

## Status of the Golden Eagle *Aquila chrysaetos* in the Western Alps

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A survey on the Golden Eagle *Aquila chrysaetos* in the Italian Western Alps (Liguria to Aosta Valley) was initiated in 1972. Since 1983, one of the authors (FB) started collecting data and since 1986 has been monitoring the whole population in the Cuneo province (Fasce *et al.* 2011).

Every year the highest possible number of the known pairs was monitored in different periods, as recommended by Fasce (1982), i.e. at least three times: before laying, during brooding and rearing and after fledging. Furthermore, new potential territories have been explored.

We collected data about pair composition, nests used and reproduction.

Whenever it was not possible to carry out monitoring during the breeding period, one or more visits were carried out post fledging (in August and September), following the methodology suggested by Fasce (1982), consisting in at least three long observations of the pair, without the young interacting with them.

The number of known pairs has progressively increased and is now 168. We evaluated the population at the beginning of the study to be between 70 and 90 pairs in the study area (Fasce *et al.* 2011): therefore the population has almost doubled. The increase was progressive (Fig. 1): in 1984 the number of known pairs was 82 (Fasce & Fasce 1984); in 1992 it had increased to 91 (Fasce & Fasce 1992), in 2003 to 129 (Fasce & Fasce 2003), in 2008 to 144 (Fasce *et al.*, 2011), in 2013 to 160 (Fasce & Fasce 2013).

This growth was due, besides the refining of the research methods and wider field efforts, to an actual population increase: in many cases we could ascertain the settlement of new pairs in territories that were previously deserted. During the last 20-25 years we observed the settlement of at least forty new pairs, with a 2% yearly increase (Fasce *et al.* 2011, Fasce & Fasce 2013).

Often a new pair settled between two occupied territo-

ries, whilst the occupation of marginal areas was less frequent: density has consequently considerably increased.

The population growth is surely attributable to a reduction of human persecution and, above all, to habitat improvement. The creation of numerous protected areas, allowing for a remarkable increase in the prey population and, therefore, in food resources also were of importance.

In the valleys of the Gran Paradiso National Park, where 31 pairs are present, some of which having territories extending over the park limits, density is of one pair per about 32 km<sup>2</sup> (31 pairs in about 1000 km<sup>2</sup>), a density which is among the highest in the world (Fasce & Fasce 2009).

A total of 976 nests were found, with heights ranging from 250 m a.s.l. (in the Ligurian Alps) up to 2650 m a.s.l. (in the Aosta Valley), 96% of which are located on cliff faces and the remaining 4% on trees (fir *Abies alba* and *Picea excelsa*, larch *Larix decidua*, Arolla pine *Pinus cembra*, pine *Pinus* spp., and Juniper *Juniperus* spp.). Remarkably a pair in the province of Cuneo had 8 nests located on trees and only two on a cliff (for details see Table 1).

During 45 years of surveys, also thanks to the help of some co-operators, a total of 4010 records on breeding were collected.

Data collected in 2016 are summarized in Table 2, together with the totals for the period 1972-2016.

The number of pairs monitored during incubation is lower than the total of reproductions, due to time constraints by PF and LF, but FB has always monitored all the pairs in the province of Cuneo also during this the incubating period.

The percentage of pairs formed by adult partners was about 94% and has not changed significantly during the whole study period. This high, and almost constant, percentage suggests a good healthy level of the population.

It was impossible to determine precisely adult mortality: we could in some cases observe a change in partners (possible only when an immature or sub-adult bird replaces an adult one); this allowed us to define the adult mortality as a very low value: 213 changes were observed for the 3532 pairs, whose composition could be analysed.

Considering only the 1985-2016 period (see further for the reason), productivity (i.e. number of fledged young per monitored pairs) ranged from a minimum of 0.22 in 2009 (32 young/146 monitored pairs) to a maximum of 0.57 in 1990 (49/86). Mean value of productivity is 0.42 (1698 young raised/ 4010 monitored reproductions).

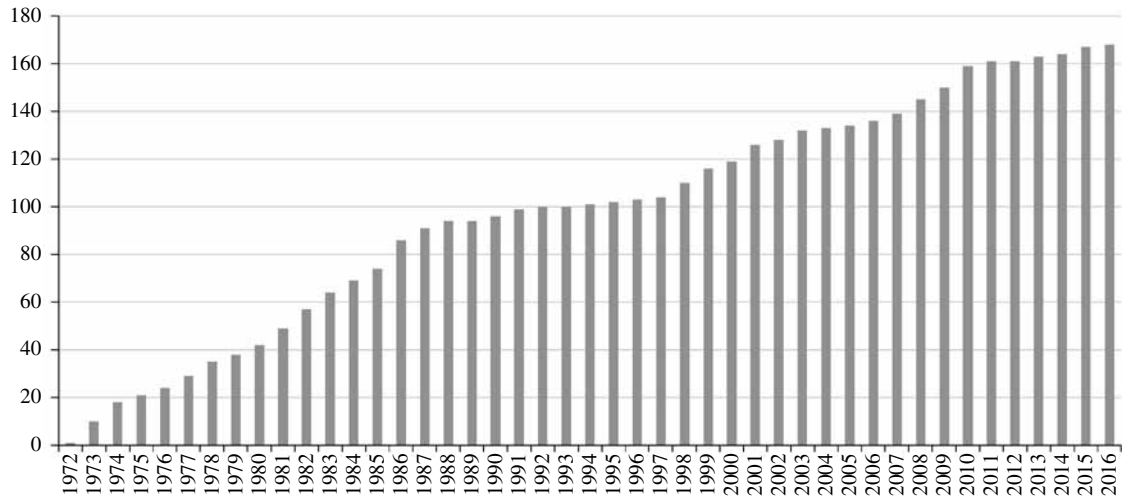


Figure 1. Increase in the known population.

Table 1. Reproductive data for 2016 and summary for the whole period 1972-2016.

| 2016   |         | Ligurian Alps | Cuneo | Torino | Aosta | Western Alps | Western Alps (1972-2016) |
|--|---------|---------------|-------|--------|-------|--------------|--------------------------|
| known pairs                                      | A       | 7             | 44    | 58     | 59    | 168          | 168                      |
| checked pairs                                    | B       | 6             | 44    | 51     | 56    | 157          | 4010                     |
| pairs checked during incubation                  | C       | 4             | 44    | 40     | 52    | 140          | 3111                     |
| pairs having laid eggs*                          | D       | 5             | 27    | 34     | 29    | 95           | 2190                     |
| pairs not having laid                            | E       |               | 17    | 10     | 25    | 52           | 1172                     |
| failures during incubation                       | F       |               | 10    | 12     | 15    | 37           | 670                      |
| pairs having fledged young**                     | G       | 5             | 16    | 21     | 13    | 56           | 1489                     |
| pairs having fledged 1 young                     | H       | 5             | 12    | 19     | 12    | 48           | 1288                     |
| pairs having fledged 2 young                     | I       | 0             | 4     | 2      | 1     | 7            | 228                      |
| n. of fledged young                              | J       | 5             | 20    | 23     | 14    | 62           | 1699                     |
| young observed only after fledging               | V       | 1             | 0     | 5      | 2     | 8            | 268                      |
| chicks dead before fledging                      | K       | 0             | 1     | 1      | 1     | 3            | 48                       |
| pairs for which age of partners has been checked | Q       | 3             | 44    | 24     | 32    | 104          | 3532                     |
| adult pairs                                      | R       | 3             | 38    | 21     | 29    | 92           | 3330                     |
| non-adult pairs                                  | S       |               | 6     | 3      | 3     | 12           | 202                      |
| % of adult pairs                                 | T = R/Q | 100%          | 86%   | 88%    | 91%   | 88%          | 94%                      |

\* The number of pairs having laid eggs (D) + the number of pairs not having laid eggs (E) can be greater than the number of pairs checked during incubation (C), because some young have been observed only after fledging.

\*\* The number of pairs having fledged young (G) + the number of failures during incubation (F) do not correspond to the number of pairs having laid eggs, because the young died before fledging in one pair in the province of Turin, one in Aosta Valley and one in the province of Cuneo: it is not therefore an incubation failure, but a reproduction failure.

**Table 2.** Reproductive parameters for 2016 and summary for the whole 1972-2016 period.

| 2016                            |               | Ligurian Alps | Cuneo | Torino | Aosta | Western Alps | Western Alps (1972-2015) |
|---------------------------------|---------------|---------------|-------|--------|-------|--------------|--------------------------|
| % of pairs having laid eggs     | $L = D/(C+V)$ | 100%          | 61%   | 76%    | 54%   | <b>64%</b>   | <b>65%</b>               |
| % of hatched chicks             | $M = G/D$     | 100%          | 59%   | 62%    | 45%   | <b>59%</b>   | <b>68%</b>               |
| % of pairs having fledged young | $N = G/B$     | 83%           | 36%   | 41%    | 23%   | <b>36%</b>   | <b>37%</b>               |
| productivity                    | $O = J/B$     | 0.83          | 0.45  | 0.45   | 0.25  | <b>0.39</b>  | <b>0.42</b>              |
| fledging rate                   | $P = J/G$     | 1.00          | 1.25  | 1.10   | 1.08  | <b>1.11</b>  | <b>1.14</b>              |

The fledging rate (number of fledged young per successful pairs) has slightly declined, whereas the number of broods with two fledged young was about constant, with a mean 18% value every year.

Considering the size of the region surveyed, during the first years of research the number of known pairs was certainly lower than the real population size, but we think that data collected since 1985 are homogeneous enough (Fasce & Fasce 2011); since 1985 the annual monitoring covered on average 92% of the known population, with the exception of the Cuneo province, where FB has monitored 100% of the known pairs since 1986. Together with the increase in the number of occupied territories, we could ascertain a progressive reduction in productivity, which is evidently in close relation with the increasing density.

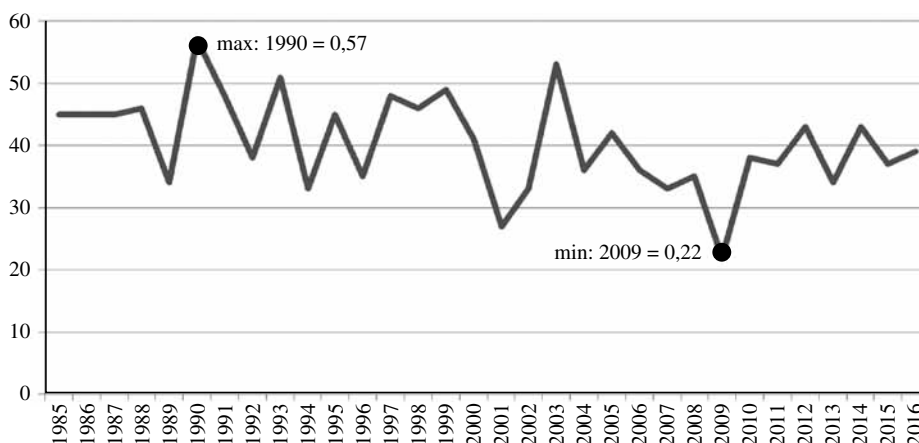
Productivity, even if globally declining, maintains an oscillating trend: years with high productivity values alternate with years having lower values for this parameter (Fig. 2). In our opinion, this trend does not seem to be dependent on climatic conditions: indeed we could verify that low productivity is not necessarily associated to bad climatic conditions, during both incubation and raising of young. Probably, the same is true for factors linked to the

trend of the prey populations, as productivity is higher in territories where food resources are larger, even when in these same territory density is higher, like for instance in the Gran Paradiso National Park.

Limiting factors have to be identified in the pre-laying phase, because, as shown in Fig. 3, the trends of productivity and of brooding pairs have similar variations. The most important limiting factor could be the presence in the territory of young birds from the previous year still present during the pre-laying phase. However there are many exceptions, like high reproductive pairs successfully breeding for several years in a row.

In our study region, threats to the species are sporadic and localized: disturbances are mostly caused by hobby and sport activities, such as rock climbing, paragliding, elisky and others. Unfortunately, disturbance caused by irresponsible nature photographers is more and more frequent: this hobby has almost exponentially increased, but precaution behaviours are often lacking, potentially causing fatalities by young or desertion of nesting areas.

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**Figure 2.** Productivity between 1985 and 2016.

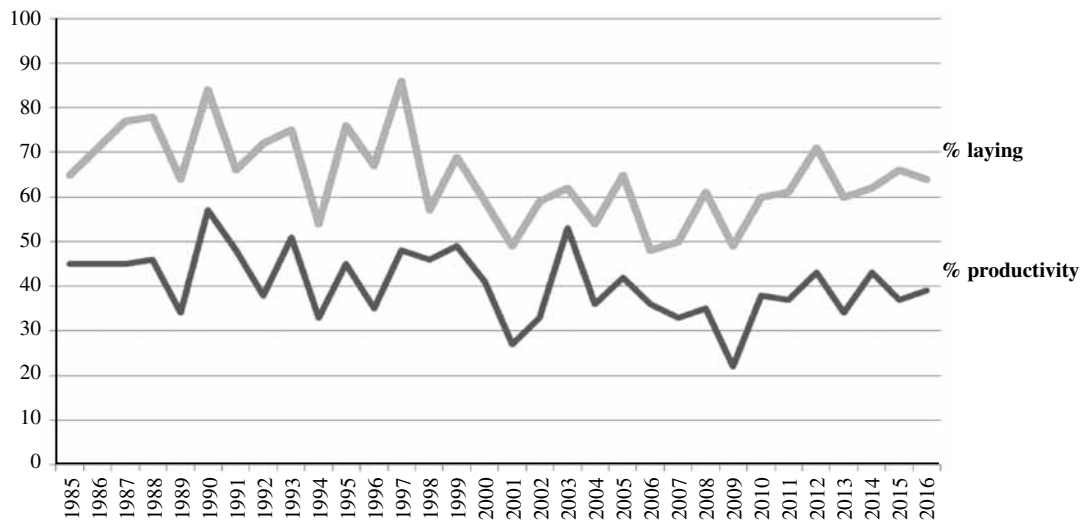


Figure 3. Laying and productivity.

Table 3. Data and distribution of the known nests.

|   | Ligurian Alps | Province of Cuneo | Province of Torino | Aosta Valley | Italian Western Alps |
|---|---------------|-------------------|--------------------|--------------|----------------------|
| n. of known nests / n. of known pairs                                 | 28/7          | 305/44            | 283/58             | 360/59       | 976/168              |
| mean n. of nests / pair   | 4             | 7                 | 5                  | 6            | 6                    |
| maximum n. of nests per pair  | 9             | 15                | 12                 | 16           | 16                   |
| n. nests on trees   | 1             | 27                | 4                  | 9            | 41                   |
| max n. of nests on trees for a single pair (n. of nests of such pair) | 1 (5)         | 8 (10)            | 1 (12 e 11)        | 2 (13)       | 8/10                 |
| maximum height a.s.l.   | 1700          | 2350              | 2400               | 2650*        | 2650                 |
| minimum height a.s.l.   | 250           | 1250              | 850                | 970          | 250                  |

\* Also a nest at 2700 m a.s.l. is known in Gran Paradiso National Park, but we never saw it to be used for reproduction.

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