

## THE LYNX IN THE ITALIAN ALPS

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**ABSTRACT** - *Lynx lynx* has spontaneously recolonized the Italian Alps, coming from the populations created by reintroductions in neighbouring countries. The study period began in 1976 with a survey carried out by Ragni, and since 1987 it has continued with a detailed monitoring programme. The first evidence of the species dates back to 1980-1982. In this work the techniques of the naturalistic method have been used to investigate the distribution, evidence for reproduction, and estimate the population size. In the last 15 years the area used by the lynx has progressively increased. Six reproductions have been observed. The size of the population was estimated at about 21 individuals (Central-Eastern Alps). Within the time period considered, the illegal killing of two individuals was recorded. Additionally there is some information about six other poached lynx. Livestock damage has not been reported recently.

**Key-words:** *Lynx lynx*, status, Italy, Alps

### INTRODUCTION

The autochthonous Italian population of lynx (*Lynx lynx*) disappeared in the Alps between the end of the XIX century and the first quarter of this century. The last record in the Western Alps originated from 1909 (stuffed specimen from Valdieri, Cuneo), whereas in the Central and Eastern Alps similar records date back to the 1830s (Valtellina, Sondrio and Cadore, Belluno). As a result of reintroductions carried out in several adjacent countries during the 1970s and 1980s, signs of lynx presence have now been found again in the Italian Alps almost 100 years after its extinction (Ragni and Possenti 1991).

From August 1976 through May 1987, Ragni carried out a survey in specific sampling areas of the Italian Alps (from the Ligurian Alps through the Julian Alps), as well as of the Southern French Alps, Southern Swiss Alps, Carnic Austrian Alps and Slovenian Alps. The survey aimed at gaining information and collecting records and observations,

in order to develop working hypotheses on whether and how the reintroductions in neighbouring countries have led to an established lynx population in the Italian Alps. For this survey, a system of objective indices of lynx presence was applied.

By May 1987, 14 cases of lynx presence had been recorded in the Italian Alps, and six others were found in the Austrian and Slovenian Alps very close to the Italian border. The observations suggested the presence of the lynx in clusters. In the vast region consisting of the central-western Alps west of Stelvio, claims of lynx presence were not supported by objective evidence. This survey was then followed by a more intensive investigation carried out at three different levels:

- **Intensive Study Area**, situated in the Southern Dolomites of Trentino, between Val di Fiemme and Val Sugana, on the border between the provinces of Belluno and Bolzano. Most of our sampling effort concentrated on this area.

- **Extensive Study Area**, corresponding to the Alpine Italian sub-region. east of Stelvio. Here we took advantage of local collaborators (game and forestry wardens).
- **Central-Western Alps**, where a monitoring effort on sampling areas was carried out by applying the same method as in the previous survey.

## METHODS

The study was carried out employing all the procedures of the naturalistic method which mainly consist in the collection of direct or indirect observations of the presence and activity of the species under study. without capturing, manipulating, or placing markers on the animals. Indices of Presence (IP) were defined as follows: direct observation of the animal, hearing its vocalization, tracks and trails, fecal and urine deposits, food remains, scratchings on trees. In addition, a collection of itnages and materials was made for collaborators and for diagnostic purposes in those cases in which records were difficult to identify (Ragni et al. 1993). We have considered only the IP correctly determined by researchers or by trained operators, and those for which we have an objective documentation.

## RESULTS

Reintroduction programs of lynx are not known to have been carried out successfully in Italy, and there are reasons to believe that unauthorised reintroductions have not been attempted (Vetrino 1989). The results of the initial survey, and of the more articulate research program which is still in progress, can be discussed by considering four 5-year periods: 1975-1979, 1980-1984, 1985-1989, 1990-1994.

From 1975 to 1979, there were no records from the Italian Alps according to the Objective Indices of Presence of the lynx. Dur-

ing the following 15 years the situation in the same region has experienced an intense evolution in this respect.

In the following we will consider areas with presence of lynx (Fig. 1). These areas are formed by UTM grids of 10x10 kilometers, in which lynx have been recorded for at least three years in a 5-year period (with the exception of the districts F and G where the presence of the lynx were observed in 1992/93).

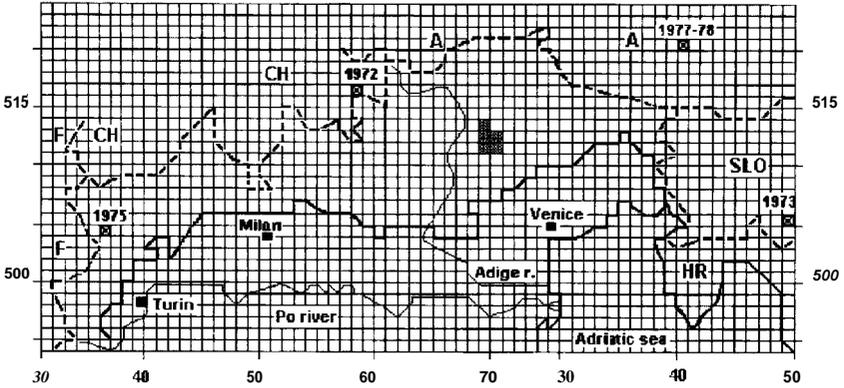
- A: Eastern Trentino-Lagorai
- B: Carnic-Julian Alps
- C: Western Trentino-Adamello Brenta
- D: Eastern Alto Adige
- E: Belluno Dolomites
- F: Ossola Valley (Novara)
- G: Aosta Valley (Aosta)

The temporal progression that can be considered stabilized is the following: since 1982 in Eastern Trentino-Lagorai; from 1985 in the Carnic-Julian Alps; from 1990 in western Trentino-Adamello Brenta and eastern Alto Adige; from 1992 in the Belluno Dolomites; from 1991 in Ossola Valley, and Aosta Valley.

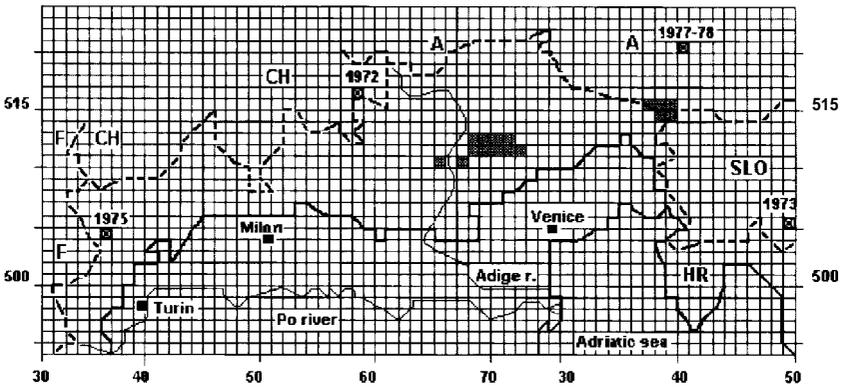
Based on the quantity and quality of the indices of presence, it was possible to put forward hypotheses on the expansion dynamics of the lynx. The lynx population present in the eastern Trentino-Lagorai (A), has probably originated from individuals belonging to the Slovenian-Austrian population. The population of the Carnic-Julian Alps (B) is very likely the remote result of either the Slovenian or Austrian reintroduction. or of both of these. The population of Adamello-Brenta and western Trentino (C), could have originated as a result of a process of new colonization of individuals coming from the eastern Trentino-Lagorai population.

Also, the population of eastern Alto Adige (D) could have originated from the eastern Trentino-Lagorai population, or be the result

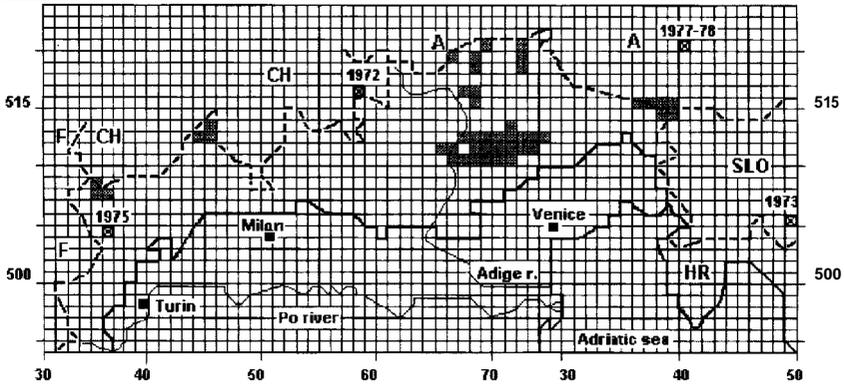
1980-84



1985-89



1990-94



**Figure 1.** Distribution of *Lynx lynx* in the Italian Alps. Shaded 10 km x 10 km squares represent objective indices of lynx presence in at least 3 of 5 years during a monitoring period. Sites of authorized reintroductions are marked with the specific year. The bold black line indicates the southern boundary of potential lynx habitat (distribution of spontaneous woody vegetation and roe deer *Capreolus capreolus*). The 10 km grid is based on the Universal Transverse Mercator (UTM) coordinates of the official state map (I.G.M.I.).

of the Austrian reintroduction. The population of the Belluno Dolomites (E) is very likely derived from the population of eastern Trentino-Lagorai. With respect to the upper Ossola Valley (F) and upper Aosta Valley (G), it is possible to exclude the colonization by other Italian populations of the eastern Alps. The most likely origin could alternatively be from the Swiss population.

#### LEGAL SITUATION AND DAMAGE TO LIVESTOCK

The new legislation on the "Rules for the protection of wild animals and for game management" (n. 157) of 11 February 1992 included the lynx among the species to receive special protection. Violations of these dispositions (that is killing, capturing or keeping protected mammals or birds) are punished with two to eight months in prison, or a 1.5 to 4 million lire fine. This means that until this legislation was passed there was no sanction for the capture or killing of individuals of the Eurasian lynx. The protection the species enjoyed was only indirect, by not being included in the list of animals allowed to be hunted. Explicative of the past legal situation is the story of the killing of a lynx in September 1989 in Roncogno (Trento). After a long legal dispute the hunter responsible for the killing was fined 600,000 Italian lire, the fine for the illegal killing of a roe-deer. The only case of recorded livestock damage attributed to the lynx, is the killing of a dozen sheep and goats, in April-May 1993, near Malles (BZ; Ragni et al. 1987).

#### ILLEGAL KILLINGS

The only two officially recognized incidents of poaching lynx in Italy occurred in 1981 at Aldino (Bolzano), and in 1989 at Roncogno (Trento). A third individual found died probably from natural causes, Although of-

ficial data are not available, it seems that since 1989 at least six individuals have been killed by hunters in Trento province alone. These killings have never been reported, and consequently it was not possible to collect any of the carcasses.

#### DEMOGRAPHIC ASPECTS OF THE LYNX POPULATION IN THE TRENTO

Table 1 presents basic data of the lynx population in the intensive study area.

A direct evaluation of the adult population of the lynx in the intensive study area is available for the year 1989 from intensive and continuous snow-tracking during winter and spring (Ragni and Possenti 1991). Based on this information, it is possible to obtain, through comparison and proportion with the consistence indices of the population, an estimate for evaluations for the 5-year period 1987-91 (Table 2).

These values correspond to a population density of the lynx in the intensive study area (considering the effective ranges of the lynx, Minimum Area Method = the area within the minimum convex polygon), in 1991, of 0.0056 individuals per square kilometer, that is, 1 adult per about 180 square kilometers. Based on the above observations, it is possible to estimate 0.5 individuals per 10 kilometer block. This was calculated in clusters of adjacent squares where the lynx was found for 3 consecutive years, in a minimum number of two squares. This density appears consistent with the density of an established population in the Alpine environment. A density of 1 individual per 100km<sup>2</sup>, in "convenient habitat", is in fact estimated with a combination of naturalistic and radiotelemetric methods in the Southern Swiss Alps. Consequently an estimate of the present (December 1994) lynx population in the Italian Alpine Region is 21 individuals, as resulting from the 42 squares considered above.

Table 1. Data on lynx occurrence in the intensive study area over the period 1987-91. (1) year; (2) number of transects visited (sampling effort); (3) number of transects with at least one index of presence (observed); (4) number of indices of presence collected in (3); (5) effective range of the lynx in km<sup>2</sup> assessed through the minimum convex polygon; (6) abundance index evaluated as (3)/(2); (7) consistence index of the population determined as (5)times (6); (X) estimate of the adult population in the effective range of 1989; (9) estimate of the adult population obtained through comparison and proportion between (7) and (8).

| (1)<br>Year | (2)<br>Transects<br>visited | (3)<br>Transects<br>with<br>IP>1 | (4)<br>Total<br>number<br>of IPs | (5)<br>Lynx<br>range<br>(km <sup>2</sup> ) | (6)<br>Index<br>of abundance | (7)<br>Consis-<br>tence<br>index | (8)<br>Adult<br>animals<br>in 1989 | (9)<br>Estimate<br>of adult<br>animals |
|-------------|-----------------------------|----------------------------------|----------------------------------|--|------------------------------|----------------------------------|------------------------------------|--|
| 87          | 22                          | 7                                | 18                               | 149  | 0.32                         | 47.68                            |                                    | 0.63                                   |
| 88          | 38                          | 16                               | 45                               | 229  | 0.42                         | 96.18                            |                                    | 1.27                                   |
| 89          | 53                          | 28                               | 77                               | 429  | 0.53                         | 227.37                           | 3                                  | 3                                      |
| 90          | 75                          | 33                               | 93                               | 896  | 0.44                         | 392.24                           |                                    | 5.175                                  |
| 91          | 225                         | 100                              | 279                              | 1062.5                                     | 0.44                         | 467.50                           |                                    | 6.17                                   |

Table 2. The estimated number of adult individuals of lynx in the intensive study area. based on snow-tracking in winter and spring.

| 1987 | 1988 | 1989 | 1990 | 1991 |
|------|------|------|------|------|
| 1    | 1    | 3    | 5    | 6    |

## REPRODUCTION

By applying the naturalistic method, two distinct phases in reproductive behaviour were identified: (1) Courting, behavioural interactions between partners, and (2) The presence and the activity of dependent kittens and yearlings. In principle, indices of presence relative to the two phases can be found year-round. Nevertheless, the best chances to find them are during snow cover, which usually lasted from October-November until May-June.

The distribution and the expected frequencies of phase (1) and (2) are as follows: **Phase 1** from the second half of November through to the end of March, with maximum activity between mid-January and mid-March; and **Phase 2** with newborn and dependent kittens

from May to January-February, and independent yearlings from February to May.

Reproduction can be considered as having occurred in a given area if the following indices of presence have been found: (1) observations of mothers accompanied by kittens, and (2) the presence of young individuals who, based on their size and time of the year, can be considered not to be self-sufficient. In these cases, the presence of an adult near the young individuals, although without evidence of a relation between them, supports the hypothesis.

## ECOLOGICAL DISCONTINUITIES AS BARRIERS

From August 1982 until June 1995, 650 objective indices of presence by lynx have

been collected in Trentino. Of these, 597 alone were found in the only intensive study area from 1987 to 1995. Among these objective indices of presence, only 50 were found closer than 100 m to houses, intensively cultivated areas, or areas markedly modified by human activity. These observations, however, were consistently located in the center of a 1 km<sup>2</sup> block of landscape with >75% herbaceous or woody spontaneous vegetation. One site was an area with an ecological discontinuity of human origin but the distances to spontaneous vegetation were always <100 m. Based on these observations, we postulate that an ecological discontinuity of human origin wider than 200 meters, crossing the range of a lynx population, may represent a barrier difficult or impossible to overcome.

With respect to non-anthropogenic ecological factors, the presence of perennial bodies of water such as rivers or lakes can be considered major barriers. The altitude of mountain passes in the central-eastern Alps did not influence the movements of lynx.

In Trentino, as in most parts of the Alpine Region, permanent settlements, power lines, intensive cultivation, perennial bodies of water, etc. are usually located in the valleys and often occupy a large space. Therefore, they form a permanent ecological discontinuity between the two mountain slopes, which is often growing less penetrable over time.

Biological conservation and wildlife management have long shown the need to keep a high genetic diversity in populations, and to preserve 'corridors' that will allow genetic exchange with populations living in areas ecologically separated. If these two conditions are not met, the populations may move towards extinction. The presence of large ecological and biogeographical barriers over the entire Alpine region needs careful evaluation with respect to conservation of the lynx. The problems addressed above demand the assessment of the genetic variability in

these small and fragmented populations.

Two main conditions guarantee a high degree of genetic variability in a new population:

(1) Ancestors originate from a large population that was at a Hardy-Weinberg equilibrium.

(2) Unselective 'sampling' of founders from a source population as a result of human choice for re-introductions.

In the case of the new population of *Lynx lynx* in the Eastern Italian Alpine region, none of the two requirements are met. The most likely origin of the Central Eastern Italian Alpine population is Slovenia, although co-origin from the Carinthian population is possible. The Slovenian neo-population originated artificially in 1973, starting with three males and three females. The Carinthian population, of similar origin, originated in 1977-78 from six males and seven females. In Slovenia, the population experienced a constant malthusian growth with immediate establishment and continuous expansion. In Carinthia, the population establishment was only observed in the early '80s. All the founding individuals were provided by the Ostrava Zoo, the only institution capable of providing lynx for re-introductions before 1985 (Vetrino 1989). Although these animals were supposedly taken from the wilderness, there are reasons to believe that some of them may have been raised in captivity. For all founders, the origin, close or remote, is Slovakia.

From the above considerations it is possible to picture the following situation. Of the lynxes present in the Italian Alpine region, about 20 adults are probably at the 5th-6th generation starting from the founders, and confronted with serious genetic problems. Open questions thus remain: (1) What is their degree of inbreeding? (2) Do they represent a minimum viable population? The inbreeding hypothesis should be tested by an accurate screening of the genetic variability by means of macromolecular, en-

zyme-genetic, morphological and ethological methods.

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#### RIASSUNTO

La lince è scomparsa dalle Alpi italiane all'inizio di questo secolo. Dopo che nei primi anni settanta ed ottanta in diversi paesi confinanti sono stati effettuati programmi di reintroduzione della lince (Breitenmoser et al., Huber and Kaczensky, Cop and Frkovic, nella presente pubblicazione), alcuni animali hanno fatto la loro ricomparsa anche nelle Alpi italiane. Per ricostruire la possibile dinamica dell'evento di ricolonizzazione, come pure per ottenere informazioni su potenziali eventi riproduttivi e sulla espansione della popolazione di linci, dal 1976 abbiamo cominciato ad effettuare un monitoraggio che doveva segnalare la presenza della lince attraverso diversi indici di presenza (osservazioni dirette, tracce, fatte, graffiature).

Nel 1981 si ebbe, nel Trentino, il primo indice di presenza oggettiva di una lince. Queste linci probabilmente appartengono alla popolazione reintrodotta in Austria e Slovenia. Nei successivi 15 anni avvenne una espansione di questa popolazione come pure una colonizzazione di aree nuove ad oriente ed occidente del Trentino (Fig. 1). Ad occidente (Ossola, Aosta), si presume

che le linci siano di provenienza svizzera. Durante il corso dello studio, nell'area centrale di indagine (Trentino) abbiamo potuto confermare sei volte la riproduzione di linci (Tab. 3); la popolazione oggi viene stimata in 20 individui. Danni nei confronti di animali domestici sono stati osservati solo una volta, mentre sono conosciuti 2 casi illegali di abbattimento di lince. Di altri 6 casi di bracconaggio, a partire dal 1989, purtroppo non abbiamo una conferma ufficiale, non è stato possibile analizzare i cadaveri.

Problemi ecologici (antropizzazione) e geografici (laghi, fiumi) hanno come conseguenza che la popolazione italiana di linci in Trentino risulti isolata e soffra quindi probabilmente di una perdita di variabilità genetica. Tutti gli individui presenti derivano da poche coppie di animali utilizzate nella reintroduzione in Slovenia, che oggi costituisce il serbatoio. Generalmente piccole popolazioni isolate non sono in grado di sopravvivere a lungo, per questo è bene sin da ora includere nei piani di reintroduzione e conservazione della lince la problematica delle barriere.

Per stabilire se le linci delle Alpi italiane sono seriamente esposte a problemi di carattere genetico (inbreeding) o se rappresentano una popolazione vitale, deve venir analizzata la loro variabilità genetica con metodologie di biologia molecolare, morfologiche ed etologiche.

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