



# Monitoring of the reproduction of the European Roller (*Coracias garrulus*) population in the Vallée des Baux during the 2021 breeding season

December 2021

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A ROCHA FRANCE  
SCIENTIFIC REPORTS

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**Acknowledgements:** We are grateful for all the landowners and farmers who gave access to their land for the maintenance and monitoring of the nests of European rollers. We warmly thank all the volunteers and interns who participated in the field work: Laura Gránicz, Maela Ikabanga, Vivian Gueymard, Fabien Marc, Cécile Defossez, Jade Costechareire and Rémi Thouvenin.

**Citation:**

Sánchez Mar et Schwartz Timothée 2021. *Monitoring of the reproduction of the European Roller (Coracias garrulus) population in the Vallée des Baux during the 2021 breeding season*. A Rocha France Scientific Reports. A Rocha France, 15p.

## INTRODUCTION

During the last decades, worldwide biodiversity has suffered a steep decline in both species numbers and population sizes. This decline includes grassland birds and their prey, notably invertebrate species. The main cause of this decline is agricultural intensification (Donald *et al.*, 2006), a process involving grassland management practices such as pest control and the extensive use of fertilisers which affect insect diversity and consequently, food availability for insectivorous species; excessive ploughing which increases erosion of the surface layers and the loss of suitable habitats and reduction in ecotone areas by the conversion of permanent grassland to other land uses such as crop monocultures. In addition, alteration and destruction of breeding habitats have a negative impact on the success of species reproduction and therefore in the size of the populations (Kovacs *et al.*, 2008).

In order to halt this ongoing decline in the populations of grassland birds, it is first necessary to estimate population size, dynamics and trends, then to set up concrete actions for the restoration and conservation of their optimal habitat, including adequate management of suitable areas, and finally to develop environmental education and awareness of land owners and farmers (Drum *et al.*, 2015). However, since breeding-habitat restoration can take time, other supplementary measures can be taken, like the installation of artificial nest boxes for cavity-nesting species (Donald *et al.*, 2006). In the European roller *Coracias garrulus*, recent research has concluded that in addition to a strong preference for nest boxes compared to natural cavities, there was no difference in breeding success or productivity between the two nest types, thus suggesting that nest boxes could act as efficient conservation tools (Schwartz *et al.*, 2020).

The European Roller (hereafter “the roller”) is a medium-large crow-shaped and colourful bird with striking pale turquoise plumage and distinctive flight behaviour. It is the only species from the Coraciidae that breeds in Europe. As a trans-Saharan migrating species, the roller arrives in Europe for breeding in late April or early May and departs to Africa between the end of August and beginning of September (Cramp *et al.*, 1982). The roller is a predominately insectivorous species, with Coleoptera and Orthoptera as its main prey (Kovacs *et al.*, 2008) with the birds hunting from perching positions such as dead branches or poles.

The roller is monogamous and shows a high philopatry. As an obligate secondary cavity breeder it depends on the activity of other species such as the green woodpecker (*Picus viridis*) and mostly nests in poplars (*Populus alba* and *Populus nigra*). Rollers can also nest in cavities made by other nesting birds in loess or sand cliffs (Kovacs *et al.*, 2008). They do not however build or collect material for the nest (Cramp *et al.*, 1982). They lay a clutch of 2 to 7 eggs that requires an incubation period of approximately 24 days with 26-27 days after hatching for the chicks to fledge (Cramp *et al.*, 1982, Fry & Fry, 2010, Guillaumot 2015, 2016).

A Rocha France has been developing a monitoring program for the population of European roller in the Vallée des Baux since 2001. The project is based on a network of nest boxes located along the valley that have been monitored and maintained since 2002. In addition, since 2016 the team has also mapped and monitored some available natural cavities in the same area that were potentially suitable for the roller’s reproduction.

During the 2021 breeding season, the monitoring was developed by Mar Sánchez, Laura Gránicz, Maela Ikabanga, Vivian Gueymard, Fabien Marc, Cécile Defossez, Jade Costechareire and Rémi Thouvenin under the supervision of Timothée Schwartz and the results of the season are presented and discussed below.

## METHODOLOGY

### SITE DESCRIPTION

The study area, the “Vallée des Baux” (43°41’N; 4°46’E. WGS84), is located in the south of France, near Arles and between three key biodiversity areas: the Camargue wetland in the southwest, the steppic plain of the Crau in the South East, and the Alpilles range to the north. Most of the valley is included with the Regional Natural Parks of the Alpilles and belongs to the Natura 2000 network, designed to protect and conserve endangered or threatened natural habitats and species within the EU (Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora).

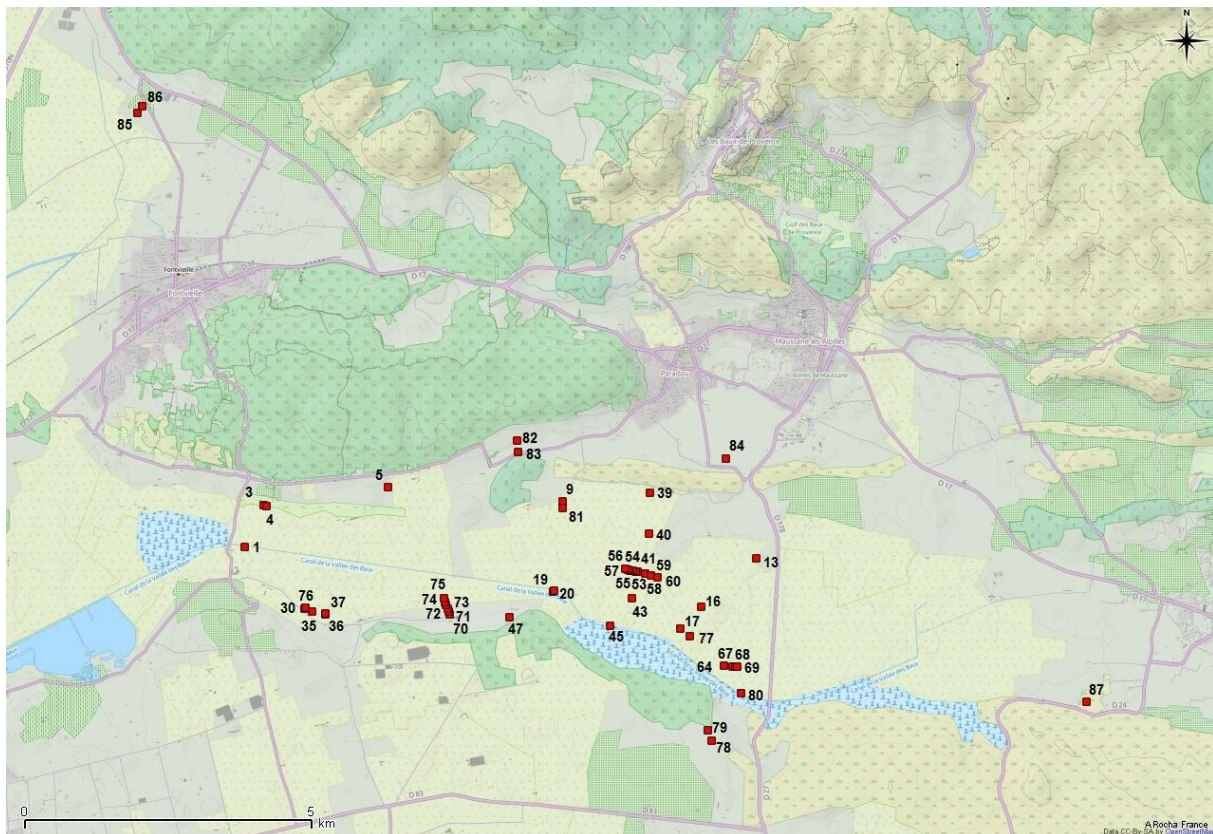


Fig.1. Map of the Vallée des Baux and location of the nest boxes set up for the breeding of the European roller.

Across the Vallée des Baux there is a wide diversity of ecosystems which includes Mediterranean riparian forest, riverbanks associated with a dense network of channels, garrigue, wetlands and agricultural land. This habitat heterogeneity allows the presence of very different fauna and flora species in the area.

The roller is predominantly an open lowland species whose preferred habitats for breeding are open forests, riparian forests and orchards. They also forage in meadows and cereal farming habitats (Cramp, 1985). Most of these habitats are found in the Vallée des Baux.

## MONITORING OF NEST BOXES AND NATURAL CAVITIES

Since the beginning of the program in 2002, the number of nest boxes has changed but since 2011 has remained constant with 51 nest boxes. The nest boxes are placed in trees at an average height of 4.25m from the floor. The main species of trees selected for placing the nest boxes were white and black poplar (*Populus alba* and *Populus nigra* respectively).

Natural cavities available for roller reproduction are also present, and more than 190 were located in 2017. In addition, 13 new ones were found in 2021, most of them in white poplars (*Populus alba*). During this 2021 breeding season, 64 of them were checked, resulting in 33 occupied ones: 12 by the roller, 20 by starling (*Sturnus vulgaris*) and one by western jackdaw (*Corvus monedula*).

The maintenance protocol for the nest boxes is separated into two phases. During the winter season, the boxes are checked, cleaned and closed by a metal grill in order to prevent other species breeding in them. In April, the nest boxes are opened and checked again in case any damage was caused by the weather during winter. Damaged nest boxes are replaced if needed.

The monitoring protocol occurs from mid-May until end of June. The nest boxes and cavities are checked to verify occupation by rollers at least three times (second half of May, first half of June and second half of June). Once located, nest boxes and cavities occupied by rollers are checked more intensively, once a week. Every evidence of occupation is written in a specific data field form, and includes other species than the roller. This procedure is done using an endoscopic camera attached in a pole. This material enables fast checking, makes climbing into the tree unnecessary, and reduces the disturbance of adults during the critical egg-laying and incubation phases of the breeding period.

## RINGING

For every occupied nest, adults are captured by placing nets outside of the occupied nest boxes and cavities. Capture attempts are made only after the full completion of the clutch and before the hatching of the eggs. Each bird is ringed using a metal ring which is placed on one specific leg (tarsus) and a coloured plastic ring with a flag which is placed on the other leg. The flags show a code with one letter and one number combined; the color of the ring and the leg on which the ring is placed (metal and plastic) depends on the year. After every adult ringing, a camera trap (WOSPORTS, Big Eye 3D) is installed facing the entrance of the nest in order to check whether the other adult of the breeding pair is ringed and attempts are made to identify it on the basis of its colour ring.

During this last breeding season, each occupied cavity and nest box was verified at least twice and a maximum of five times with the aim of determining the number of laid eggs and their hatching date. Egg laying date, hatching date and fledging date can be determined either by direct observation, or by back-calculation by accounting for 2 days between each laid egg, an incubation period of 21 days from the 3rd laid egg, hatching of the three first eggs the same day and then 1 day between the hatching of each egg. Roller chicks are ringed at the age of two to three weeks in nest boxes alone, before fledging. The chicks born in the cavities are not ringed due to the difficult access and the time needed.



## RESULTS

### SIZE OF THE ROLLER POPULATION

During the 2021 season a total of 33 roller nests were found in the Vallée des Baux: 21 in nest boxes and 12 more in natural cavities (Figure 2, Appendix 1). The number of breeding pairs in nest boxes in 2021 is similar to 2019 (20) and 2020 (21), showing a stability in the population of the Vallée des Baux (Figure 2) In contrast, the number of pairs breeding in natural cavities has been changing a lot since 2017. However as, in contrast to nest boxes, the time spent looking at natural cavities has been highly variable over the years. This prevents direct comparison and trend analysis of the number of pairs breeding in natural cavities.

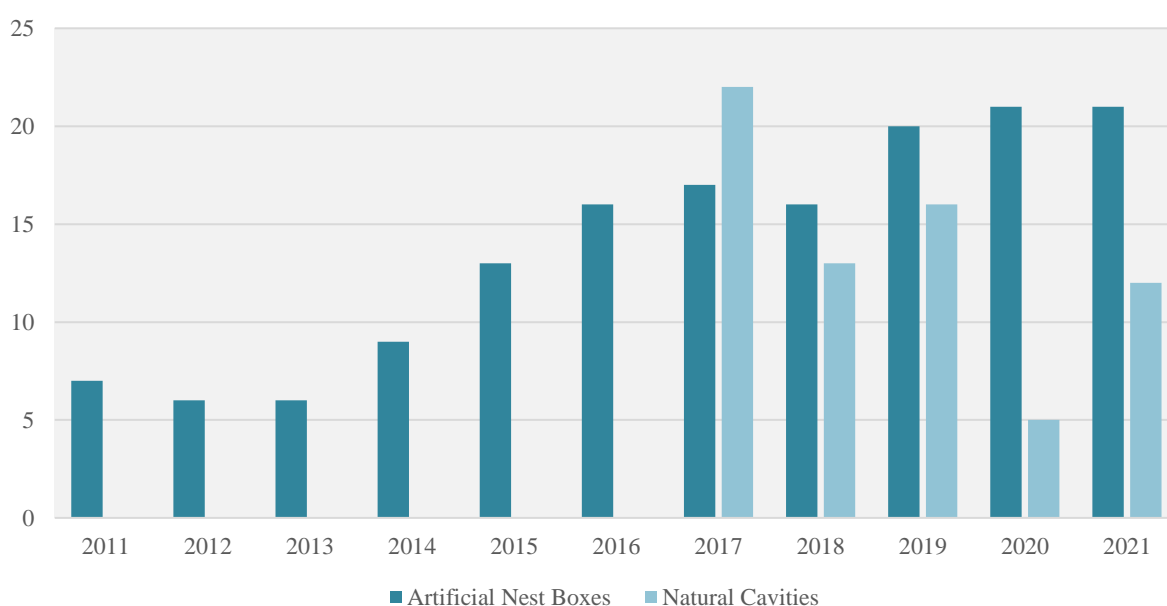


Fig. 2: Number of nest boxes and natural cavities occupied by the European roller between 2011 and 2021 in the Vallée des Baux (France).

### NEST BOX OCCUPATION RATE

Occupation rate of nest boxes has been stable during the last three breeding seasons with 39% in 2019, 41% in 2020 and again 41% in 2021 (Figure 3). This apparent stability follows a strong increase between 2013 and 2019.

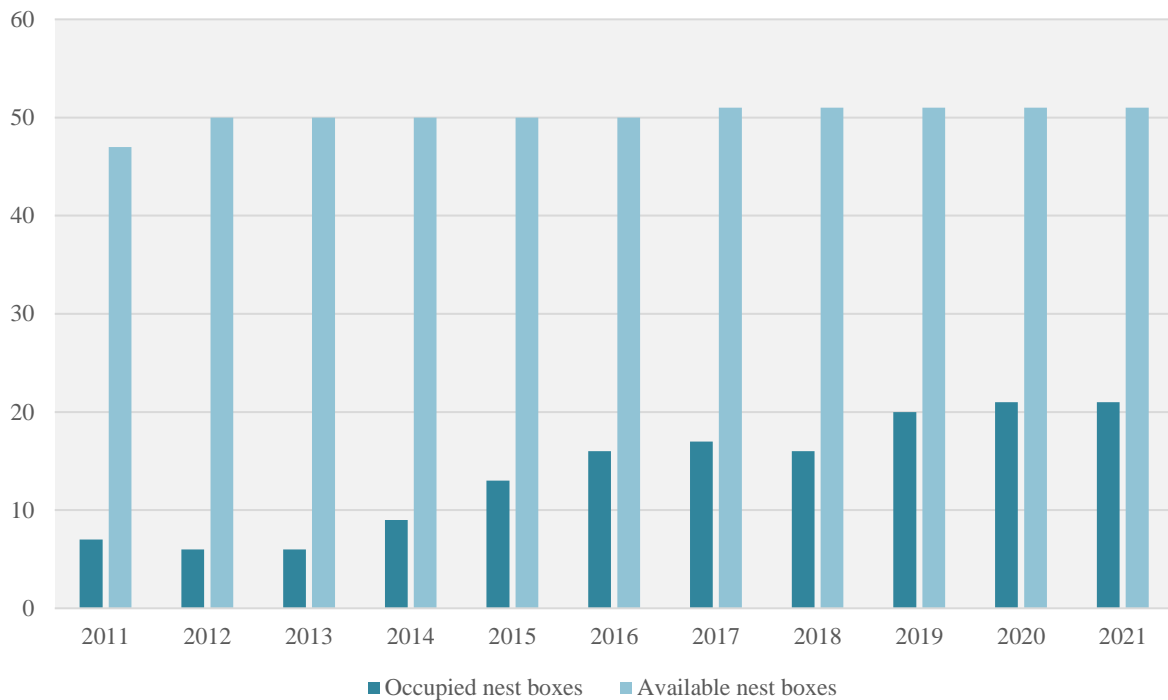


Fig. 3: Number of nest boxes available and occupied by the European roller between 2011 and 2021 in the Vallée des Baux (France).

#### MONITORED CAVITIES AND THEIR OCCUPATION

The breeding of the rollers occurring in natural cavities has been monitored since 2016 and the effort has been variable through the different years (Figure 4). In this 2021 season, 64 cavities were checked, and roller nests were found in 12 of them.

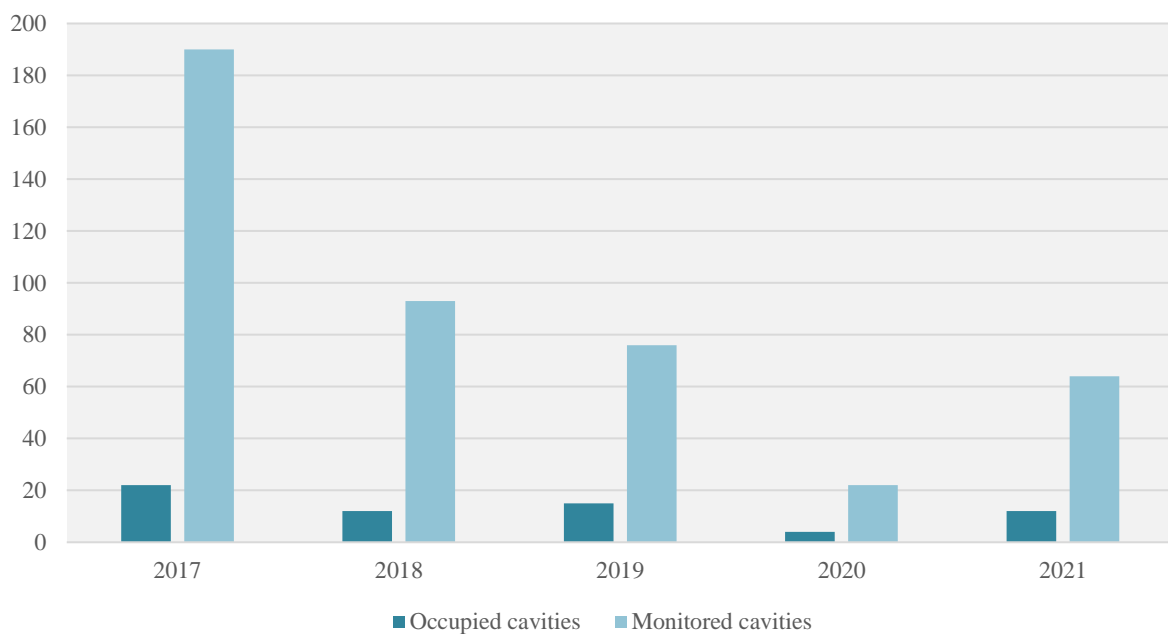


Fig.4: Number of natural cavities monitored and occupied by European rollers between 2017 and 2021

In 2017 there were a total number of 191 detected cavities suitable for the roller, most of them located in white poplars (*Populus alba*) (Schwartz et al. 2020). This year we also found 13 new cavities that could be used by the rollers. We also found a pair of rollers breeding inside a cavity located in a pine tree (*Pinus alepensis*) for the first time in the valley.

#### BREEDING AND REPRODUCTIVE SUCCESS IN NEST BOXES

One nest box could not be checked during the breeding season and its occupation by rollers was only detected during the cleaning and maintenance period during autumn 2021. This nest box contained two dead chicks but we could not determine if any other chick successfully fledged and how many eggs were laid inside. Only one breeding attempt failed among the 20 other occupied nest boxes during this 2021 breeding season. We could not identify the reasons for this failure, but we suspect predation. Overall, we counted 95 laid eggs, 83 of them hatched and 77 of the chicks fledged and were ringed (Figure 5). Thus, 87% of the eggs laid hatched successfully and 92% of the hatchlings went to fledgling.

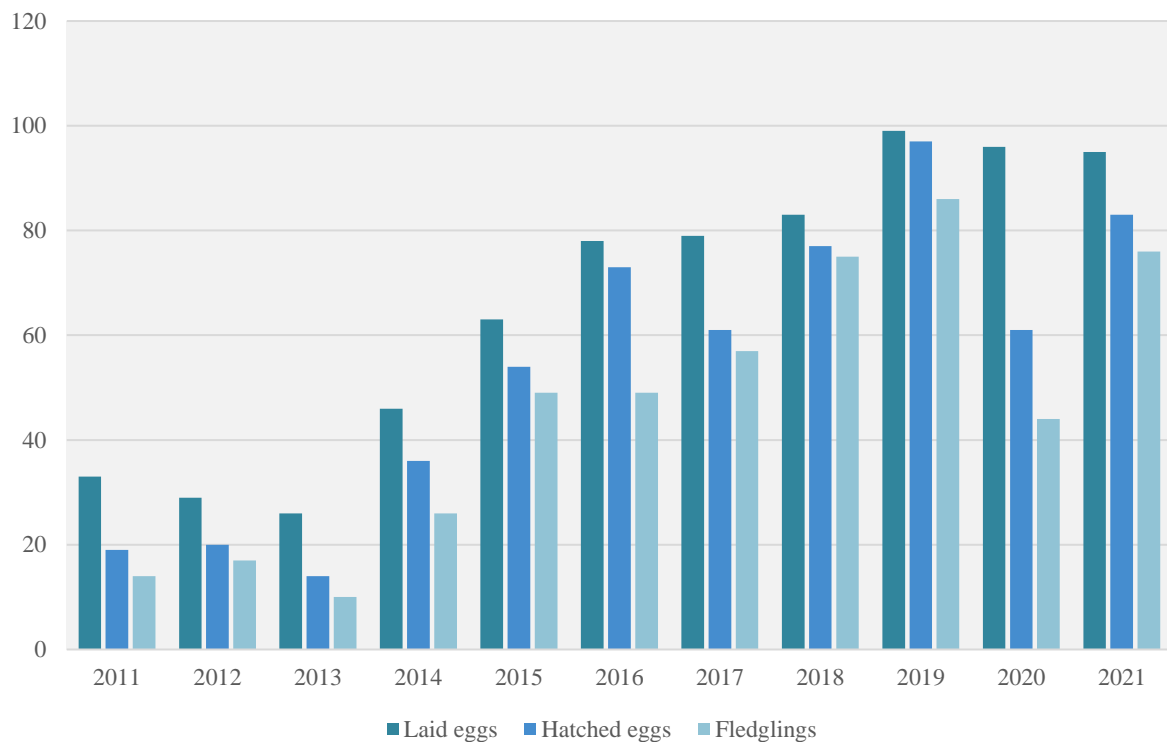


Figure 5. Total number of eggs laid, hatchlings and fledglings of European rollers breeding in nest boxes in the Vallée des Baux between 2011 to 2021.



## BREEDING AND REPRODUCTIVE SUCCESS IN NATURAL CAVITIES

In the 12 nests monitored in natural cavities, we counted 34 laid eggs and 27 of them hatched (Figure 6). However, as our visits to natural cavities were not as regular as visits to occupied nest boxes, we cannot estimate the number of fledglings and hence the overall breeding success in natural cavities in 2021.

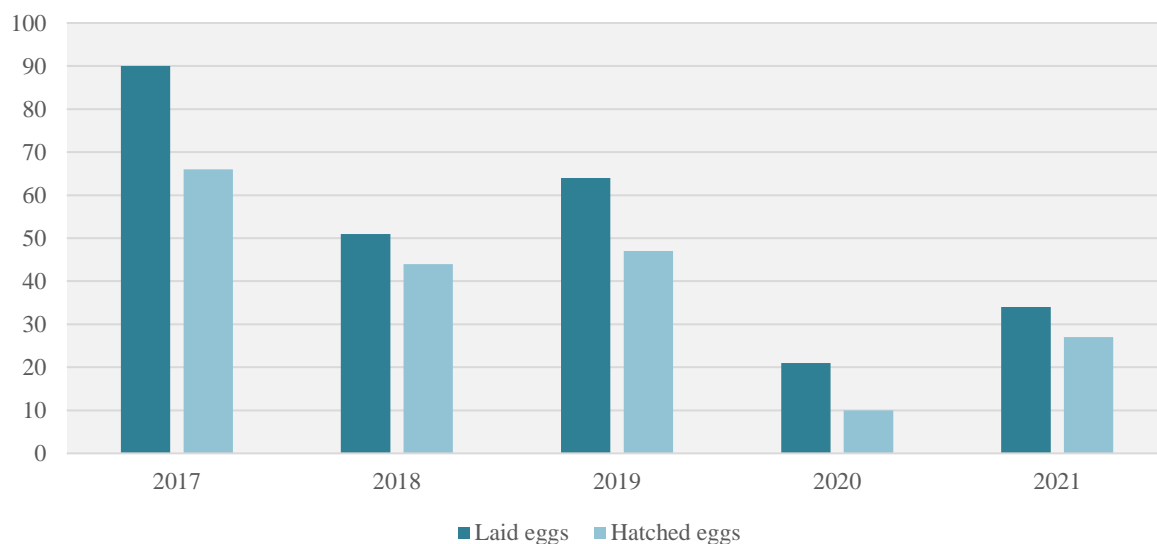


Figure 6. Total number of eggs laid and hatchlings of European rollers breeding in natural cavities in the Vallée des Baux between 2017 to 2021

## AVERAGE CLUTCH SIZE AND NUMBER OF FLEDGLINGS

The average clutch size per nest in the nest boxes during this last breeding season continued to be somewhat under the average of the previous years: 4.75 in 2021; 4.76 in 2020, 4.95 in 2019 and 5.18 in 2018. The average number of fledglings in 2021 was slightly higher than in 2020 (4.1 in 2021 and 3.43 in 2020), but these values are lower than the ones obtained in 2019 (4.85) and 2018 (4.85) (Figure 7). Overall, average clutch size has been stable since 2011 while the average number of fledglings has been increasing (GLMM,  $z=2.92$ ,  $p<0.01$ ).

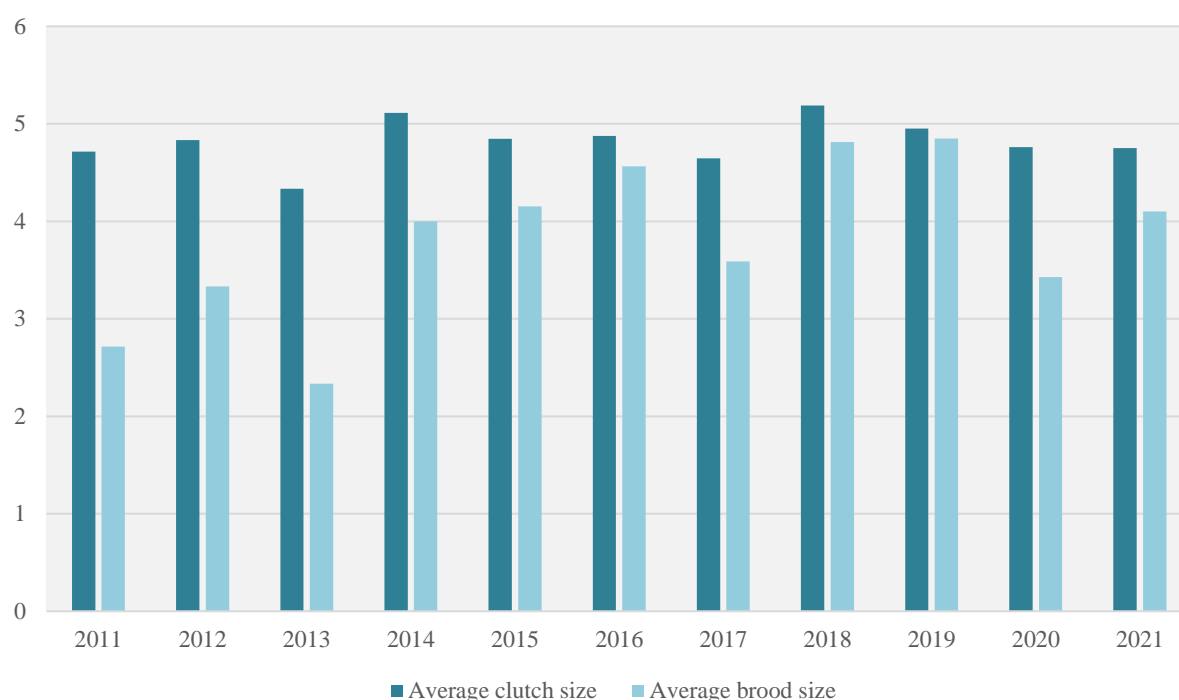


Figure 7. Average clutch size and average number of fledglings of European rollers breeding in nest boxes in Vallée des Baux between 2011 to 2021.

## RINGING

In this 2021 season 16 adults were captured during the incubation period, two of them breeding in cavities. There were 8 males and 8 females and most of them were more than 2 years old. (Table 1)

Table 1: Information about adult European rollers ringed during the breeding season 2021 in the Vallée des Baux

RING	SEX	AGE	NEST ID 2021	RING	SEX	AGE	NEST ID 2021
GY188409	M	2A	82	<b>GY188420</b>	M	+2A	41
GY188410	M?	+2A	35	<b>GY188421</b>	M?	2A	58
GY188411	M?	+2A	70	<b>GY188422</b>	M	+2A	68
GY188412	F?	+2A	75	<b>GY188423</b>	F	+2A	81
GY188413	F	+2A	Cav67	<b>GY188424</b>	M?	+2A	86
GY188415	F?	+2A	76	<b>GY188430</b>	F	+2A	87
GY188416	F	+2A	Cav8	<b>GY188434</b>	F	+2A	37
GY188417	F	+2A	70	<b>GY61206</b>	M?	2A	55

Besides, two already ringed adults were recaptured, and both showed strong philopatry, occupying the same nest box in two consecutive years (Table 2)

Table 2. Information about adult European rollers recaptured in the Vallée des Baux in 2021

RING	SEX	AGE	NEST 2021	NEST 2020	NEST 2019
GY168202	F?	+2A	5	5	5
GY168727	F	+2A	86	86	?

There were 76 chicks ringed in nest boxes during the 2021 season. The average weight was 145.6 g at the ringing day, two grams more than the 2020 weight average (143.5 g).

## DISCUSSION AND CONCLUSIONS

### EVOLUTION OF NEST BOXES OCCUPANCY IN THE VALLÉE DES BAUX FROM 2011 TO 2021

Since 2011, the occupancy rate has increased, starting from 16% and reaching 41% of the boxes occupied by pairs of rollers in 2021. This increasing trend might reflect an increase in the population size. However, we cannot exclude that a number of these pairs moved from nearby natural cavities, as rollers show a strong preference for nest boxes in the study area (Schwartz et al., 2020). Thus, we cannot be completely sure that the local population increased in the last 10 years.

Occupation rate of nest boxes has been stable in the last three years. Given the preference of rollers to nest boxes and as many available natural cavities were not occupied in the study area in 2021 (see above), this trend very likely reflects a local stability in the number of roller pairs.

### EVOLUTION OF CAVITIES OCCUPANCY IN THE VALLÉE DES BAUX FROM 2017 TO 2021

The monitoring of natural cavities started more recently. 191 suitable cavities were detected all along the valley in 2017, and 13 new ones found this 2021 season. The occupancy rates have remained low in comparison to the one for nest boxes. In 2017 12% of the monitored cavities were occupied by rollers. However, the monitoring of natural cavities was less intensive after 2017 and variable between years. Only a variable fraction of the cavities identified in 2017 were monitored each year, thus making interannual inferences impossible. It is very likely that the number of roller pairs breeding in natural cavities has been underestimated after 2017.

### NEST BOX BREEDING SUCCESS DURING THE 2021 BREEDING SEASON

Only one breeding attempt failed among the 20 monitored occupied nest boxes, similar to the 2019 breeding season, but much lower than 2020 (6 failures), hence this was one of the best years since 2011 (Fig. 3). Furthermore, the numbers of eggs laid, hatchlings and fledglings remained high and stable compared to 2019 and 2020 (Fig. 5) with 87% hatchlings of the 95 eggs laid and 92% of the hatchlings successfully fledged (76 chicks). This tremendous breeding success is a very good news for the roller population in the Vallée des Baux and in South of France.

### BREEDING AND REPRODUCTIVE SUCCESS IN NATURAL CAVITIES DURING THE 2021 BREEDING SEASON

Given the fact that the monitoring of cavities was not as regular as visits to the occupied nest boxes, is not possible to estimate the breeding success for this breeding season. Even so, 34 eggs were found and 80% (27) them successfully hatched.

### EVOLUTION OF AVERAGE CLUTCH SIZE AND NUMBER OF FLEDGLINGS FROM 2011 TO 2021

The average clutch size has remained approximately the same since the beginning of the study. In contrast, the productivity of rollers (average number of fledglings) experienced broader variations and increased significantly from 2011 to 2021. It is expected that clutch size would be more stable over time than productivity, as it is not dependent on environmental stochasticity (e.g. food availability, weather, predation, etc), as opposed to productivity. Hence, the increasing productivity is a good sign for the population, as it could mean that local environmental conditions have improved, for instance in terms of quality of foraging habitats or in terms of predation risks. Roller populations in South of

France are expected to have a fast pace-of-life in contrast to more eastern and northern populations (Schwartz et al. 2021). As fast populations are supposed to be more sensitive to variations in productivity, this increasing productivity strongly supports the hypothesis of a growth of the population from 2011 to 2021, illustrated by the increasing number of breeding pairs observed in nest boxes in the Vallée des Baux. Further studies exploring habitat quality and macro-insect surveys would be useful in order to better understand this increasing productivity.

#### RINGING

Although only two adult rollers were recaptured in 2021, both displayed strong philopatry and came back to the same nest where they were breeding previously. Furthermore, the individual tagged as GY168202 returned during three consecutive years to the same nest (2019, 2020 and 2021). These observations confirm the overall strong philopatry of rollers. However, the overall low number of recaptures in 2021 indicates a high turnover and hence probably a high mortality of adult rollers, which could also relate to the fast pace-of-life of this population (Schwartz et al. 2021).

#### CONCLUSION

The increasing number of collected data about the nest boxes in the Vallée des Baux combined with the better knowledge about the species enable us to demonstrate that the roller population is increasing. The mean values of clutch size, number of hatchlings and fledged chicks in nest boxes remained stable compared to previous years and show high values compared to other studies made in South of France and in the rest of Europe (Finch et al. 2019, Schwartz et al. 2021). These results confirm the positive impact of nest boxes on the conservation of European roller in the Vallée des Baux.

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**Appendix 1:** Map of nestboxes and natural cavities occupied by European rollers in Vallée des Baux in 2021

