

# MINGOZZI TONI - ESTEVE ROGER

## ANALYSIS OF A HISTORICAL EXTIRPATION OF THE BEARDED VULTURE *GYPÆTUS BARBATUS* (L.) IN THE WESTERN ALPS: FORMER DISTRIBUTION AND CAUSES OF EXTIRPATION

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### Abstract

*Historical data on the former range and the temporal pattern and causes of extirpation of the bearded vulture *Gypaetus barbatus* in the western Alps are discussed. Bibliographical and museological research provided a list of 106 reference data (about 60% of which were original), concerning a minimum of 95 detailed records (65-67 birds shot, 20 field observations and 10 nest sites). These showed that during the 19th century the species was widespread from north to south along the inner-alpine axis of the western Alps, particularly in the southern half. At the beginning of the 20th century the range was already highly reduced and only five main areas were still occupied. Reproduction ceased around 1910, while the species probably survived for a further 15-20 years (last birds shot in 1920 and last alleged observations between 1924 and 1930).*

*Extirpation appears to have been a man-induced process, in its final and decisive phase at least. It is likely that other non-human causes of decline took place at an earlier phase, but the part they played in the process is not clearly ascertainable. Human persecution peaked during the last decades of the 19th century; population quickly decreased and final extirpation took place over only three or four decades.*

Keywords: *Gypaetus barbatus*, historical distribution, extirpation, western Alps, France, Italy.

### INTRODUCTION

Between the end of the last century and the first decades of the present, four large carnivorous vertebrates, wolf *Canis lupus*, brown bear *Ursus arctos*, lynx *Lynx lynx* and bearded vulture or lammergeier *Gypaetus barbatus*, disappeared from the western Alps. The historical distribution and the

temporal pattern and causes of the extirpation of the three mammalian species on the French and Italian sides of the massif have been discussed elsewhere (Brunetti, 1984; Mingozi *et al.*, 1988; Erôme, 1989; Guidali *et al.*, 1990; Mingozi, 1995).

No recent and detailed analysis of the disappearance of the bearded vulture in this alpine sector has yet been published, with the exception of some local works (Paulus & Tron, 1944; Holloway & Jungius, 1975; Fritsch, 1976; Huboux, 1980; Mazoyer, 1985; Etienne, 1989), despite the international reintroduction project now in progress in the Alps (Frey & Walter, 1989; Coton & Estève, 1990; Frey & Bijleveld, 1993). The main papers related to this topic, going back more than 30 years, were concerned with incomplete and imprecise lists of birds shot (Moltoni, 1955; Corti, 1958, 1961), subsequently quoted by other authors (e.g. Bijleveld, 1974; Tosi, 1978; Hiraldo *et al.*, 1979).

In this paper we review the historical data on the presence of the bearded vulture in the western Alps, on the basis of systematic research of original references. Our aims are to define with greater accuracy the former range of this species and to outline the spatial and temporal pattern of its disappearance in this biogeographical region. The most probable causes of its extirpation (i.e. local extinction) are also discussed. This work provides a background to the current reintroduction project in the French-Italian western Alps.

## **MATERIALS AND METHODS**

### **Sources of data**

Research on the historical distribution relied on three potential sources of data: bibliographical, museological and public or private archives.

Bibliographical analysis entailed extensive research of all possible original references. Literature checking covered not only national ornithological journals and historical handbooks but also a number of local bulletins - zoological, natural history and alpine - game-magazines, statistical accounts or even daily newspapers (see References).

Museological research involved 22 ornithological collections. The specimen checking was done either directly by the authors or through correspondence with museum curators (see Acknowledgments). On the whole, the Municipal Museums (Nat. Hist.) of Aix-en-Provence, Annecy, Barcelonnette, Chambéry, Gap, Digne, Grenoble, Hyères, Marseille, Nîmes, Toulouse, as well as the Guimet Museum of Natural History of Lyon and the Paris National Museum of Natural History, were checked in France. In Italy, specimen checking involved the Municipal Museums of Florence (La Specola), Genoa, Milan, Rome, the Regional Museum of St Pierre (Aosta), the Craveri Museum of Bra (Cuneo) and the Turin University Museum of Zoology. Two major private collections were visited by one of us (T.M.), the Pazuconi Collection (Broni, Pavia) and the Piodi Collection (Venaria, Turin), both in North Italy.

Finally, further research was carried out in some public and private archives in Turin (State Archives, Gran Paradiso National Park and Zoological Museum).

## Data validation

Data listed in previous works on the subject were often characterized by a lack of critical analysis. Obviously, it is impossible to adjudge the reliability of historical records (excepting museological evidence); however, in the present reconstruction we attempted to validate the data by checking :

(1) the geographical location of records. As a consequence, three records (Crespon, 1840, 1889) concerning places outside the alpine region were excluded.

(2) the degree of precision and details relating to records anomalous on a spatial and/or temporal global view. As an example, live observations in Gran Paradiso National Park (Aosta Valley, Italy) up to 1956 (in Couturier, 1962) were excluded because they lacked information; similarly, the statement of Mélon (1951) that a pair was still present in the early 1950s in the Fiz Massif (Savoie, France).

(3) the different references relating to the same record. Thanks to this, a false identification was recognized for a shooting dated 1911 (Hugues, 1912 vs Hugues, 1937) and for a live observation dated 1950 (Tuccu, 1950 and Ragionieri, 1950 vs Bocca & Maffei, 1988). Moreover, a record dated 1935 for the Maritime Alps (Huboux, 1980; Cheylan, 1981) was due to a mistaken temporal interpretation of L'Hermitte's (1936) references.

All the selected records are listed in Appendices 1, 2 and 3. Appendix 1 shows in chronological order data concerning birds that were shot, caught alive or found dead. Place names are quoted in their original forms. Some additional detailed references up to 1930, i.e. live observations and breeding sites, are listed in Appendix 2, with the same format as Appendix 1. Moreover, 11 generic records of historical occurrence are listed in Appendix 3.

## RESULTS

### General aspects

Appendix 1 lists 60 records concerning 65-67 individuals, plus two nestlings, killed over a time span of 131 years (1789-1920).

On the whole, eight records were unpublished and 29 more, although published, were not quoted in the most complete previous reviews (Corti, 1958, 1961); consequently, about 60% of the list is new in some way.

Appendix 2 gives 19 records (five of which are new) concerning field sightings of live subjects (17 individuals at least) and nest sites (seven). Taking into account some other data quoted in Appendix 1 (cf. column Details, Nos 6, 16, 30, 33, 36), we relied on a minimum of 95 historical records (65 individuals shot, 20 observations and 10 nest sites); the 11 generic reports of presence in Appendix 3 lead to a grand total of 106 reference data.

### Sex, age and shooting dates

The majority of the 65-67 individuals shot (Appendix 1) were of unspecified sex (76.9%,  $n = 50$ ). For

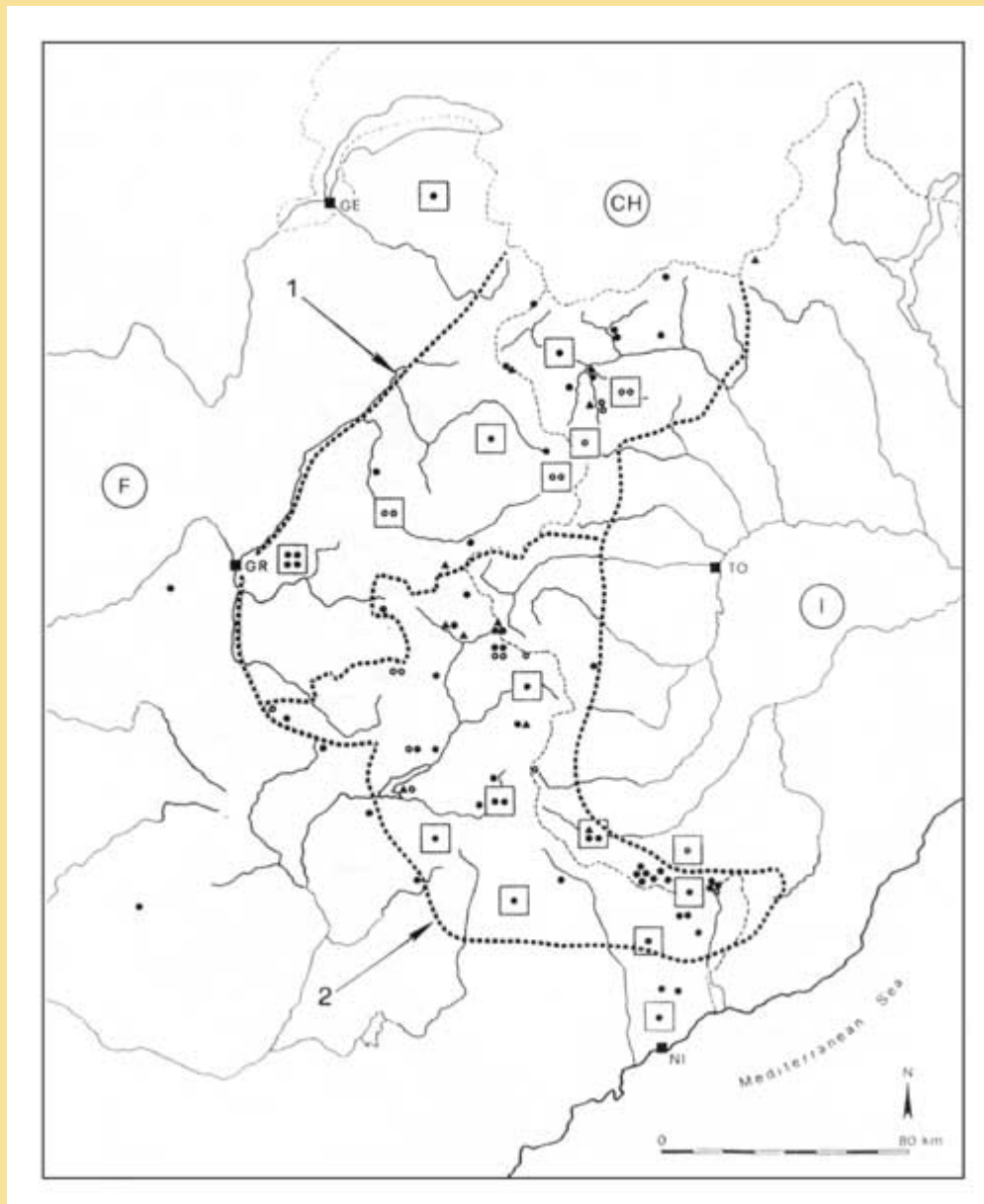
the rest, 11 were males while only six were females (data were not statistically significant according to the chi-squared test).

More than half of birds were reported to be adults (56.9%,  $n = 37$ ) and only 10.8% ( $n = 7$ ) juveniles or subadults, while the age was not specified for the remaining 32.3%,  $n = 21-23$ .

In most of the cases (77.8%,  $n = 21-22$ ), the shooting dates were related to the period December-April, which is the first crucial phase of the breeding season.

### Eco-geographical distribution

The geographical localization and distribution of the 95 more detailed records are shown in Fig. 1.



**fig. 1** - Mapping and distribution of historical records of the bearded vulture in the western Alps ( $n = 95$ ). ●, shooting records, nestlings excluded, ( $n = 65$ ); ○, live observations ( $n = 20$ ); □ nest sites ( $n = 10$ ). In boxes, records without precise locations. ---, political borders. ····, northern (1) and southern (2) part of the inner-alpin axis. GE, Geneva (CH); GR, Grenoble (F); TO, Turin (I), NI, Nice (F).

A greater frequency of occurrence in the French alpine sector is evident from the map. Of the 65-67 birds listed, 40-42 (61.5%) were killed on the French Alps, 18 (27.7%) on the Italian side and seven (10.8%) at sites on the boundary between the two countries. This difference reflects the disproportionate extent of the two alpine zones: 32.200 km<sup>2</sup> in France, 14.700 km<sup>2</sup> in Italy, i.e. 68.7% and 31.3% of the total area (46.900 km<sup>2</sup>). When the seven border records are shared between both countries the percentage values of individuals shot becomes 66.9% (F) and 33.1% (I), matching almost exactly the respective extents of the two alpine regions. If the 17 live observations are included, the ratio of historical records between the French and Italian Alps increases slightly in favour of the latter (35.4% vs 64.6%).

A general ecological analysis of data distribution is also illustrated in Fig. 1. The map shows a simplified ecological zoning of the western Alps, drawn from Ozenda (1985): the peripheral pre-alpine and oceanic sectors are separated from the inner-alpine axis, which is characterized by a prevalence of siliceous rocks and a more continental climate; the inner-alpine axis is also divided into a northern (1) and a southern (2) part, the latter being partly subject to a submediterranean climate.

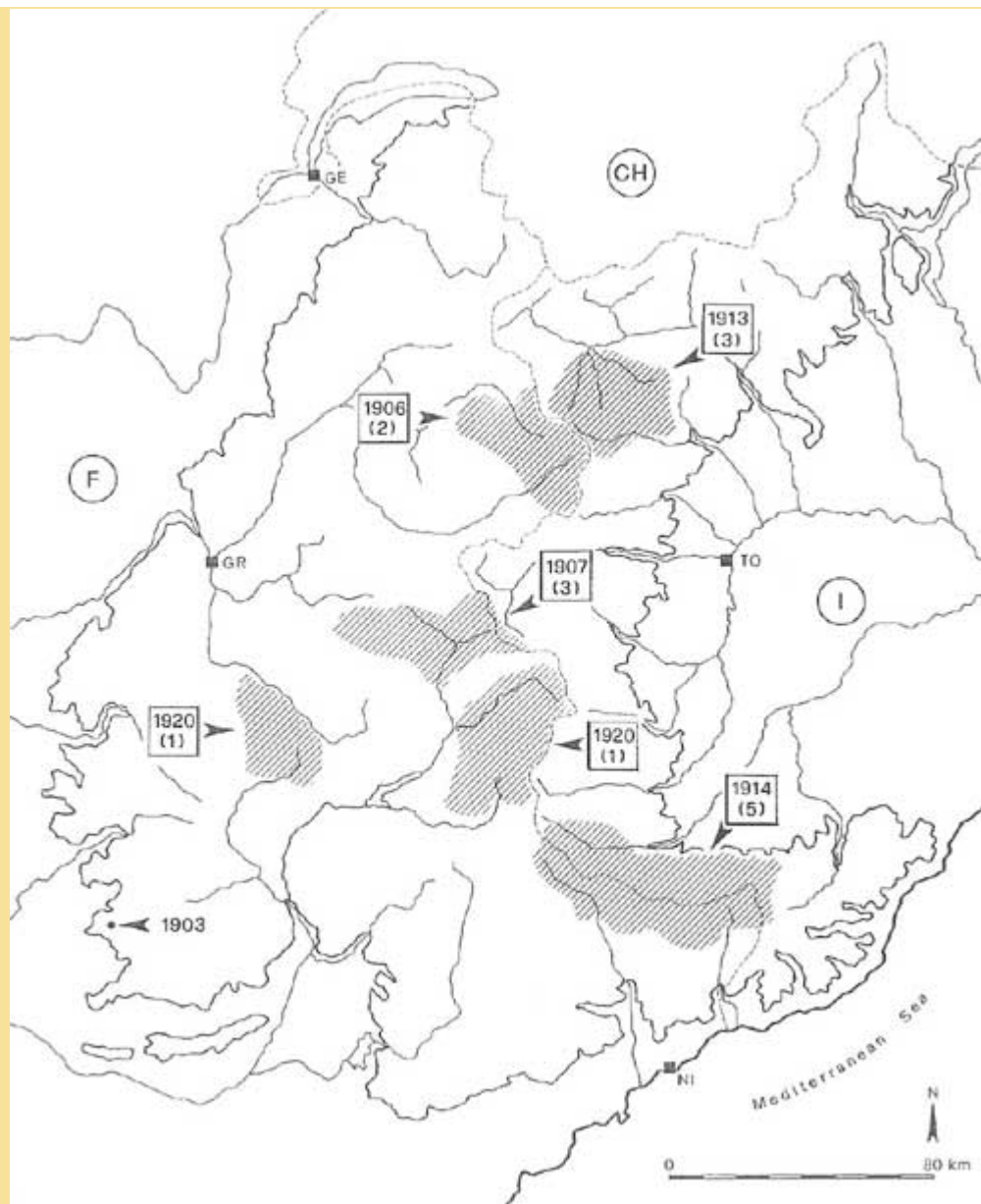
Examination of Fig. 1 shows that most of the records (90.5%,  $n = 86$ ) belong to the inner-alpine axis. Inside this zone, the records are predominantly in the southern part (62.8%,  $n = 54$ ), which includes, partially or totally, the southern Turin valleys, the Cuneo valleys and the French departments of Hautes Alpes, Alpes de Haute Provence and Alpes Maritimes. The northern part, which includes the Aosta and the northern Turin valleys and the French departments of Savoie, Haute Savoie and Isère, has the remaining 32 records (37.2%).

### **Spatial-temporal distribution.**

A temporal analysis of the historical data listed in Appendix 1 provides a picture of the changes in the range of the species from the 19th century to the early decades of the present.

Most of the records (69.8%,  $n = 74$ ) were made prior to 1900; the resulting distribution (Fig. 2) should be considered the minimal range during the 19th century. The species was widespread from north to south along the inner-alpine axis of the western Alps; in contrast, its presence was less certain throughout the external pre-alpine sectors, where only a few records occurred, with no evidence of breeding.





**fig. 2** - Last occupied areas of the bearded vulture in the western Alps at the beginning of the 20th century. In boxes year of the last shooting and, in brackets, total number of records. ---, minimal range during the 19th century for comparison (see text for details).

The remaining 32 (30.2%) references are for the years 1900-1930. The distribution (Fig. 2) shows a reduction of the range to the following areas (from north to south):

(1) the Gran Paradiso (I) and Vanoise (F) Massifs in the Graian Alps, with respectively three and two birds shot (final date: 1913) as well as the last probable occurrences in the whole alpine range (two individuals observed in 1924-1925 and 1930, and one individual in 1928, in the Gran Paradiso National Park; Festa, 1925; Blanc in Couturier, 1962; Tuccu, 1950; cf. Appendix 2, Nos 17, 18 and 19).

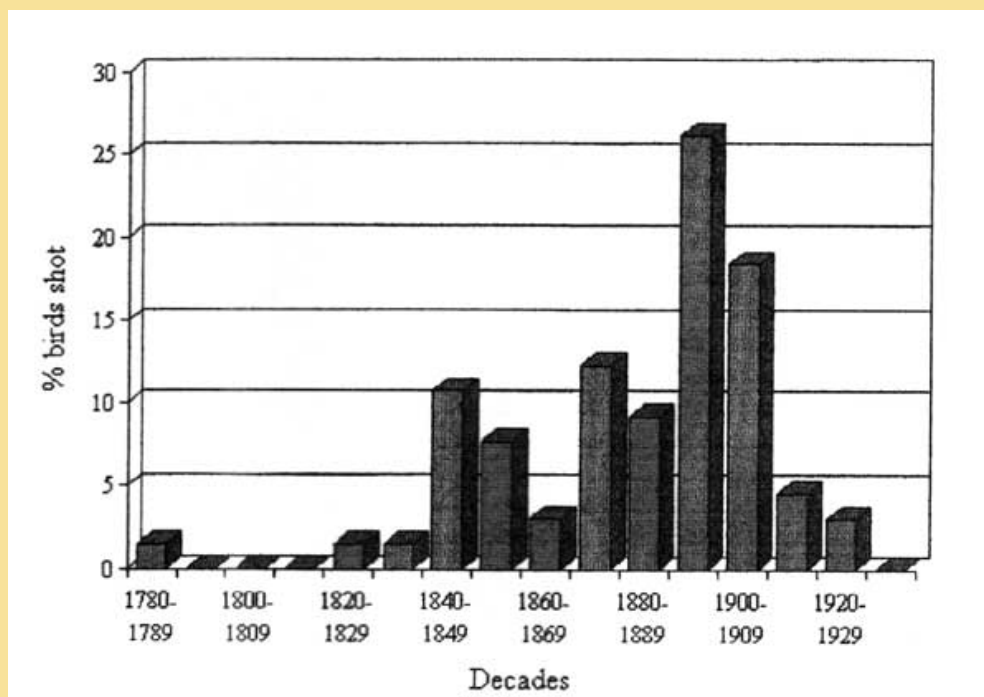
(2) the Briançonnais (Hautes Alpes, F), including the Ecrins-Pelvoux Massif (F), and the bordering part of the upper Susa Valley (I) in the Cottian Alps, from where there is the last evidence of reproduction (one breeding pair shot at Montgenèvre Pass, French-Italian border, in April 1907; Ghidini, 1907; Bonomi, 1910; Appendix 1, No. 54; Appendix 2, No. 13).

(3) the Dévoluy (Hautes Alpes/Isère, F) and the Queyras-Haute Ubaye (Hautes Alpes/ Alpes de Haute Provence, F), where the two last shootings occurred, both dated 1920 (Cheylan, 1981), together with some more generic and earlier records of presence (Appendix 2, No. 14; Appendix 3, Nos 7, 10).

(4) the Alpes Maritimes (both countries), from the Larche Pass to the Tende Pass, an area of several records, including as many as five specimens dating from 1902 to 1914 and one observation relating to 1909. In this area the species probably survived and bred (upper valley of Stura di Demonte, surroundings of Isola and Tende Pass) up to 1914/1922 at least (Ghidini, in Richard, 1914; Ghidini, 1914; Lavauden, in L'Hermitte, 1936. Appendix 3, Nos 9, 11).

Outside these areas, there is only one geographically peripheral record, coming from Mont Ventoux (Vaucluse, F) and dating 1903 (Bérenquier, 1903 in Hugues, 1937; Caziot, 1913; Appendix 1, No. 48).

The number of individuals shot per decade (years 1790/1930) is illustrated in Fig. 3; the graph shows that more shootings occurred in the decade 1890/1899, with 26.1% ( $n = 17$ ) of all records ( $n = 65$ ).



### Nest sites

Historical references provided information on the geographical location of 10 nests (see Fig. 1 and Appendix 1, Nos 16, 30, 33; Appendix 2, Nos 1, 3, 4, 6, 7, 12, 13). In most cases, this information was quite general, i.e. the name of a mountain or a pass, while more precise details were lacking. As an exception, we quote No. 16 (Appendix 1), referring to the nest destroyed in the Vallon de Ceillac (F) in April 1872, for which a quite precise site description was found in an unpublished document (P. G. Berlie, ms). Even so, this site is not precisely identifiable today (J. F. Terrasse, pers. comm.). We carried out special research into three other sites, Nos 7, 12, 13 in Appendix 2; only the first one, on the eastern cliffs of the Signal

de St Chaffrey (Briançon, F), was in some way recognizable.

Nevertheless, the historical data appeared sufficiently detailed to attempt an evaluation of the distance between neighbouring nest sites, such as the three well-documented ones for the Briançon region, i.e. No. 30, Appendix 1 (Grand Aréa, Vallée de la Guisanne), No. 7, Appendix 2 (Signal de St Chaffrey) and No. 13, Appendix 2 (Montgenèvre Pass), 9 km (No. 30 vs No. 7) and 7 km (No. 7 vs No. 13) apart. However, we do not know whether the three nest sites were ever simultaneously occupied since the data referred to a time span longer than 20 years.

### **Specimens still preserved in museums and collections**

Thirty-two specimens shot in the western Alps are still preserved in natural history museums and collections of France (18), Italy (12) and the United Kingdom (two) (23 were killed in the French Alps, seven in the Italian and two on the border of the two countries; see Appendix 1).

Despite our checking, some uncertainty regarding this list still remains. In fact, bibliographical and museological data did not always correspond, as shown by the four specimens quoted for the Grenoble Museum (F): only three of them, with incomplete and only partially matching data labels, were present in this collection (M. Dunand, pers. comm.).

Six more specimens, lacking data labels, are preserved in French museums and collections: one juvenile in Nîmes Museum (G. Gory, pers. comm.), one individual in Guimet Museum, Lyon (J. Clary, pers. comm.), one individual in Hyeres Museum (C. Nicolai, pers. comm.), two individuals in Marseille Museum (A. Delcourt, pers. comm.) and one adult in a private collection in Barcelonnette (C. Joulot, pers. comm.). The origin of these specimens remains uncertain, even though they were probably shot in the western Alps.

## **DISCUSSION**

### **Distribution of records**

Figure 1 shows a tendency of records to cluster in different alpine sectors, namely the area including the Valdieri valleys and the Tende Pass in the Italian Maritime Alps (12 records at least), the Briançon region in the French Cottian Alps (12 records) and the Gran Paradiso Massif in the Italian Graian Alps (nine records).

The two Italian alpine sectors (both protected areas today) were formerly royal game preserves of the House of Savoy; as a consequence, two factors should explain their richness of records. First, favourable habitat conditions and a consequently high population density of the species: these zones were certainly richer in wild ungulate populations (i.e. chamois *Rupicapra rupicapra* and ibex *Capra ibex*) - potential sources of food - than the surrounding areas (Richard, 1914). Thus, their ecological suitability and attractiveness had to be greater



for the vulture, just as it is nowadays (almost all of its spontaneous reappearances in the western Italian Alps between 1977 and 1980 were recorded here, Mingozzi, 1981). Second, a better availability of historical information: the shooting of every large carnivore was encouraged (see below) and normally reported to the Royal Zoological Museum of Turin.

The richness of records of the Briançon region cannot be attributed to a special source of information but was likely due to a previous high population density. On the assumption that the three reported nest sites were simultaneously occupied by neighbouring pairs, the distances between them correspond to a breeding density as high as presently estimated in the Central Spanish Pyrenees (average distance = 8.813 km; Donazar *et al.*, 1993).

### **Extirpation time pattern**

Bailly (1853) and Salvadori (1872) stated that the bearded vulture exhibited an initial population decrease in the first half of the 19th century. On the whole, historical evidence (see also Roux, 1825; Temminck, 1835; Durazzo, 1840; Jaubert & Lapommeraye, 1859) indicates that the species was widespread and common at the end of the 18th to beginning of the 19th centuries and then, 50-60 years later, quite rare in different parts of the western Alps.

Nevertheless, around 1850-1860 the total population may still have been quite substantial, even if it was probably reduced in range. A lot of birds were in fact still shot in the following 60-70 years and the vulture was still not considered rare around 1860-1870 in some alpine sectors, in particular Ubaye and Briançonnais (Berlie, 1898; Rérolle, 1900).

However, a clear pattern of rarefaction has been depicted by historical data only since the end of the 19th century. Indeed, Fig. 3 reveals a great increase in the number of birds shot during the decade 1890-1899 and then a rapid decline until final extirpation, 30 years later.

It is difficult to confirm the reality of this trend, although a very similar extirpation pattern was depicted for another alpine species, the lynx (see Mingozzi, 1995). Clearly, information was lacking before the decade 1890-1899 since shooting became an event worth reporting at the same rate as bird rarity increased.

In any case, the last juvenile vulture was shot in 1904 in the Valdieri valleys (No. 49, Appendix 1) while the last evidence of breeding was in 1907 at Montgenèvre Pass in the Cottian Alps (No. 13, Appendix 2). Since then there has been only one breeding record, more indefinite than the former and relating to the Italian Maritime Alps for 1914 (No. 9, Appendix 3), but no further killing or live observations of juvenile birds were recorded. Therefore, the data seem to indicate that reproduction stopped around 1910, while the species probably survived for a further 15-20 years (the normal life expectancy of a large raptor). Two birds were shot in 1920 in the French Hautes Alpes (see above and Appendices 1 and 2) and it seems that one or two individuals were present in the Gran Paradiso National Park between 1924 and 1930 (see above and Appendix 2). No further reliable records appeared after 1930 until the well-known spontaneous reappearance of the species between 1970 and 1980 (Tosi, 1978; Huboux, 1980; Tosi & Piantanida, 1980; Géroutet, 1981; Mingozzi, 1981).

## Causes of extirpation

Past authors (Rérolle, 1900; Lavauden, 1911) attributed the decrease of the bearded vulture populations to the disappearance of other large carnivorous vertebrates, mainly the wolf, but also the brown bear and the lynx. However, one may note that the bird also lives in areas where none of these three mammals has been present since historical times (e.g. Corsica, Crete) or where they are very scarce (Pyrenees).

Recent authors (see, for example, Géroudet, 1974; Hiraldo *et al.*, 1979; Walter, in Mundy, 1985) have stated that deliberate human persecution was the main reason for extirpation in the Alps; the same opinion was also held by Hiraldo *et al.* (1979) for Spain. Haller (1983) postulated that climatic cooling at the beginning of the 17th and early 19th centuries in Europe probably had a negative influence on living conditions of the species.

Moreover, Coton and Estève (1990) listed the decrease of wild ungulate populations among the possible extirpation causes. During the 19th century the ibex became almost extinct in the whole alpine chain and the chamois was certainly not as common as nowadays (see de Tschudi, 1859; Perlini, 1923). However, as pointed out by past authors (e.g. Bailly, 1853; de Tschudi, 1859; Rérolle, 1900), sheep, goats, cattle and other livestock, rather than wild ungulates, were a much more important potential food resource to the vulture, in the last century at least. In the Aosta valley alone the official census of 1881 revealed 44,488 cattle, 35,030 sheep and 21,648 goats (Janin, 1991).

Analysis of the historical evidence has shown that direct human persecution affected the lammergeier populations in the western Alps, at least since the beginning of the 19th century.

It appears that the killing pressure in the early 19th century was not as deliberate and powerful as in the following decades. At that time the commonest hunting technique used in the Piedmont Alps was a simple ditch in the ground with a carcass inside, where birds jumped in to feed and were beaten to death with sticks (de Tschudi, 1859). Accordingly, the rarefaction process claimed by authors for the first half of that century was probably due to other natural or indirect human causes. However, not enough is known about environmental changes and land use transformations. The early decline of the vulture in the central and eastern Alps, where extirpation took place 30-40 years before that of the western Alps (see Glutz von Blotzheim *et al.*, 1971), might also have played a part in the process, reducing any chance of immigration and thus insularizing the western alpine population.

From the middle of the 19th century direct human persecution achieved great prominence and effectiveness for at least two reasons: collection for taxidermy became highly popular (see Fatio & Studer, 1889, in Richard, 1914) and pest control became a widespread method of game management; in the House of Savoy royal preserves, bounties of 50 lire, or 200 to 500 francs (equivalent to a monthly wage of a game warden) were paid for each bird shot (Rérolle, 1900; Couturier, 1962; Videsott, 1971).

The shotgun appears to be the means most commonly used everywhere in the western Alps;

nearly all the 65-67 birds listed in Appendix 1 were certainly or likely killed in this way. Seemingly, no technical improvement in firearms favoured such a destruction; the breech loader shotgun came into common usage in the royal preserves only at the beginning of this century (photographic archives of GPNP, Turin). Rather, as pointed out by Berlie (1898), meat baits poisoned with strychnine - already widely used for fox *Vulpes vulpes* control - perhaps played a more important destructive role than first appeared; although only one bird (perhaps two) in our list (No. 28 in Appendix 1; Salvadori, 1895) was killed by strychnine, obviously birds that died for this reason were seldom found.

Persecution affected mostly adult birds in the crucial phase of the breeding season (see above). As a consequence, the effect on the populations would have been especially severe (see Hiraldo *et al.*, 1979; Newton, 1979).

## CONCLUSIONS

Assessment of the former range and analysis of the causes of extinction are the first two management problems that must be addressed in any reintroduction programme (see Boitani, 1976).

The present study has ascertained the former distribution, the range reduction and the most likely date of disappearance of the bearded vulture in the western Alps. As far as the causes of extirpation are concerned, two clear considerations emerged from the analysis of the historical data: the species was subject to intense human persecution from the middle of the 19th century at least and there is no evidence that, in the same period, natural causes or indirect human activities had a significant effect on population decline.

From a historical point of view, these general conclusions would justify the current international project of reintroduction of the species into the western Alps, in particular to the Argentera-Mercantour Massif, one of the best documented and previously occupied sites.

The destructive effects of human persecution on raptor populations have been demonstrated in various case studies (e.g. Love, 1983). Nevertheless, the present analysis is still insufficient to confirm persecution as the major cause of extirpation, even if the evidence suggests this hypothesis. The real extent of persecution endured by the species is not ascertainable; as a consequence, it is not possible to assess whether the human persecution shown by the data would have been sufficiently intense to result in extermination of the bearded vulture population in the space of 30-40 years.

To this purpose, the rapid population decline should be compared with the biological vulnerability of the species; by making assumptions about population size at various survival rates, it should be possible to assess what rate of additional adult mortality caused by people would have led to the historically observed rate of extirpation. A Population Vulnerability Analysis (PVA) (Gilpin & Soulé, 1986) to examine human impact is discussed elsewhere (Mingozzi & Balletto, in press).

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## Appendix 1

### List of bearded vultures shot, found dead or caught alive (chronological order)

| No. | Year | Department or subregion | No. of inds., sex and age | Date | Place | Preservation site and other details | References |
|-----|------|-------------------------|---------------------------|------|-------|-------------------------------------|------------|
|-----|------|-------------------------|---------------------------|------|-------|-------------------------------------|------------|

|    |             |                             |              |              |  |   |                                |
|----|-------------|-----------------------------|--------------|--------------|--|---|--------------------------------|
| 1  | 1789        | Turin Valleys (I)           | 1 f. juv.    | Dec.         | Monte Castelluzzo, Torre P., Val Pellice | Formerly preserved in a private collection (Piossasco, Turin)   | M. Goante, ms; Salvadori, 1897 |
| 2  | before 1825 | Alpes Maritimes (F)         | 1 juv.       | ?            | Mountains between l'Escarère and Peille  |   | Roux, 1825                     |
| 3  | before 1838 | French-Italian border       | 1 ind.       | ?            | Col du Géant (3354 m), Mt Blanc Massif   |   | Poncey, 1916                   |
| 4  | 1841        | Aosta Valley (I)            | 1 ind.       | Apr.         | ?  | Formerly preserved in the Zoological Museum of Turin University | Salvadori, 1914                |
| 5  | 1842        | Isère (F)                   | 4-5 inds     | Jan. to Feb. | ?  |   | Bouteille, 1843                |
| 6  | 1844        | Savoie (F)                  | 1 m. ad.     | Dec.         | Chapelle-en-Maurienne                    | Chambéry Museum. Two other subjects observed                    | Bailly, 1853                   |
| 7  | 1848        | Haute Savoie (F)            | 1 subad.     | ?            | Chablais                                 | Annecy Museum   | Bailly, 1853                   |
| 8  | 1850        | Alpes de Haute Provence (F) | 1 m. (?) ad. | ?            | Vallée de Barcelonnette                  | Chabrand Museum, Barcelonnette                                  | Rochon-Duvigneaud, 1933        |
| 9  | 1851        | Savoie (F)                  | 1 m. ad.     | Feb., 15     | Near Modane                              | Chambéry Museum   | Bailly, 1853                   |
| 10 | 1853        | Alpes de Haute Provence     | 1 f. (?) ad. | ?            | Vallée de Barcelonnette                  | Chabrand Museum, Barcelonnette                                  | Rochon-Duvigneaud, 1933        |

| (F) |                |  |             |                      |  |  |   |
|-----|----------------|--|-------------|----------------------|--|--|---|
| 11  | 1855<br>(?)    | Alpes<br>Maritimes<br>(F)              | 1 m.<br>ad. | Jul.                 | Near Nice                                  | Tring<br>Museum  | Hiraldo <i>et<br/>al.</i> , 1979                          |
| 12  | before<br>1857 | Alpes de<br>Haute<br>Provence<br>(F) ? | 1 m.<br>ad. | ?                    | Basses Alpes                               | Nîmes<br>Museum (cat.<br>No. 82)                                     | Unpublished<br>(G. Gory,<br>pers. comm.)                  |
| 13  | ÷<br>1860      | Aosta<br>Valley (I)                    | 1 ind.      | ?                    | Verrayes                                   |  | Vescoz,<br>1915   |
| 14  | ÷<br>1865      | French-<br>Italian<br>border           | 1 ind.      | ?                    | Petit-St-<br>Bernard Pass<br>(Graian Alps) |  | Rérolle,<br>1900  |
| 15  | ÷<br>1870      | Hautes<br>Alpes (F)                    | 1 ind.      | ?                    | La Cluse,<br>Devoluy                       |  | Alpinus,<br>1874  |
| 16  | 1872           | Hautes<br>Alpes (F)                    | 1 ad.       | Apr.,<br>12 or<br>13 | Vallon de<br>Ceillac,<br>Ubaye             | Belonging to<br>a breeding<br>pair (nest with<br>1 egg<br>destroyed) | Unpublished<br>(M. Berlie,<br>ms., 6<br>February<br>1886) |
| 17  | 1874           | Alpes<br>Maritimes<br>(F)              | 1 m.<br>ad. | Jan.                 | Mont Bego,<br>Vallée des<br>Merveilles     | Craveri<br>Museum  | Giglioli,<br>1907;<br>Arrigoni,<br>1929                   |
| 18  | 1874           | Alpes<br>Maritimes<br>(F)              | 1 ad.       | ?                    | Mont<br>Mounier                            |  | Caziot, 1913  |
| 19  | 1876           | Alpes<br>Maritimes<br>(F)              | 1 f.<br>ad. | Jun.,<br>21          | Mont Bego,<br>Vallée des<br>Merveilles     | Craveri<br>Museum  | Giglioli,<br>1886, 1907;<br>Arrigoni,                     |



|    |           |                             |          |          |                             |   |  |
|----|-----------|-----------------------------|----------|----------|-----------------------------|---|--|
| 20 | 1878      | Alpes de Haute Provence (F) | 1 ad.    | Jun.     | Tournoux, St Paul-sur-Ubaye | Toulouse Museum                                     | Unpublished                                      |
| 21 | ÷<br>1878 | Isère (F)                   | 1 juv.   | ?        | Presles, Pont-en-Royans     | Grenoble Museum                                     | Rérolle, 1900; Lavauden, 1910                    |
| 22 | 1879      | French-Italian border       | 1 ad.    | Jan., 3  | Tende Pass (Maritime Alps)  | Genoa Museum  | Salvadori, 1895; Boschetti, 1904; Arrigoni, 1929 |
| 23 | 1883 (?)  | French-Italian border       | 1 ind.   | ?        | Tende Pass (Maritime Alps)  |   | Salvadori, ms.; Salvadori, 1895                  |
| 24 | 1884      | Alpes de Haute Provence (F) | 1 ind.   | ?        | Ubaye                       |   | Berlie, 1898                                     |
| 25 | 1885      | Alpes Maritimes (F)         | 1 juv.   | Jan., 21 | Couaraze, near l' Escarène  | Florence Museum (cat. No 2590)                      | Giglioli, 1886, 1907                             |
| 26 | 1885      | Alpes Maritimes (F)         | 1 ind.   | ?        | ?                           |   | Foucachon, in Caziot, 1913                       |
| 27 | 1887      | Cuneo Valleys (I)           | 1 f. ad. | Mar., 27 | Monte Valletta, Val Gesso   | Zoological Museum, Turin University (cat. No. 2796) | Giglioli, 1889; Salvadori, 1895                  |

|    |           |                             |                           |          |   |  |                                      |
|----|-----------|-----------------------------|---------------------------|----------|---|--|--------------------------------------|
| 28 | 1889      | Cuneo Valleys (I)           | 1 ad.                     | Mar., 25 | Vallone Rogerol, Terme di Valdieri, Val Gesso | Zoological Museum, Turin University (cat. No. 11680) | Salvadori, 1895                      |
| 29 | 1890      | Alpes de Haute Provence (F) | 1 ad.                     | ?        | Near Barcelonnette                            | Hyères Museum  | Cheyland, 1981                       |
| 30 | ÷<br>1890 | Hautes Alpes (F)            | 1 ad.                     | ?        | Grand Aréa, Vallée de la Guisanne, Briançon   | Shot in the nest                                     | Derennes, 1890                       |
| 31 | ÷<br>1892 | Hautes Alpes (F)            | 1 ad.                     | ?        | Vallée de Nevache, Briançon                   | Grenoble Museum                                      | Rérolle, 1900                        |
| 32 | ÷<br>1892 | Hautes Alpes (F)            | 1 ad.                     | ?        | Vallée de Cervières, Briançon                 | Grenoble Museum                                      | Rérolle, 1900                        |
| 33 | 1892      | Cuneo Valleys (I)           | 2 ads (pair) and 2 chicks | ?        | Val Stura di Demonte                          | Subjects shot in the nest                            | Gallet, in Rérolle, 1900             |
| 34 | 1895      | Cuneo Valleys (I)           | 1 ad.                     | Mar., 3  | Val Gesso                                     | Zoological Museum, Turin University (cat. No. 11708) | Salvadori, 1895                      |
| 35 | 1895      | Hautes Alpes (F)            | 1 m. ad.                  | Feb., 20 | Alp de Cervières, Briançon                    | Found dead, at 2200 m. Paris Museum                  | Rérolle, 1900; Anfrie, 1917          |
| 36 | 1896      | Hautes Alpes (F)            | 1 ind.                    | ?        | Meadows of Réallon, near Mont Guillaume,      | Found dead; one other observed                       | Thouard, in Rérolle, 1900; Lavauden, |

|    |            |                             |        |         | Embrunais                                 |  | 1911   |
|----|------------|-----------------------------|--------|---------|---|--|--|
| 37 | 1898       | Alpes de Haute Provence (F) | 1 ad.  | Jan., 6 | Blégiers, near La Javie                   | Marseille Museum (cat. No 6562)  | Rérolle, 1900; L'Hermitte, 1915, 1936 (A. Delcourt, pers. comm.) |
| 38 | 1898       | Cuneo Valleys (I)           | 1 ad.  | ?       | Vallone di S. Anna di Valdieri, Val Gesso | Rome Museum  | Unpublished  |
| 39 | 1898       | Hautes Alpes (F)            | 1 ad.  | ?       | Mont Guillaume, Embrun                    | Grenoble Museum  | Unpublished  |
| 40 | 1898       | Hautes Alpes (F)            | 1 ind. | ?       | Brezières, south to Gap                   |  | Martin, in Rérolle, 1900   |
| 41 | 19th cent. | Alpes Maritimes (F)         | 1 ad.  | ?       | Vallée de la Magna                        | Norwich Museum. Killed (...) many years ago  | Gurney, 1901   |
| 42 | 19th cent. | Aosta Valley (I)            | 1 juv. | ?       | Prarayé (Bionaz), Val Pelline             | Shot in the last years of the century. Formerly preserved in the CAI office, Aosta | Vescoz, 1915   |
| 43 | 19th cent. | Aosta Valley (I)            | 1 ind. | ?       | Roisan, Val Pelline                       | Shot in the last years of the century  | Vescoz, 1915   |
| 44 | 19th cent. | Aosta Valley (I)            | 1 ind. | ?       | Roisan, Val Pelline                       | Shot in the last years of  | Vescoz, 1915   |

|    |            |                     |          |         |  | the century                                    |   |
|----|------------|---------------------|----------|---------|--|--|---|
| 45 | 19th cent. | Hautes Alpes (F)    | 1-2 inds | ?       | Fréaux, Vallouise                          | Shot in the last years of the century          | Pic, in Rérolle, 1900                           |
| 46 | 1902       | Cuneo Valleys (I)   | 1 ad.    | Feb.    | Monte Merà, S. Anna di Valdieri, Val Gesso | Rome Museum                                    | Carruccio, 1902                                 |
| 47 | 1902       | Alpes Maritimes (F) | 1 ind.   | ?       | ?  |  |   |
| 48 | 1903       | Vaucluse (F)        | 1 ind.   | Jul., 8 | Mont Ventoux, Orange                       |  | Bérenguier, 1903, in Hugues, 1937; Caziot, 1913 |
| 49 | 1904       | Cuneo Valleys (I)   | 1 juv.   | ?       | Val Gesso                                  | Natural Park of Argentera Museum, Valdieri (I) | Moltoni & Vandoni, in Martorelli, 1931          |
| 50 | 1905       | Savoie (F)          | 1 ind.   | ?       | Massif de l'Iseran                         |  | Lavauden, 1911                                  |
| 51 | ÷<br>1905  | Aosta Valley (I)    | 1 ind.   | ?       | Mont Poignon, Val di Cogne                 |  | L. Dayné & E. Perron, in Couturier, 1962        |
| 52 | 1906       | Savoie (F)          | 1 ad.    | Sep.    | Col de l'Iseran                            | Guimet Museum, Lyon                            | Unpublished (J. Clary, pers. comm.)             |

|    |               |                              |                 |             |  |  |  |
|----|---------------|------------------------------|-----------------|-------------|--|--|--|
| 53 | 1906<br>(?)   | Hautes<br>Alpes (F)          | 1 ad.           | ?           | La Grave (?),<br>Massif de<br>l'Oisans | Guimet<br>Museum,<br>Lyon  | Unpublished<br>(J. Clary,<br>pers.<br>comm.) |
| 54 | 1907          | French-<br>Italian<br>border | 2 ads<br>(pair) | Apr.        | Montgenèvre<br>Pass (Cottian<br>Alps)  |  | Ghidini,<br>1907                             |
| 55 | 1909          | Cuneo<br>Valleys (I)         | 1 ind.          | Dec.        | Val Gesso<br>(upper valley)            | Shot at the<br>beginning of<br>the month   | Bonomi,<br>1910                              |
| 56 | 20th<br>cent. | Aosta<br>Valley (I)          | 1 ind.          | ?           | Mont<br>Poignon, Val<br>di Cogne       | Shot in the<br>first years of<br>the century   | Blanc in<br>Couturier,<br>1962               |
| 57 | 1913          | Aosta<br>Valley (I)          | 1 m.<br>ad.     | Oct.,<br>29 | Becca di Tos,<br>Val di<br>Rhêmes      | St Pierre<br>Natural<br>History<br>Museum,<br>Aosta<br>(formerly in<br>CAI office,<br>Aosta) | Anon.,<br>1913a, b;<br>Ghidini,<br>1914      |
| 58 | 1914<br>?     | French-<br>Italian<br>border | 1 ad.           | ?           | Tende Pass<br>(Maritime<br>Alps)       | Piodi<br>Collection,<br>Venaria<br>(Turin)   | Unpublished                                  |
| 59 | 1920          | Hautes<br>Alpes (F)          | 1 ad.           | ?           | Roc des<br>Vautours, Col<br>Rabou, Gap | Gap Museum   | Cheyland,<br>1981                            |
| 60 | ÷<br>1920     | Hautes<br>Alpes (F)          | 1 ad.           | ?           | Queyras                                | Gap Museum   | Cheyland,<br>1981                            |

## Appendix 2



## Live observations and other detailed references (up to 1930)

| No. | Year                    | Department or subregion | Date     | Place                                  | Details   | References                     |
|-----|-------------------------|-------------------------|----------|--|---|--------------------------------|
| 1   | Beginning of 19th cent. | Novara Valleys (I)      | ?        | Macugnaga, Valle Anzasca               | Breeds on the rocky cliffs of the Monte Rosa, above Macugnaga                               | Von Welden, 1824               |
| 2   | Mid. 19th cent. (?)     | French-Italian border   | ?        | Tende Pass (Maritime Alps)             | One ind. observed very close in flight over the Pass  | De Filippi, in Salvadori, 1895 |
| 3   | 1847                    | Savoie (F)              | ?        | Valloire, Vallée de la Maurienne       | One or two pairs breed regularly on the cliffs of the Mont Thabor, or surrounding mountains | Bailly, 1847                   |
| 4   | Before 1853             | Savoie (F)              | ?        | Saint Bernard, Vallée de la Tarentaise | It has bred in the last few years....   | Bailly, 1853                   |
| 5   | 1865                    | Hautes Alpes (F)        | Summer   | Massif des Ecrins                      | Two adults observed above the l'Empetra meadows, below the Boeufs Rouges Glacier            | Alpinus, 1874                  |
| 6   | 1875                    | Hautes Alpes (F)        | Jun., 20 | Embrun                                 | One adult observed close to the nest on Morgon's mountain                                   | Fargue, 1875                   |
| 7   | Up to 1885              | Hautes Alpes (F)        | ?        | Briançon                               | A pair has bred in the eastern cliffs   | Rérolle, 1900                  |

|    |                         |                       |          |                                 |  |                            |
|----|-------------------------|-----------------------|----------|---------------------------------|--|----------------------------|
|    |                         |                       |          |                                 | of the Signal de St Chaffrey                             |                            |
| 8  | 1895                    | Hautes Alpes (F)      | Feb., 20 | Vallée de Cervières, Briançon   | One adult observed at the Alpe de Cervières              | Anfrie, 1896               |
| 9  | 1898-1899               | Hautes Alpes (F)      | Winter   | Vallée de Cervières, Briançon   | Some subjects observed at Cervières                      | Rérolle, 1900              |
| 10 | 1899                    | Hautes Alpes (F)      | Winter   | Briançonnais                    | Present every winter on the Dormillouse                  | Rérolle, 1900              |
| 11 | 1899                    | Cuneo Valleys (I)     | Autumn   | Val Maira                       | One observed over the Italian slope of the Mt Chambeyron | Berlie, 1898               |
| 12 | Beginning of 20th cent. | Aosta Valley (I)      | ?        | Valsavaranche                   | One nest found on Mt Roletta                             | Blanc, in Couturier, 1962  |
| 13 | 1907                    | French-Italian border | ?        | Montgenèvre Pass (Cottian Alps) | Breeding of one pair                                     | Bonomi, 1910               |
| 14 | 1908                    | Isère (F)             | ?        | Grand Ferrand, Le Trièves       | One probable observation                                 | Lavauden, 1910             |
| 15 | 1909                    | Cuneo Valleys (I)     | Dec., 15 | Prealps near Cuneo              | One female observed alive (captured ?)                   | Ghidini, in Castelli, 1939 |
| 16 | 1911                    | Savoie (F)            | October  | Haute                           | Two (pair)   | C. Côte, in                |

|    |               |                      |                   |  |  |                                 |
|----|---------------|----------------------|-------------------|--|--|---------------------------------|
|    |               |                      | ?                 | Maurienne (?)                            | observed   | Decrue,<br>1911                 |
| 17 | 1924-<br>1925 | Aosta<br>Valley (I)  | Autumn-<br>winter | Gran Paradiso<br>National Park           | Two<br>observed by<br>the Park<br>wardens                                | Festa, 1925                     |
| 18 | 1928          | Turin<br>Valleys (I) | Spring            | Valle<br>dell'Orco, Gran<br>Paradiso N P | One<br>observed in<br>the upper<br>valley                                | Tuccu,<br>1950                  |
| 19 | 1930          | Aosta<br>Valley (I)  | ?                 | Valsavaranche,<br>Gran Paradiso<br>N P   | Two<br>observed<br>five or six<br>times in the<br>Vallone di<br>Levionaz | Blanc, in<br>Couturier,<br>1962 |

### **Appendix 3**

#### **Generic records of historical occurrence**

| <b>No.</b> | <b>Year</b>              | <b>Department or subregion</b>              | <b>Reports</b>  | <b>References</b>          |
|------------|--------------------------|---|---|----------------------------|
| 1          | 1801                     | Swiss-Italian border, Grand-St-Bernard Pass | Species present   | Murith, in Poncy, 1913     |
| 2          | Before 1840              | Alpes Maritimes (I/F)                       | Species present in the regions of Ormea (Cuneo, I) and Brigue (F 06)  | Durazzo, 1840              |
| 3          | 1840                     | Swiss-Italian border, Grand-St-Bernard Pass | Species rare  | Engelhardt, in Poncy, 1913 |
| 4          | 19th cent. (second half) | Aosta Valley (I)                            | Species present in the Massifs of Gran Paradiso, Mont Blanc, Grand-St-Bernard and Matterhorn. Sometimes it comes down as far as Châtillon | Pavesi, 1904               |

|    |             |                             |  |   |
|----|-------------|-----------------------------|--|---|
| 5  | 1885        | Alpes Maritimes (F)         | It exists at Roubion, near Beuil   | Rochon-Duvigneaud, 1933                               |
| 6  | 1894        | Alpes Maritimes (F)         | Last observations in the region of Beuil and Roubion   | Maynard, in Caziot, 1913                              |
| 7  | 1910        | Alpes de Haute Provence (F) | It exists near Maurin, Haute Ubaye   | Lavauden, 1911  |
| 8  | 1911        | Savoie (F)                  | It still exists in the Massif de l'Iseran  | Lavauden, 1911  |
| 9  | 1914        | Cuneo Valleys (I)           | It still breeds regularly in the Maritime Alps, on the mountains of the upper Valley of Stura di Demonte | Ghidini, in Richard, 1914; Ghidini, 1914; Anon., 1915 |
| 10 | 1915        | Alpes de Haute Provence (F) | Present at Tournoux  | Cheyilan, 1981  |
| 11 | Before 1922 | Alpes Maritimes (F)         | It still exists (...) in the surroundings of Isola and Tende Pass  | Lavauden, in L'Ermitte, 1936                          |