

The Lynx in the Italian south-eastern Alps

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Abstract. From 1986 to May 1995 I collected records of signs of lynx presence in the region of Friuli Venezia Giulia. A series of regularly checked trail transects, explorative excursions, and the collection of second hand observations led to a total of 150 records. They confirm lynx presence and allow an assessment of the situation. The first lynx are believed to have immigrated to the northern part of the study area from Austria. An increase and the distribution in the signs of presence show a south-westerly expansion. The trend in the Julian Alps and Pre-Alps is also increasing. Some interpretations of the status of this new population are made. The study area is in the far south-eastern Alps. This area is important as a corridor between the Alps and the Balkans, where a re-introduced lynx population exists which would be able to support the Alpine lynx population through dispersing lynx.

Introduction

The lynx (*Lynx lynx*) probably disappeared in the middle of the 19th century in the eastern Alps (Toschi 1968). It came back at the beginning of the 1990s (Molinari 1991) as a consequence of re-introduction projects in Austria (Festetics et al. 1980) and Slovenia (Cop 1977). Because of the lack of specific research into the arrival of this predator, I started an inquiry in the Tarvisiano in 1986. This area is important as a corridor between the Alps and the Balkans, and is a geographical key spot for species with long-distance migration or dispersal. It is in the centre of three areas important for lynx. In two of them re-introductions took place: in Austria in 1977 at a distance of 50 km from the Tarvisiano, and in Slovenia in 1973, 120 km away (Fig. 1). The third area is 140 km to the west, where a lynx population of unknown origin exists (Ragni 1991). The purpose of this study was to confirm lynx presence, to collect the heterogeneous records and to estimate the number of individuals.

Study area

The study area is located in the Eastern Alps and it includes an area of about 5000 km² (Fig. 1). It is made up of the Alpine region and its foothills (the Pre-Alps) in Friuli Venezia Giulia and the adjoining areas of Veneto, Austria and Slovenia. It is divided into two study sites, the first extensive and the second intensive.

Intensive study area: Conventionally called Tarvisiano, it is placed in the north-eastern part of the region (Fig. 1), bordering on Austria (Carinthia) and Slovenia. It is an area of about 500 km² whose centre is the Tarvisio Forest. The main valley, Valcanale, is divided by two drainage systems; in the east by the Slizza-Danube, in the west by the Fella-Tagliamento. The geology, the land morphology, the slope gradient, and the exposure from the west to the east of the main valley create a remarkable variety of forest and landscape forms. The mountain chains consist of the Julian Alps (altitude up to 2200 m), Carnic Alps (3000 m) and the Caravanche (1800 m). The climate is a transition between the continental and the oceanic régime, particularly favourable to a diverse vegetation. 65% of the area is covered with woods (Di Bernardo

et al. 1995), which are in a preservation state rarely met in the whole Alpine arc. These woods give way to grazing lands above the timberline in the Carnic Alps, and in the Julian Alps they rise up to the base of the rocky walls. Extended like a mosaic through the whole forest are pastures (13%). As a consequence the area has an excellent biodiversity. Sylviculture has a long tradition and the system adopted can be defined as "group shelterwood cutting". This favours the maintenance of a permanent forest and natural rejuvenation, and conserves this considerable biodiversity. The exploitation is lower than the natural increase. Agriculture is limited to the valley bottoms. Livestock-farming is not very common and confined to only a few areas.

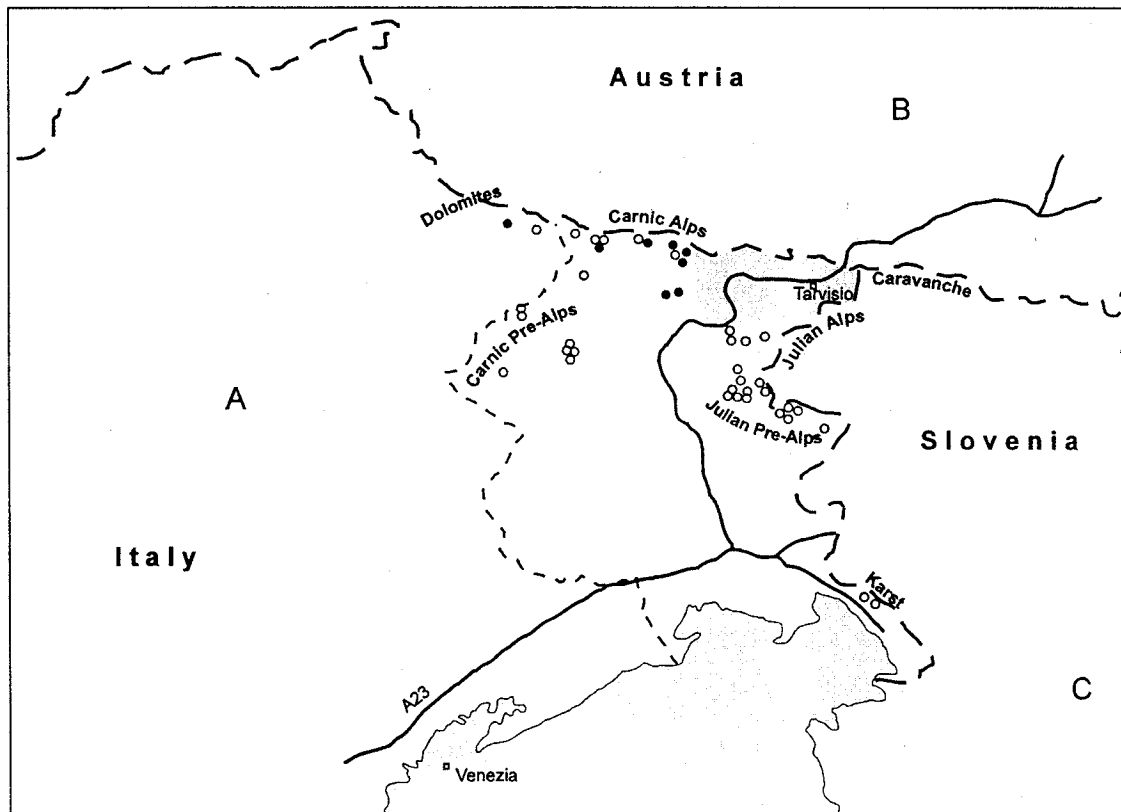


Figure 1. The location of the study area. A is the centre of a lynx population of unknown origin. B and C are the sites of re-introductions in Austria and Slovenia, respectively. Shaded area: intensive study area; points: "confirmed" signs of presence; circles: "unconfirmed" signs of presence. A23: highway.

The fauna is diverse with good sized populations. The red deer (*Cervus elaphus*) is present with about 2000 individuals, the roe deer (*Capreolus capreolus*) with 2500-3000 individuals, and the chamois (*Rupicapra rupicapra*) with about 1200-1500 individuals (which is the historical minimum, as the chamois at present is strongly affected by a *Sarcoptes scabiei* epidemic). The ibex (*Capra ibex*) is represented by a small population of 130 individuals, and the wild-boar (*Sus scrofa*) appears only sporadically. Brown hare (*Lepus europaeus*) and alpine hare (*Lepus timidus varronis*) are present in small numbers. The avifauna is rich, with a good number of grouse. All the common Alpine species of rodents and small carnivores occur. The presence of the brown bear (*Ursus arctos*), the golden eagle (*Aquila chrysaetos*), the griffon-

vulture (*Gyps fulvus*), the appearance, even if sporadically, of the bearded-vulture (*Gyps barbatus*), and the now permanent presence of the lynx show how the food chains at present continue throughout.

Extensive study area: This zone includes 4500 km² of mountain and hill areas (Fig. 1). In addition to the mountain chains mentioned before, it includes the Carnic Pre-Alps, the Julian Pre-Alps, and in the south-east the Karst. These mountainous zones descend into high lowlands, formed by rough river drifts.

The region's climate is extremely varied, presenting typically marine aspects (south-east), that become more and more alpine to the north. With the decline of the sea's influence, the precipitation level increases. The vegetation is variable as a consequence of the climate, going from typically Mediterranean characteristics of the Karst (pine-woods and oak groves) to the alpine zones with mountain forests (spruce-beech woods, larch-woods) through bands of hornbeam woods, beech-woods and chestnut woods. There is a high degree of cover and forest continuance. At present a process of considerable human depopulation is taking place, so that as time passes nature is allowed to regain precious habitat for fauna.

The fauna is represented by the same species listed for the intensive study area. In the region live ungulates which are important for feline diet, although with changing densities. Roe deer, red deer, chamois and wild-boar are common, but there is no accurate study of their population sizes. The ibex, the moufflon (*Ovis musimon*) and the fallow-deer (*Dama dama*) are also present in small nuclei.

Methods

In 1986 I started to collect records of lynx observations. At that time the study area was restricted to "Foresta di Tarvisio" (300 km²). In addition to collecting records of lynx observations, I started a preliminary survey by means of transects based on a cartographical analysis of the area of highest lynx presence recorded as well as potential lynx habitat. I always followed trails because a much greater distance can be checked per day, and I observed that lynx followed trails as well. On these transects I collected all signs of presence (see Table 1). To find further signs of presence I added explorative excursions into areas from which other people had reported lynx signs.

In 1988/89 second hand observations from the Julian and Carnic Pre-Alps, at a distance of 25 - 69 km from the Tarvisiano, started to increase and made an expansion of the initial study area necessary. As a consequence the whole study area had to be divided into an intensive (500 km²) and an extensive (4500 km²) study area.

Trail transects were periodically checked every 15 days and the explorative excursions even more often. At the beginning most field work was concentrated in the non-winter months. Later this practice was altered so that by the end of 1991, at least 60% of the field work was carried out in winter, taking advantage of the snow. Because of the size of the study area, cooperation with foresters, game-wardens, hunters and amateur naturalists became necessary. All the people involved had attended training sessions enabling them to identify signs of lynx presence. From 1988 to 1992, a Bavarian hound (Bayrischer Gebirgsschweisshund) was used; this breed is particularly effective in searching for carcasses and potential lynx kills, especially in situations where humans find tracking difficult, e.g. in the absence of snow.

The signs of presence have been divided into the categories "confirmed" and "unconfirmed", confirmed meaning that they were found by myself or collaborators, or second-hand observations that have been double-checked. Second hand observations not confirmed have been put into the category unconfirmed. The category confirmed was further divided into "certain" and "probable".

From 1988 to 1990 I collected only second-hand records of lynx presence from the extensive study area. A series of investigations started in 1990; its aim was to collect more detailed information about lynx presence and also about suitable potential habitats.

Cooperation was established during this phase with different people, but their expertise cannot be compared with the staff of the intensive study area. Promising reports were checked by the author. The data analysis was also divided into intensive and extensive study areas. In the intensive study area only confirmed records were analysed, and in the extensive one all records.

Table 1. The number and the kind of all confirmed signs of presence found in the intensive study area per year, the search effort and the observations per 100 days (index).

Year	Direct observations	Tracks	Vocalization	Excrement	Kills	Total	Search effort (days)	Index
1986		2				2	70	2.8
1987		3		1	1	5	156	3.2
1988		6		1	1	8	188	4.2
1989	1	8		2	2	13	198	6.5
1990		10		1	1	12	212	5.6
1991		7		2	3	12	204	5.8
1992	3	8			3	14	180	7.7
1993		5		1	1	7	132	5.3
1994	1	4	1		4	10	124	8.0
1995		4			5	9	108	8.3
Total	5	57	1	8	21	92	1572	5.9

Results

A total of 150 signs of lynx presence were collected up to May 1995, 42 of them in the extensive, and 108 in the intensive study area. In the extensive study area 82% of the signs of presence fall in the reliability category "unconfirmed" (Fig. 1). To give a more confident picture of the situation, in the intensive study area the records belonging to the reliability category "unconfirmed" (14% of all records) were not included in the analysis. The number of signs of presence found in the different categories in the intensive study area are shown in Table 1. The first lynx observation was made in the Julian Alps as early as 1979 (Fig. 2a). The next record dated only from 1986 (Fig. 2a). In 1989 a series of pictures of a lynx chasing a marmot was taken (C. Vuerich, pers. comm.) and confirmed lynx presence. From this period to 1991, signs of presence increased (Table 1), but only in the Carnic Alps (Fig. 2a).

In the early 1990s, the signs of presence in the south-west of the intensive study area increased. In 1992 the first records were found south of the highway in the Julian Alps and the

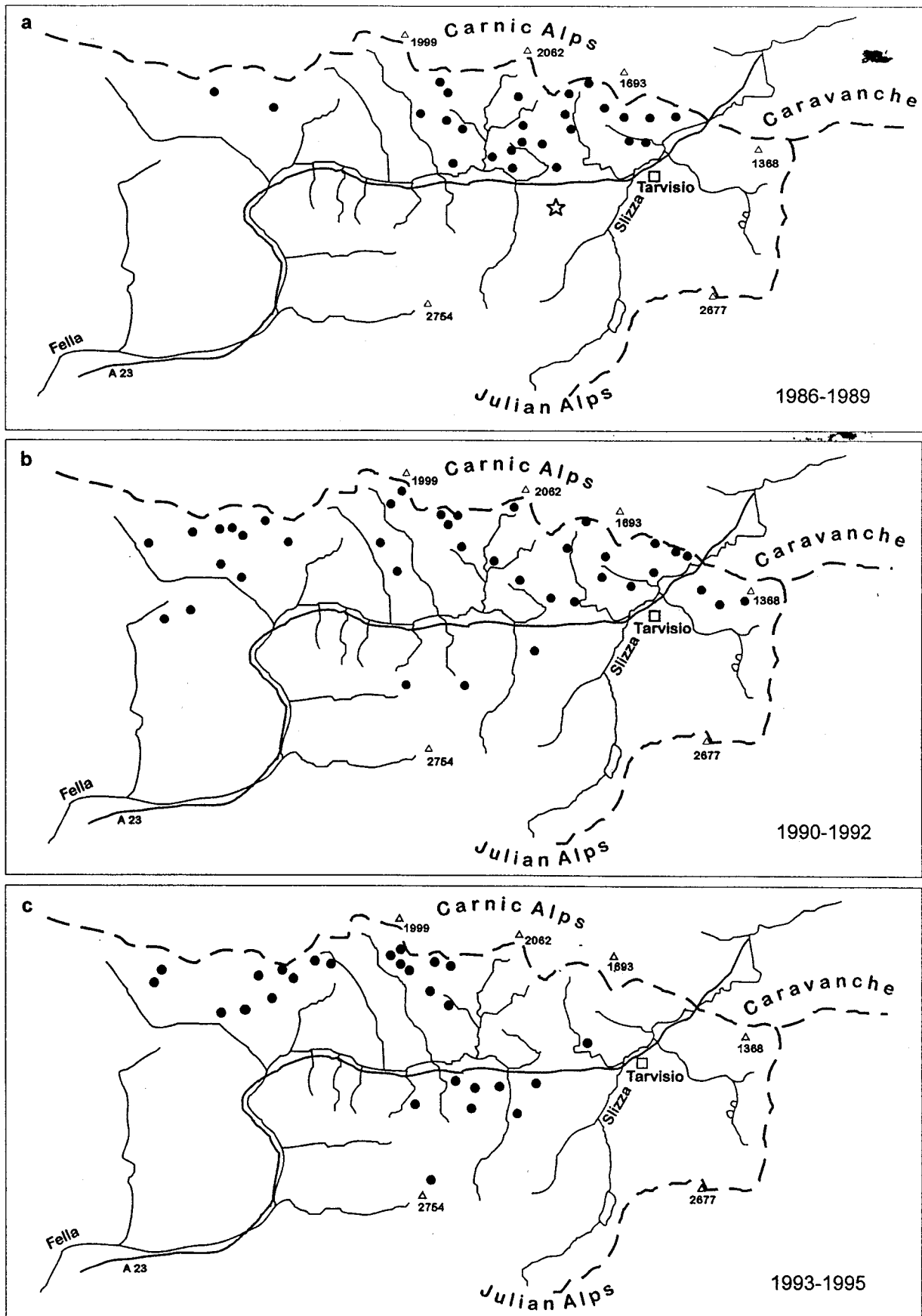


Figure 2. Confirmed signs of lynx presence in the intensive study area; a: 1986 - 89 (star: first isolated record in 1979); b: 1990 - 92; c: 1993 - May 1995. Lines: rivers; broken line: state boundaries; A23: highway; triangles: major mountain peaks with altitude.

Caravanche (Fig. 2b). In the period from 1993 to May 1995 the signs of presence south of the highway and in the south-west increased further (Fig. 2c). These trends exist in the extensive study area, too. The south-westerly expansion already noticed in the intensive study area was also observed in the extensive one. In 1993 the first sign of presence was found in the region of Veneto and a remarkable number of records collected during the last two years comes from the Julian Alps and Pre-Alps. Correlating the search effort per year with the collected signs of presence according to time, we can see a slightly increasing trend (Fig. 3). Despite a reduced search effort in recent years, the number of signs of presence found remain high. This trend seems to be true for the extensive study area, too, but was not shown because of the weakness of the data.

The number of kills found has increased since 1991; in particular the predation on red deer has obviously gained in importance (Table 2). Seven out of eight red deer kills were found only in the past two years; 88% of the kills in this period were red deer.

Table 2. The number and species of kills found per year in the intensive study area.

Year	Roe deer	Chamois	Red deer	Hare	Marmot	Capercaillie	Sheep	Total
1987	1							1
1988				1				1
1989	1				1			2
1990	1							1
1991		1	1			1		3
1992		1					2	3
1993	1							1
1994	1		3					4
1995	1		4					5
Total	6	2	8	1	1	1	2	21

Some anecdotal observations allow assumptions to be made on the number of lynx in the intensive study area: in spring 1994 in the slope of the Carnic Alps of the Tarvisio Forest, it was possible to hear two distinct individual lynx during the mating season (confirmed also by the tracks). In the meantime, tracks were found in a different area of the Julian Alps, confirming that at least three individuals were present in the intensive study area.

Discussion

The surveys were very variable because of the different search effort each year, the presence or absence of the dog, and the extremely varying weather conditions (snow). Together with the searcher's increasing experience, this had an influence on the finding signs of presence. Nevertheless the first aim of this study - to confirm lynx presence - has been fulfilled.

The first record of a lynx observation in 1979 in the Julian Alps remained isolated for years. The origin of this animal is not known. At that time the highway A23 Udine-Villach had not been built. This might be the reason why the lynx could belong to the population re-introduced

in Slovenia in 1973 (Cop 1977) or to the one re-introduced in Austria in 1977 (Festetics et al. 1980).

In the 1990s the lynx are believed to have immigrated to the northern part of the intensive study area from Austria (Fig. 2a). Data from the neighbouring regions support this assumption. In Carinthia (A) lynx presence had been confirmed (Huber 1995) whereas in the south, in the Julian Alps and also in the adjacent Slovenian region, no evidence had been found up to then. The first signs of lynx presence south of the highway date back to 1992. It is difficult to judge whether these individuals immigrated from the south, from the re-introduced population in Slovenia, or from the north, from the lynx that had already settled in the Carnic Alps. I believe these individuals immigrated from Slovenia because the highway separating the Carnic from the Julian Alps could represent an almost invincible barrier. Observations from the neighbouring Slovenian territory also support this interpretation (J. Cop, pers. comm.).

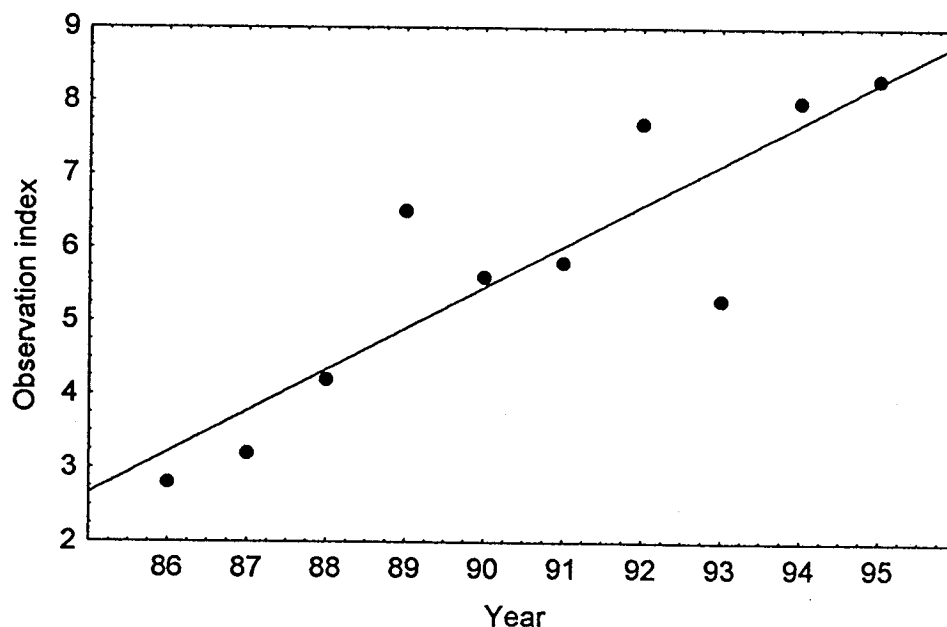


Figure 3. Observation index (ratio of signs of lynx presence per 100 days of search effort; Table 1) per year. The regression ($y = -44.94 + 0.56x$; $R = 0.875$, $P = 0.001$) indicates an increasing trend of lynx presence in time.

The increase and the location of the signs of presence that extend westwards to the Dolomites as well as southwards to the Carnic Pre-Alps (Fig. 1) indicate a south-westerly expansion. In the Julian Alps and Pre-Alps the trend is increasing, too. The continuity of suitable habitat without a biogeographical barrier between the Alpine regions of Italy and Slovenia suggest increasing immigration from the high density Slovenian population (J. Cop, pers. comm.). This speculation is supported by the fact that hunting pressure has decreased in Slovenia (in particular at the borders) since 1993 (J. Cop, pers. comm.).

The interpretation of the expansion of the area occupied by lynx raises many questions. Did individual lynx increase their home ranges or did the number of individuals increase? Did the lynx in the study area reproduce (as yet there is no evidence) or were there always new immigrations? Are we still facing a colonisation phase (hence with its own dynamics) or a thriving population? To answer these questions we need to know the spatial distribution or density of

the lynx, their age structure and sex ratio. Breitenmoser and Haller (1993) postulated that in the first phase of lynx expansion, a high number of predators would feed on a dense population of naïve prey that were easy to kill. This high predation results in decreased prey availability and induces a second phase, where the predators hunt over a larger area and consequently have larger home ranges. Before expanding their home ranges, the lynx included unusual prey, such as domestic sheep, into their diet due to the reduced availability of roe deer and chamois. The decrease in observations in the intensive study area on the one hand, as well as the surprisingly high predation on the exceptional prey, red deer, since 1994 indicate that in the intensive study area the lynx could already be in the second phase. The small number of sheep and the high number of red deer in the intensive study area would explain why the lynx switched to red deer. A temporary increase in predation on red deer was also observed in Austria some years after the re-introduction of lynx (Gossow and Honsig-Erlenburg 1986). Another reason why lynx switched to red deer might be the reduced availability of roe deer and because the best alternative prey, the chamois, suffered a decrease through *Sarcoptes scabiei*. There is only a little evidence for both hypotheses so far. To get an idea of lynx density in a certain area, the spatial organisation of individuals has to be known (Breitenmoser et al. 1993). The use of radio-telemetry could reveal more about the spatial organisation of this secretive cat and enable the finding of more kills.

Opinions on the arrival of the lynx by the people vary. Italian hunting officials remained rather indifferent, they simply noted the return of this predator without taking a position. They seem to accept a "natural" return. The lynx is a species well protected by law. Unfortunately local hunters look on the lynx as a rival and are in favour of hunting it. Livestock predation has fortunately been low so far, and compensation will be paid for losses. Another problem that has to be mentioned here is habitat fragmentation. The Julian Alps are separated from the Carnic Alps by highway A23, a main road, and a railway line all running parallel. That is why it is important to conserve the last remaining corridors.

Large contiguous habitat and its conservation remain a key factor for lynx survival. The re-introduced Slovenian population could support both the threatened autochthonous population in the south-western Balkans and the feeble population in the Alps. This underlines the importance of the Tarvisio region as a migration corridor between the Balkans and the Alps, as has already been shown for the brown bear (Schröder 1992, Molinari 1994, Kusak and Gutleb, unpubl.).

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Riassunto

Nei primi anni 1980 la lince ricompare nelle estreme Alpi sud orientali italiane, Regione Friuli Venezia Giulia (Fig. 1). La situazione inedita e la mancanza di ricerche specifiche hanno indotto, nel 1986, ad avviare il presente lavoro. A partire dal 1988 é stata creata un'area di studio intensiva (500 km², Fig. 2a), convenzionalmente chiamata Tarvisiano, ed una di studio estensiva (4500 km²). Sono stati individuati una serie di sentieri che vengono percorsi a scadenze regolari in tutte e quattro le stagioni, con maggior frequenza nel periodo di innevamento. Vengono rilevate orme e piste su neve e terreno plastico, residui di attività varie, percezione di richiami sonori ed avvistamenti. Fino ad ora sono stati raccolti complessivamente 150 indici di presenza (Tab. 1) che hanno consentito di confermare la presenza e di elaborare un quadro generale della situazione del felide. Si ritiene che le prime linci siano immigrate a nord dell'area di studio dall'Austria (Fig. 2a). L'espansione degli indici di presenza mostra un'espansione verso sud ovest (Fig. 2b, 2c). A partire dal 1992 compaiono le prime linci nelle Alpi Giulie, a sud dell'autostrada. L'indice di osservazioni nel tempo (Fig. 3), mostra inoltre un incremento della presenza di lince. Quest'area é un'importante corridoio faunistico tra le Alpi e i Balcani. Considerata la situazione ambientale dell'area, (morfologia e stato di conservazione della stessa, distribuzione e consistenza degli ungulati), ci sono buone ragioni per credere che la lince sia destinata ad aumentare in un prossimo futuro. L'indagine é tutt'ora in corso, vi é l'intenzione di approfondirla.

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