

5.5. Temporal dynamics of cliff-nesting raptor populations in Sierra Nevada

Martín, J.ª; Barea-Azcón, J.M.ª; López-Sanjuan, R.ª and Gil-Sánchez, J.M.ª

¹ Environment and Water Agency of Andalusia ² Wilder SOUTH Society

Abstract

The temporal dynamics of the golden eagle and peregrine falcon populations in Sierra Nevada were analysed for the last 7 breeding seasons and for Bonelli's eagle during the last 12 seasons. The 23 pair of golden eagles of this subpopulation make it one of the largest of the south-eastern Iberian Peninsula. Most of the breeding pairs are distributed on the long axis of the mountain range as well as at the middle and high areas of the large fluvial and glacial valleys. The 15 pairs of Bonelli's eagles occupy areas with the greatest thermicity of the mountain range, coinciding with the carbonate zone. Its trend over the last 10 years is also stable, although its productivity continues to fluctuate, probably depending on climatic parameters. The peregrine falcon population of Sierra Nevada remains stable, with a slight increase to 14 breeding pairs.

➤ Aims and methodology

The trends in the populations of the golden eagle (2008-2014), Bonelli's eagle (2003-2014), and peregrine falcon (2008-2014) were analysed in Sierra Nevada from two reproductive parameters of reference (productivity and number of territories occupied). After the identification of breeding pairs, the reproductive process was monitored based on at least 3 visits per pair during which incubation, number of hatchlings and number of fledglings that finally left the nest were verified. Produc-

tivity was calculated as the total number of fledglings that left the nest/occupied territory. A territory was considered occupied on confirming an incubation, chicks in the nest, or the consistent presence of individuals in the territory over different visits. To analyse the effects of climatology on the productivity, a multiple regression was made where the dependent variable was productivity of each of the species, and the independent variables were monthly temperature and accumulated precipitation at

6 weather stations representative of the study area situated from 600 to 2150 m.a.s.l. (mean 1445.83 m.a.s.l.). Monthly temperature and precipitation were included for January and May, the average for these 5 months, and the average for the first 3 months as a reference for the conditions in the preliminary phases of the reproductive period.

➤ Results

In Sierra Nevada, the presence of 23 golden eagle territories were confirmed in 2014 as opposed to 19 in 2008, at the beginning of the monitoring programme. This value represents a density of 1.34 territories/100 km², which is greater than the density reported for the provinces of Granada (0.46/100 km²) or Almería (0.39/100 km²), and is similar to that established for other mountains of the Betic range. The productivity trend fluctuated over the last 7 years, with peaks alternating with troughs in

successive years (Figure 1). The mean value for this parameter during the period 2008-2014 was 0.8 fledglings/territory occupied, which is under the Andalusian mean for the year 2008 (1.04 fledglings/territory occupied) and is identical to the Spanish mean for this same year (0.8 fledglings/territory occupied) [18].

Bonelli's eagle presented 15 territories in Sierra Nevada. Population trend since 2003 appears to be a slight increase for a gain of 5 territories,

although since 2013 two of those territories has been lost. Density of this species in Sierra Nevada is 0.93 territories/100 km², while for the rest of Andalusia the rate is 0.37 territories/100 km² and in Spain the figure is 0.15 territories/100 km². As in the case of the golden eagle, the density of territories is similar to that of other mountain areas of the Betic range. Productivity shows a slightly negative trend since, in 2010 and 2013, only 7 fledglings to leave the nest in a total of 10 territories occupied,



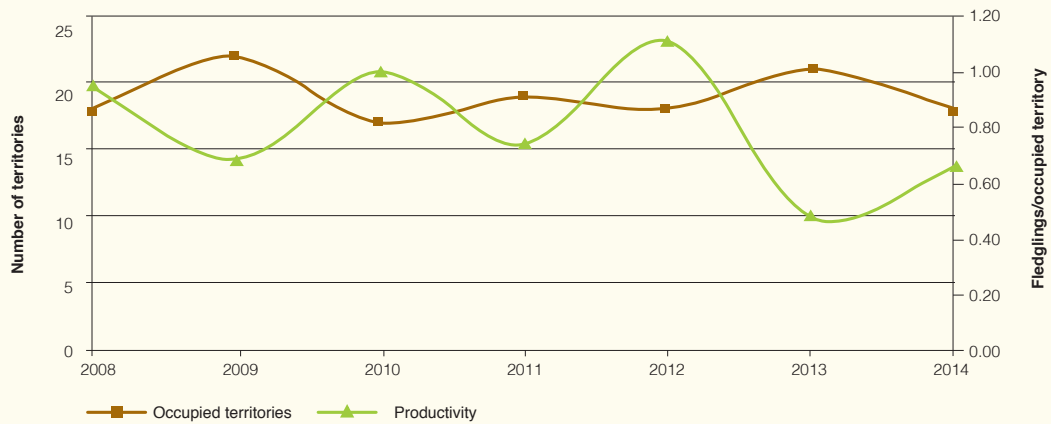
while in 2014 only 9 fledglings left the nest in 9 territories occupied (Figure 2). This plunge in productivity was also registered in the rest of the province of Granada (Gil-Sánchez, unpubl. data). Even so, the mean value for the period 2003-2014 was 1.23 fledglings/territory occupied, which is higher than the Andalusian mean for the year 2005 (1.17 fledglings/territory monitored) and far higher than the Spanish mean for this same year (0.92 fledglings/territory monitored)[19]. Ever since the monitoring program was started (2008) the population of peregrine falcon has increased from 11 to 14 territories, although it

is highly probable that the increase is not real but due to improved sampling coverage. This implies a density of 0.81 territories/100 km². This value is far higher than the density for Andalusia in the year 2008 and also greater than for Spain in the same year (0.32 and 0.49 territories/100 km², respectively). The productivity of the peregrine falcon population of Sierra Nevada for the period 2008-2014 was 1.51 fledglings/territory monitored (Figure 3). This value can be considered moderate or even low, taking into account that the mean productivity in Andalusia and Spain in general are 1.74 and 1.42, respectively, for 2008 [20].

Influence of climate on cliff-nesting raptor reproduction in Sierra Nevada

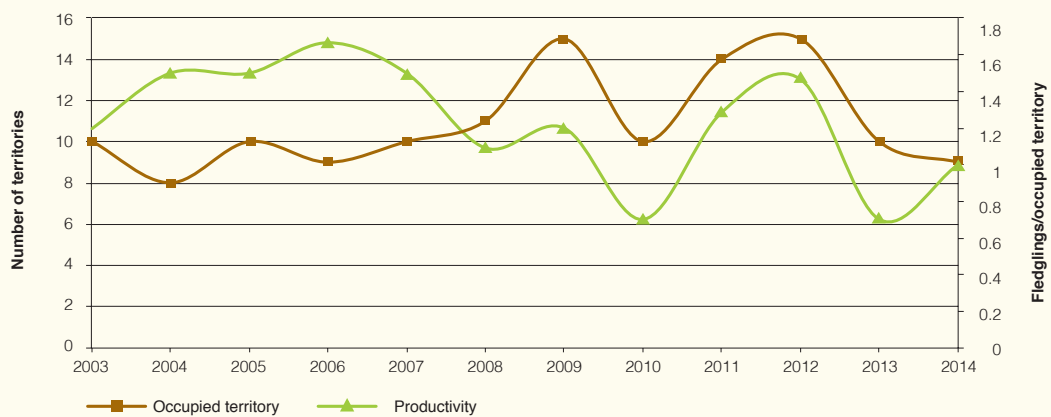
Only the productivity of Bonelli's eagle proved to be influenced by climatic variables considered in the analysis ($p < 0.05$). In this way, the multivariate analyses showed that the abundance of the precipitation during the month of March was negatively correlated with productivity in this species (Figure 4).

Figure 1



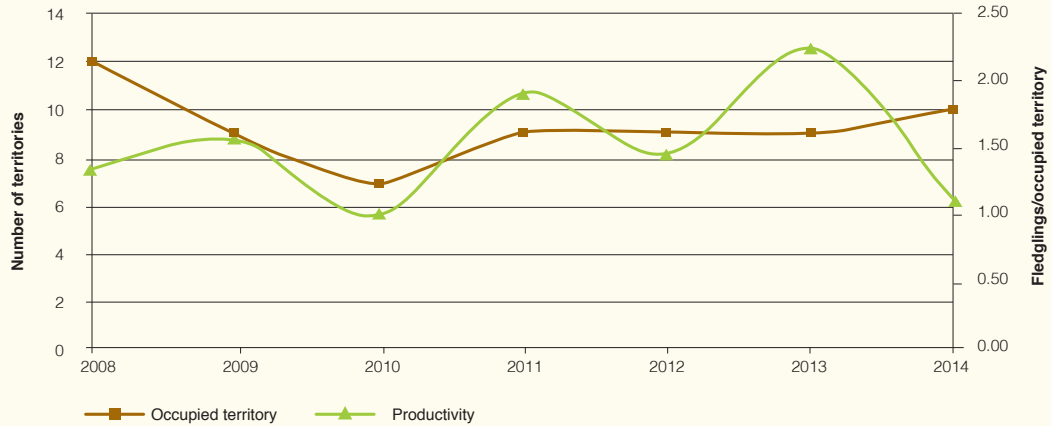
Productivity and number of occupied territories by the golden eagle in Sierra Nevada. Annual values since 2008.

Figure 2



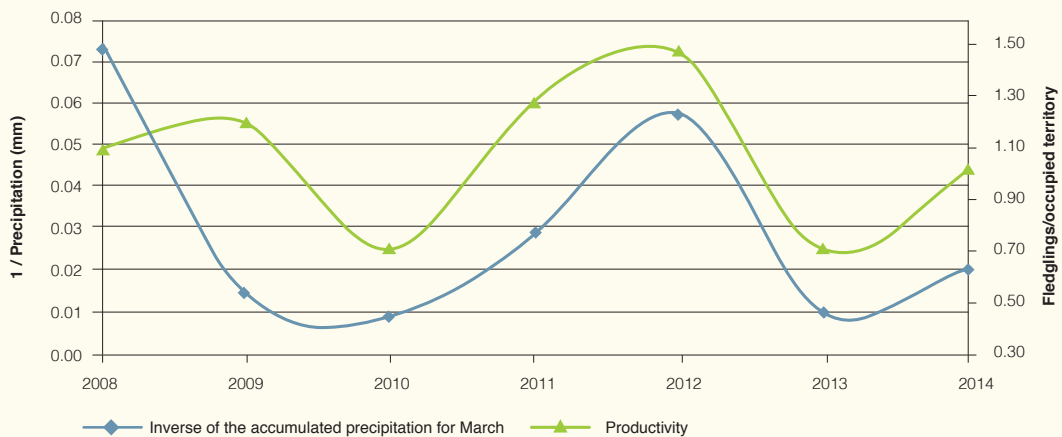
Productivity and number of occupied territory by Bonelli's eagle in Sierra Nevada. Annual values since 2008.

Figure 3



Productivity and number of occupied territory by peregrine falcon in Sierra Nevada. Annual values since 2008

Figure 4



Relation between productivity of Bonelli's eagle and accumulated precipitation during the month of March.

> Discussion and conclusions

The golden eagle population, with 23 territories, is one of the most important of the Betic ranges. The trend of the population in recent years should be considered stable, as the slight increase detected may be due to the better sampling coverage. The productivity of the

population during the last 7 years presents a fluctuating trend inversely related to the number of territories occupied ($r_s = 0.71$; g.l.= 6; $p < 0.05$). This is because the number of chicks is usually lower in the breeding seasons in which the number of occupied territories is higher, though

this relation does not reach statistical significance ($r_s = 0.49$; g.l.= 6; n.s.). An increase in the population size and greater proximity to the closest territory of the same species negatively influences productivity.

Bonelli's eagle population has grown slightly since 2003 in contrast to a clear surge of the species in the rest of Andalusia. In Sierra Nevada, the golden eagle colonizes the long axis of the mountain range as well as the middle and high zones of the large river and glacial valleys. Bonelli's eagle is restricted to warmer and more anthropized settings, which coincide with the peripheral areas and in large part with the carbonate portion. Contrary to what occurs

in the case of the golden eagle, there was a positive relation between the number of territories occupied and the number of hatchlings ($r_s = 0.95$; g.l.= 6; $p < 0.001$) during the reproduction season of 2008 to 2014. No relation was found between the two parameters in the reproduction season of 2003 to 2007. The multivariate analyses between accumulated precipitation and Bonelli's eagle population in Sierra Nevada showed a close relationship between the reduc-

tion in precipitation during March and higher values of productivity of this species. Consequently, the predictions of reduced precipitation could benefit this species [21]. In any case, the final result is hardly predictable due to the existence of phenomena of interspecific competition with the golden eagle, the repercussion of which could be considerable on the trend of Bonelli's eagle at the local scale [22].



A pair of golden eagles photographed at one of the few territories located over limestone substrates present in Sierra Nevada.