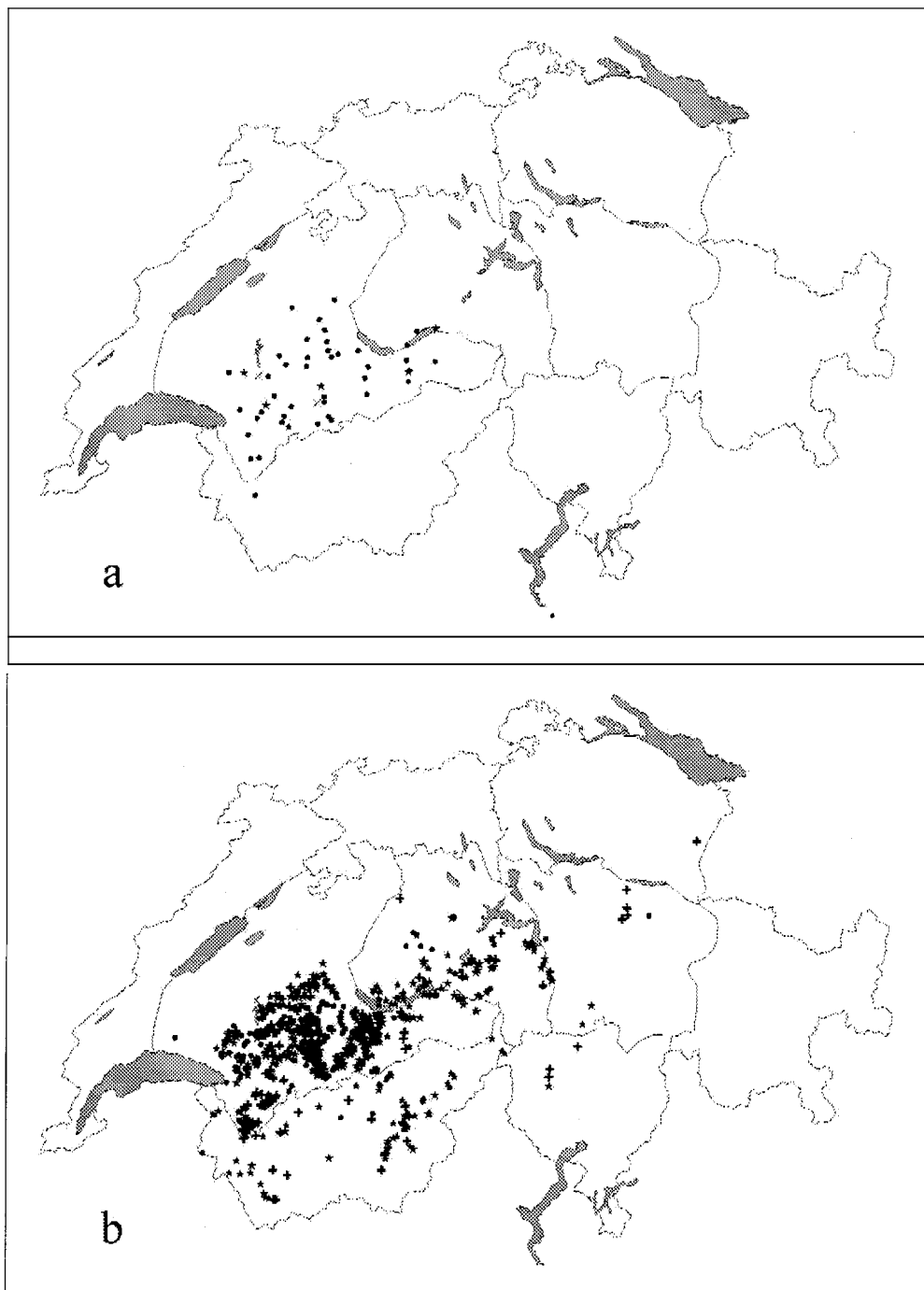


Figure 3 - Distribution of the lynx in Switzerland for the five-year period 1995-99. (a) Quality 1 data: dead lynx found (dots), photos (crosses) and captures (stars). (b) Quality 2 data: killed livestock (dots), wild prey remains (stars) and tracks (crosses).

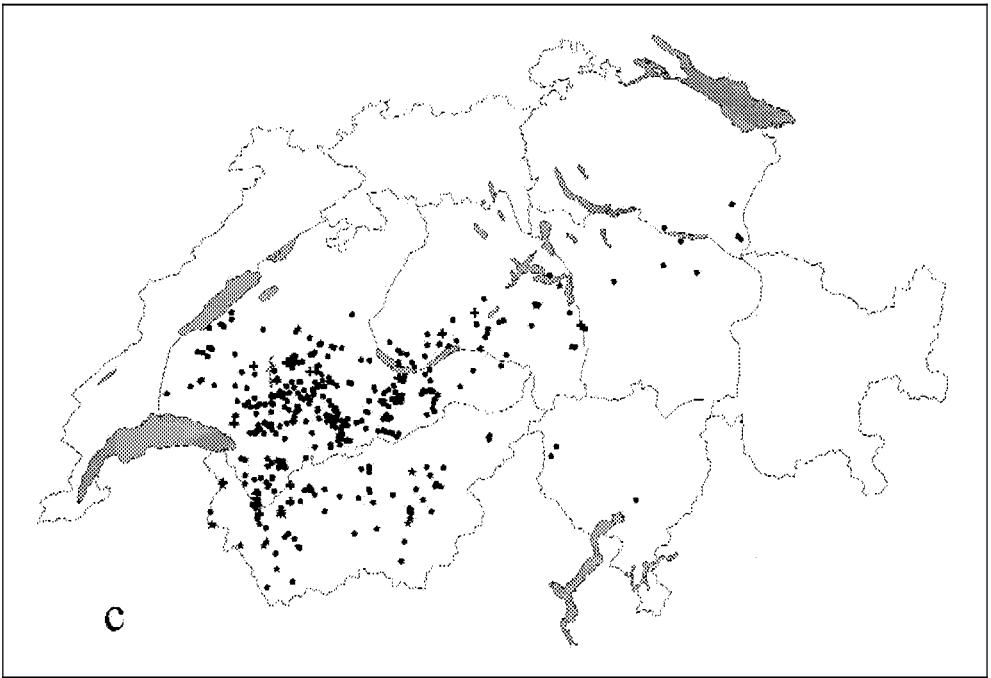


Figure 3 (cont.) - Distribution of the lynx in Switzerland for the five-year period 1995-99. (c) Quality 3 data: wild prey remains (stars), tracks (crosses), sightings (dots) and vocalisations (squares).

federal and the cantonal governments. Cantonal game wardens are in charge of the evaluation of every attack on livestock reported. Permits to remove lynx who attack livestock may be issued by the Swiss Agency for Environment, Forest and Landscape (SAEFL) in order to stop attacks in high damage areas. From 1995 to 1999, three lynx have been shot for this reason. The Swiss hunting ordinance obliges the SAEFL to establish a management plan for the lynx. The *Swiss Lynx Concept* was implemented in August 2000 and defines the general conservation and management goals, the co-operation between the SAEFL and the cantons, and criteria for interventions.

RESULTS

From 1995 to 1999, more than 1600 signs of presence were recorded in the Swiss Alps. More Q1 data were reported than in any previous 5-year period. The number of lynx found dead more than doubled compared to the pre-

Table 1 - Number of lynx found dead and livestock killed for different periods. Data from 1971 to 1994 derived from Breitenmoser *et al.* (1998).

Period	Number of lynx found dead	Number of livestock killed
1971-79	7	9
1980-84	11	171
1985-89	9	303
1990-94	16	162
1995-99	41	519
TOTAL	84	1164

vious five years (Table 1), indicating the possibility of an increased population trend. Most lynx mortalities occurred in the region of the north-western Swiss Alps (Fig. 3a). Only one dead lynx was reported from the canton of Valais and one north of the Aare river. Both mortalities occurred close to the compartment

Table 2 - Number of records collected per year. Data from radio-tracking was not considered in this analysis.

QUALITY 1	1995	1996	1997	1998	1999	Total
lynx found dead	3	8	8	7	15	41
capture			2	2	2	6
photo				2		2
TOTAL	3	8	10	11	17	49
QUALITY 2						
livestock killed	52	72	104	104	187	519
wild prey remains	65	76	96	88	104	429
tracks	17	24	70	31	25	167
TOTAL	134	172	270	223	316	1115
QUALITY 3						
wild prey remains	0	1	1	13	3	18
tracks	0	4	3	9	6	22
sightings	31	61	142	70	113	417
vocalisations	0	3	7	1	1	12
TOTAL	31	69	153	93	123	469

VI. Besides, one orphaned lynx was caught north of the Aare river and put into captivity. The number of lynx found dead peaked in 1999 (Table 2). Even though three times more hard facts were reported for the 1995-99 period than for 1990-94, the polygon drawn around the signs of lynx presence of Q1 decreased from 7590 km² to 3800 km².

Quality 2 data were most often reported, representing 68% of all records. Almost half of these records were cases of livestock depredation, mainly sheep (Table 2). This is obviously the most complete category because livestock killed by lynx are reimbursed. The number of wild prey remains reported increased considerably, doubling from 1995 to 1999 (Table 2). The number of lynx tracks reported however peaked in 1997. The distribution of the Q2 data indicates an expansion of the lynx population into the northern part of the canton Ticino, compared to the previous 5-year-period (Breitenmoser *et al.*, 1998). Furthermore, even though isolated, one confirmed track was recorded from the eastern part of the canton of St. Gallen (Fig. 3b). The polygon drawn around the signs of lynx pres-

ence of Q2 increased from 10500 km² in 1990-94 to 16400 km² in 1995-99. Even though the number of records of Q2 tripled from 315 in 1990-94 to 1115 in 1995-99, the area of lynx distribution increased only by 50%.

In areas where lynx presence was regularly confirmed, the effort to report Q3 data decreased considerably. That's why tracks and wild prey remains reported by people other than game wardens were only small in number (Table 2). Most of the Q3 data were sightings. When considering also Q3 data in the distributional analyses (Fig. 3c), lynx appear to have immigrated to the Swiss Plateau south of the Lake of Neuchâtel in the past 5 years where they did not occur before. This new appearance still has to be confirmed with Q1 or Q2 data.

To obtain a rough estimation of the number of lynx living in the Swiss Alps, we extrapolated the very detailed knowledge from the north-western Swiss Alps (compartment VI) to the whole of the Swiss Alps by comparing the potential habitat and the Q2 data available. The estimation of the size of the potential lynx habitat per compartment is shown in

Table 3 -Estimated and potential number of lynx in the Swiss Alps. The compartments of the Jura Mountains (Nr. I & IX) were not considered in this analysis.

N. of compartment	Potential habitat (km ²)	Quality 1	Quality 2	Quality 3	Estimated n. of lynx	Potential n. of lynx
II	510	0	1	4	0	18-19
III	1057	3	98	38	6	37-40
IV	1294	0	14	7	1	46-49
V	1207	0	0	0	0	43-46
VI	1552	45	909	346	55-59	55-59
VII	1213	1	89	71	5-6	43-46
VIII	1336	0	4	3	0	47-51
TOTAL	8169	49	1115	469	67-72	289-310

Table 3. We estimated the number of self-provisioning lynx, e.g. adults and subadults (kittens < 1 year old are excluded), in compartment VI to be 55-59 individuals. In the same compartment, 909 Q2 data were recorded. Therefore we calculated one self-provisioning lynx per 16 Q2-data gathered. In the adjoining compartments III and VII, where 98 and 89 Q2 data were recorded, we estimated the lynx number to be 6 and 5-6 individuals, respectively (Table 3). According to our model, the lynx population in the Swiss Alps was estimated at roughly 70 individuals, even though the potential habitat could host about 300 self-provisioning lynx.

DISCUSSION

The monitoring system established in 1992 showed its effectiveness already in 1994, when an increase in the north-western Swiss Alps was detected, due to an increase in the number of signs of presence reported by game wardens (Breitenmoser *et al.*, 1998). Since hard fact data were not available in all areas of lynx occurrence, the Q2 records became extremely important for the assessment of the lynx distribution. A network of trained people that cover the whole area is a prerequisite to ensure the reliability of the observations reported. Kills and tracks may then be verified by the game wardens. This "professional" approach is important because the number of data reported by the general public can vary, e.g. the

fluctuations in the number of observations may also reflect changes in public awareness. The Austrian experience has shown that intensified publicity can immediately produce more records (Huber and Kaczensky, 1998) without there being more lynx present.

The trends of Q1 and Q2 records showed that (1) the lynx population in the north-western Swiss Alps increased from 1994 to 1999, that (2) there is a moderate presence of the species in the central and south-western parts and (3) none or hardly any lynx are found in the eastern Alps of Switzerland. The Q2 data recorded from the northern part of the canton Ticino, may indicate a southward expansion of the Swiss population. New lynx occurrences in the Ossola and Aosta valley in Italy confirm this trend (Molinari *et al.*, this volume). However, single lynx who left the closed population can roam for many years through a not really settled compartment. Such individuals can produce signs of presence at low density and over a huge area, as they search for conspecifics.

The mortality in the north-western Alps was very high. Besides, the losses given in Table 1 are minimum estimates. Undoubtedly, the number of unknown cases of lynx illegally killed is quite large. For example, only four out of nine radio-tagged lynx that were killed would have been found if untagged. We assume illegal killing to be the most important single cause of mortality. Some hunters and

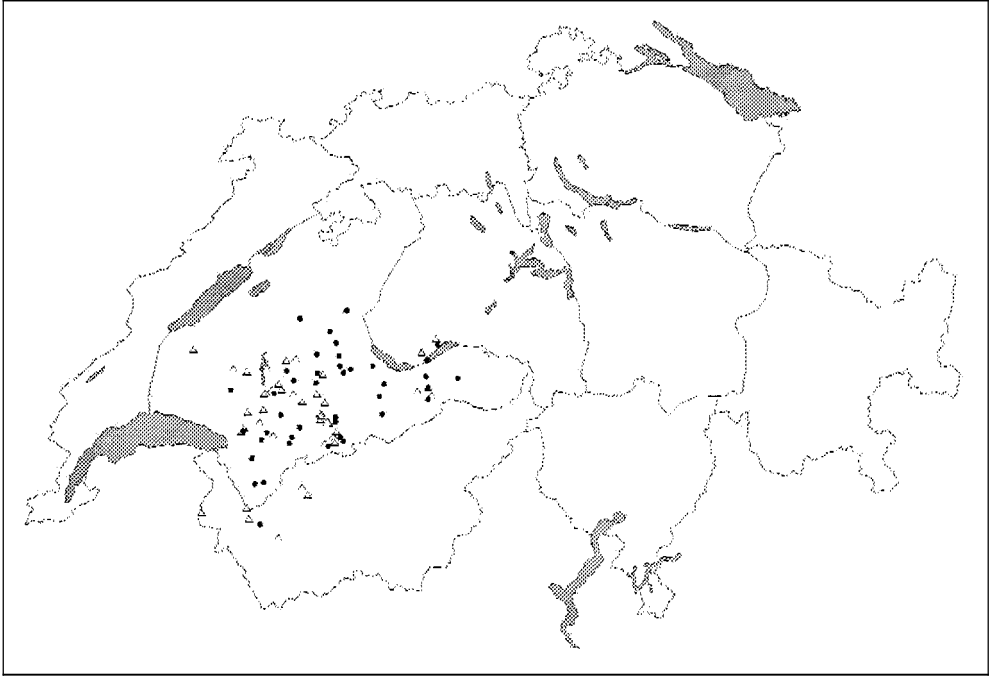


Figure 4 - Comparison between the distribution of known lynx mortality (Quality 1, dots) and records of reproduction (Quality 3, triangles),

sheep breeders still consider lynx as a pest and openly state that they would shoot any lynx given the opportunity.

The high increase in the number of signs of presence of Q1 and Q2 data from 1995-99 compared to the previous pentad was translated only into a marginal increase in the area colonised by lynx. Observations to the east of the river Reuss still remained scattered and well separated by wide areas without any record. The analysis of the distribution and number of lynx signs of presence indicate that lynx seem to be "trapped" in the geographical area of the north-western Swiss Alps (compartment VI). This hypothesis was confirmed by the reports of lynx reproduction (Fig. 4) and by the telemetry study that revealed that the lynx density in this area was much higher than in previous years. But still, only 2 out of 43 radio-tagged lynx left the compartment VI (Breitenmoser-Würsten *et al.* 2001).

We distinguished four different categories of lynx status in the Swiss Alps (Fig. 5): in com-

partment VI, we observed a population at high density that may have acted as a source population. Lynx in compartments III and VII were found to be in a population low (sink). We attribute the few Q2 records from compartments IV and VIII to single individuals only, whereas in compartments II and V no lynx occurred.

We estimated the number of lynx in the Swiss Alps to be 70 individuals assuming that lynx numbers in the compartment VI (Fig. 2) were estimated correctly and the number of Q2 data reported in the same area was representative for all other compartments as well. Our method for the estimation of the lynx number is very much depending on the quality of the monitoring data. For future validation of the index it is desirable to compare our results with other areas where monitoring programs include radio-tracking and a "verification network".

Breitenmoser *et al.* (1998) estimated the lynx number in the Swiss Alps at 50 individuals in

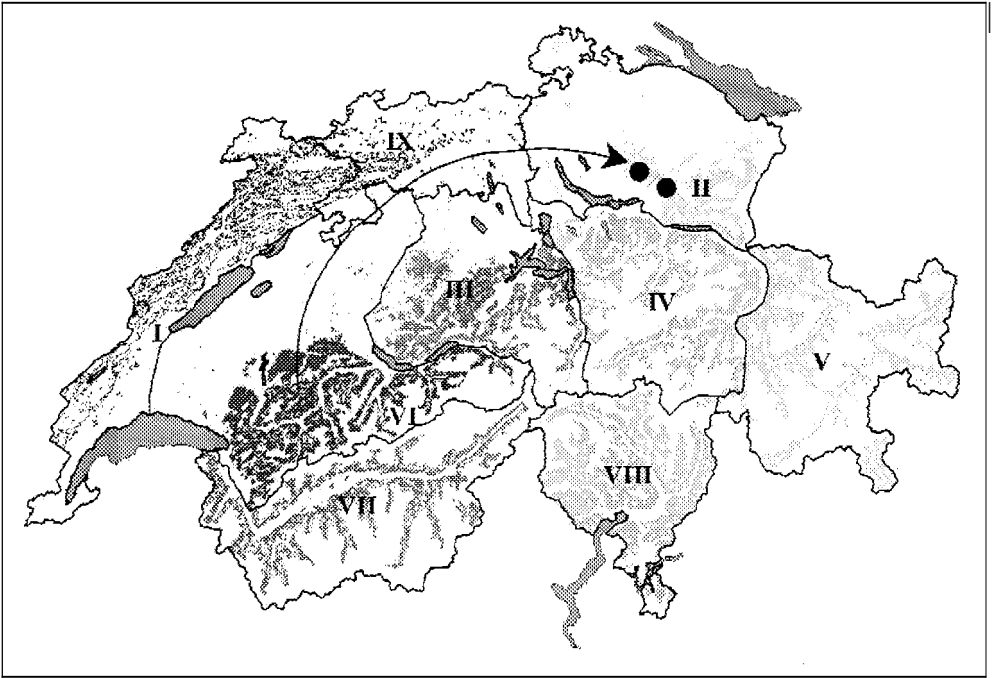


Figure 5 - Distinction of compartments with different levels of lynx abundance: source population (compartment VI), sink population (compartments III and VII), single individuals without the typical social organisation (compartments IV and VIII), and compartments with no lynx (compartments II and V). The status of the lynx in the Swiss Jura Mountains is unknown (compartments I and IX). The dots mark the release sites 2001. See text for further details.

the years from 1990-94 compared to our recent estimate of 70 individuals. This increase is only caused by higher lynx abundance in the compartment VI, whereas the lynx numbers in the compartment III and VII decreased. Despite a locally high lynx density in the north-western Alps, the estimated lynx numbers are far from the potential capacity. To counteract the uneven distribution of lynx in Switzerland, 3 male and 3 female lynx were translocated from compartment VI to compartment II in spring 2001 (Fig. 5). We believe that the expansion of the Swiss lynx population is crucial for the conservation of the lynx in the whole Alps.

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ZUSAMMENFASSUNG

Anhand der Anzahl und räumlichen Verteilung der Luchsnachweise untersuchten wir die Entwicklung der Population in den Alpen von 1995 bis 1999. Dazu standen uns drei verschiedene Datengrundlagen zur Verfügung: (1) die getöteten und tot aufgefundenen Luchse; (2) Die nachweislich vom Luchs getöteten Haustiere; (3) Meldungen von gerissenen Wildtieren, Luchsspuren, Kote, Direkt-

beobachtungen und Lautausserungen. Aufgrund der Überprüfbarkeit dieser Nachweise wurden sie in 3 Kategorien eingeteilt: Qualität 1 beinhaltet die Meldungen von toten Luchsen, verwaiste Luchsjunge, die eingefangen wurden, und Fotos von Luchsen, also Nachweise, die beweisbar sind. Qualität 2 beinhaltet die Haustierrisstatistik sowie alle Meldungen von qualifizierten Leuten, meistens Wildhiiter, über gerissene Wildtiere, Luchsspuren und Kote. Qualität 3 beinhaltet alle Nachweise, die von unbekanntem stammen, sowie Direktbeobachtungen und Lautausserungen, also Nachweise, die nicht überprüfbar sind. Von 1995 bis 1999 wurden mehr als 1600 Luchsnachweise in den Schweizer Alpen gemeldet. Die hohe Anzahl von Qualität 1 und 2 Daten zeigte, dass (1) die Anzahl der Luchse in den Nordwestalpen angestiegen ist, dass (2) die Anzahl Luchse in der Zentralschweiz und im Wallis zurückgegangen ist, und dass (3) es in der Ostschweiz keine oder höchstens einzelne Luchse hat. Anhand von einer Telemetriestudie und der Anzahl Nachweise von der Qualität 2 wird die Anzahl Luchse in den Schweizer Alpen auf 70 Individuen geschätzt. Um der ungleichmassigen Verbreitung entgegenzuwirken, werden Luchse von den West- in die Ostalpen umgesiedelt. Die Ausbreitung der Schweizer Luchspopulation ist entscheidend für die Zukunft des Luchses in den ganzen Alpen.

RÉSUMÉ

Sur la base du nombre et de la distribution des indices de présence récoltés, l'évolution de la population de lynx dans les Alpes suisses a été analysée et comparée avec la situation des années précédentes. Pour procéder à cette évaluation, trois sources d'information sont disponibles: (1) lynx abattus ou trouvés morts; (2) relevés des cas de prédation confirmés de lynx sur le cheptel domestique; (3) annonces des indices et observations suivantes: cas de prédation sur des ongulés sauvages, empreintes, pistes, excréments, observations visuelles et cris de lynx. Basés sur les moyens de vérification applicables pour

les différents indices, nous distinguons 3 catégories de qualité des observations: la qualité 1 englobe tous les indices vérifiables tels que des lynx trouvés morts ou récupérés vivants et des photos de lynx. La qualité 2 comprend toutes les données rapportées par des personnes formées, avant tout des gardes-faune, concernant des cas de prédation sur le cheptel domestique et sauvage, empreintes, pistes et excréments. La qualité 3 regroupe les cas de prédation sur le cheptel sauvage et la découverte de traces (empreintes, pistes) annoncés par d'autres personnes ainsi que les indices non vérifiables tels que des observations visuelles, des excréments et des cris de lynx. Pour la période 1995 à 1999, plus de 1600 indices de présence de lynx ont pu être récoltés. Les résultats indiquent, (1) qu'avec un nombre élevé d'indices de la catégorie 1 et 2, la population de lynx est croissante dans la région du nord-ouest des Alpes pour la période étudiée, (2) que la région de la Suisse centrale et le Valais montrent une tendance à la stagnation et (3) que le lynx est absent ou tout au plus présent sporadiquement dans les Alpes orientales suisses. Sur la base d'études de terrain menées par radiotélémetrie et des données de la qualité 2, le nombre de lynx dans les Alpes suisses est estimé à 70 individus. Pour contrebalancer cette inégalité de la distribution et du fait que l'expansion de la population de lynx suisse relève d'une importance cruciale pour la conservation de l'espace dans l'ensemble de l'Arc alpin, des lynx vont être déplacés du nord-ouest vers la partie orientale des Alpes suisses.

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