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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 prcscnce 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 Prc-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 thc Balkans, where a reintroduced lynx population exists which would be able to support the Alpine lynx population through dispersing lynx.

Key-words: Lynx lynx, status. distribution, prey, Tarvisiano, Italy, Alps

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 of importance to lynx. In two of them reintroductions had taken place: in Austria in 1977 at a distance of SO kin 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 collate the heterogeneous records and to estimate the number of individuals.

STUDY AREA

The study area is located in the Eastern Alps and includes an area of about 5000 km^2 (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 intensive and the second extensive.

Intensive study area: Conventionally called Tarvisiano, it is placed in the north-eastern part of the region of Friuli Venezia Giulia (Fig. 1), bordering on Austria (Carinthiaj and Slovenia. It is an area of about 500 km^2 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 3000 m), Carnic Alps (2200 m) and the Caravanche (1800 m). The climate is a transi-

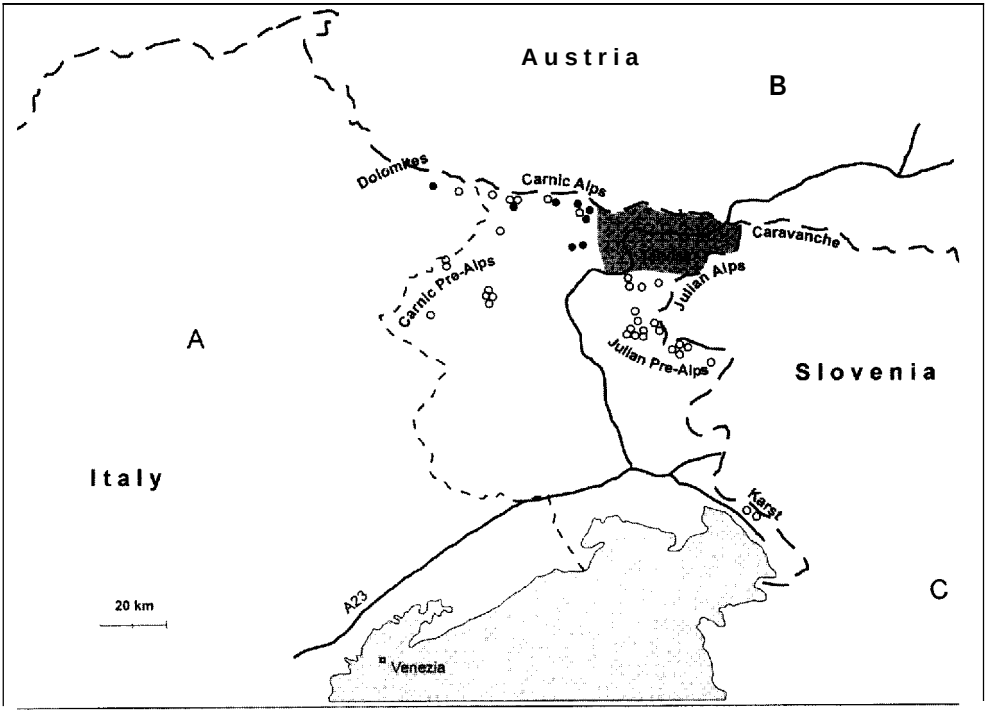

Figure 1. Location of the study area and of lynx observations adjacent to the intensive area. 1990-95. For details of the intensive area see Fig. 2. *A* is the centre of a lynx population of unknown origin. *B* and *C* are the sites of re-introductions in Austria and Slovenia, respectively. Shaded area: intensive study area. Points: 'confirmed' signs of presence. Circles: 'unconfirmed' signs of presence. Bold lines are highways (e.g. A23), bold-dashed lines are international boundaries, and a dashed line represents a district boundary.

Lion 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 state of preservation 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 cliffs. 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.

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* epidetnic). The ibex (*Capra ibex*) is represented by a small pop-

ulation 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 chrisaetos*), 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 km^2 of mountainous and hilly areas (Fig. 1). In addition to the mountain ranges 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 mediterranean 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 continuity. 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. Ungulates important to lynx diet are abundant in this region. although with heterogeneous 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 km^2). 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 could be checked per day, and I observed that lynx followed trails as well. On these transects I recorded all signs of presence (see Table 1). To find further signs of presence I added explorative excursions into areas where 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 km^2) and an extensive (4500 km^2) study area.

Trail transects were periodically checked every 15 days and the explorative excursions were carried out 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, thus 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 people involved had attended training sessions enabling them to identify signs of lynx presence. From 1988-92, a Bavarian hound (Bayrischer Gebirgsschweisshund) was used; this breed is par-

Table 1. The number and kind of all confirmed **signs** of lynx presence found in the intensive study area. Search effort was also recorded, and **a** standardized index of observations per 100 days was calculated.

Year	Direct observations	Tracks	Vocalization	Excrement	Kills	Total	Search effort (days)	Index
1986		3				2	70	2.8
1987				I	I	5	156	3.2
1988		6		I	I	8	188	4.2
1989	1	8		2	2	13	I98	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	I	8	21	92	1572	5.9

ticularly 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 were divided into the categories '*confirmed*' and '*unconfirmed*', *confirmed* meaning that they were found by myself or collaborators, or were second-hand observations that had been double-checked. Second-hand observations not confirmed were 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; it5 aim was to collect more detailed information about lynx presence and also about suitable potential habitats. Cooperation was established during this phase with additional people, but they were not as highly trained as the staff of the intensive study area. Promising reports were checked by the author. The data analysis was also different for the intensive and extensive study areas. In the intensive study area, only confirmed records were analysed whereas all records were used in the extensive study area. An annual observation index was calculated as the number of signs of lynx presence per 100 days of search effort.

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 excluded from the analysis. The number of signs of presence found in the intensive study area are shown in Table I. The first lynx observation in the Julian Alps was made 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 thus confirmed

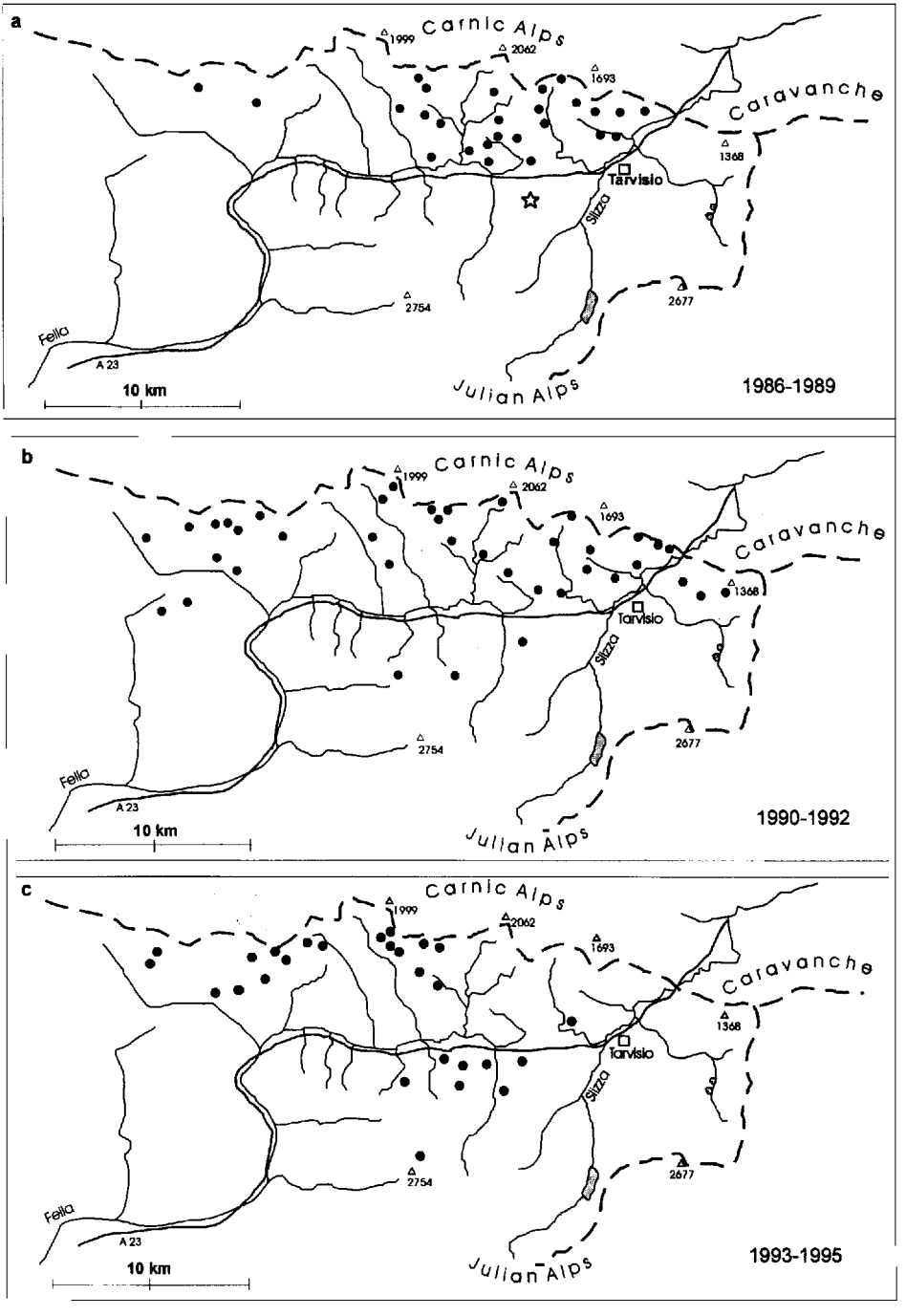

Figure 2. Confirmed signs of lynx presence in the intensive study area; (a) 1986-89 (star: first and isolated record in 1979); (b) 1990-92; (c) 1993 - May 1995. Lines: rivers; broken line: state boundaries; bold line: highway A23; triangles: major mountain peaks (with altitude).

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

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 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 existed 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 came 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 that were found remained high. This trend also seemed to apply for the extensive study area. but was not shown here in detail because of weak data.

The number of kills found has increased since 1991: the predation on red deer has probably become more important in the nineties (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.

Some anecdotal observations allow conclusions about 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 tracks). In the meantime, tracks were also 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 a dog, and the extremely varying weather conditions (snow). Together with the searcher's increasing experience, this had an influence on 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

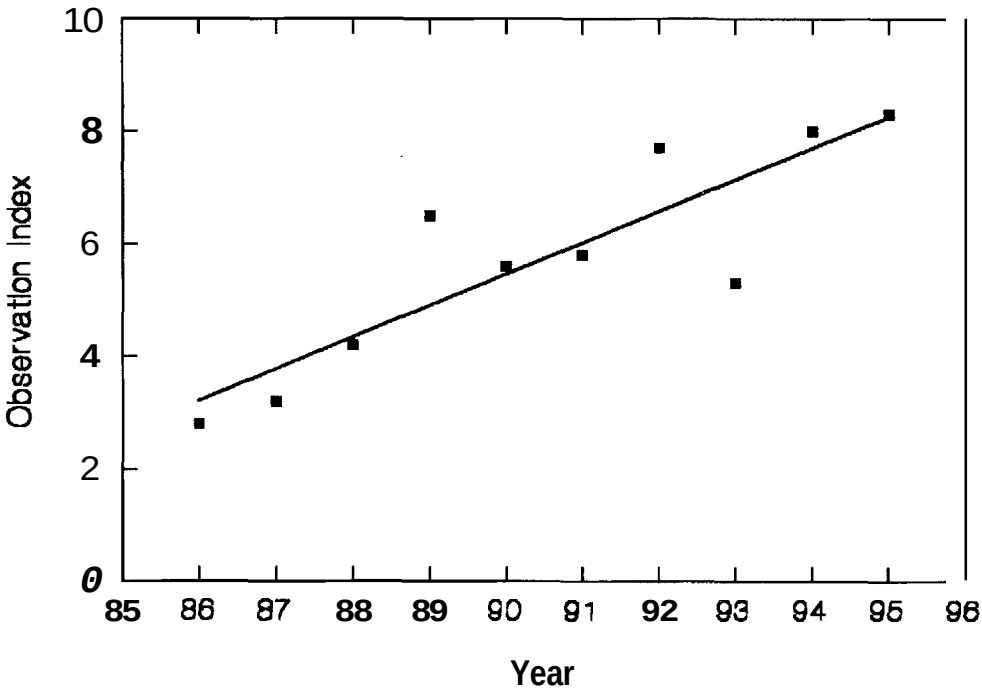

Figure 3. Observation index (ratio of signs of lynx presence per 100 days of search effort; Table 1) per year. The regression ($y = -44.93 + 0.56\,x$; $R = 0.875$, $P = 0.001$) indicates an increasing trend of lynx presence in time

for years. The origin of this animal is not known. The highway A23 (Udine-Villach) had not been built at that time. and this lynx may have emigrated from the population re-introduced in Slovenia in 1973 (Cop 1977) or perhaps from the one re-introduced in Austria in 1977 (Festetics et al. 1980).

In the 1990s, 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 hypothesis. In Austrian Carinthia, 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 by then. The first signs of lynx presence south of the highway originated from 1992. It is difficult to judge whether these individuals immigrated from the south, from the re-introduced population in Slovenia, or from the northern population already established in the Carnic Alps. I postulate that these individuals immigrated from Slovenia because the highway separating the Carnic from the Julian Alps may represent barrier. Observations from the neighbouring Slovenian territory also support this interpretation (J. Cop. pers. comm.).

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 population in Slovenia (J.Cop, pers. comm.). This speculation is further supported by the fact that

hunting pressure has decreased in Slovenia (in particular near the borders) since 1993 (Cop and Frkovic 1996).

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 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 nai've prey that were easy to kill. This high predation results in decreased prey availability and induces a second phase, with predators hunting over a larger area and consequently having larger home ranges. Before expanding their home ranges, 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 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 little evidence for both hypotheses so far. To get an idea of lynx density in a certain area, the spatial oganisation of individuals has to be known (Breitenmoser et al. 1993). The use of radiotelemetry could reveal more about the spatial organisation of this secretive cat and enable the finding of more kills in our region.

Attitudes towards the arrival of the lynx vary among the people of the region. 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, and the lynx has been well protected by law. Unfortunately. local hunters consider lynx 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 both a major highway (A23) and a railway line running parallel. Therefore. it is important to conscrvc thc 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 corridor between the Balkans and the Alps, as already shown for the brown bear (Schroder 1992, Molinari 1994. Kusak and Gutleb, unpubl.).

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RIASSUNTO

Nci primi anni 1980 la lince ricornpare 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 presentc lavoro. A partire dal 1988 é stata creata un'area di studio intensivo (500 km^2. Fig. 2a), convenzionalmente chiainata Tarvisiano, ed una di studio estensivo (4500 km^2). 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 nevc e terreno plastico. residui di attività varie, percezione di richiami sonori ed avvistamenti.

Fino ad ora sono stati raccolti complessivamente 150 scgni di presenza (Tab. 1) che hanno consentito di confcrmare 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 dei scgni 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 (numero segni di presenza in relazione allo sforzo di campionamento * 100 giorni, Fig. 3), mostra inoltre un incremento della presenza di lince. Quest'area e un importante corridoio faunistico tra le Alpi e i Balcani. Considerata la situazione ambientalc 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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