Forest Lab report 2025

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Introduction

In Catalonia, since the Iron Age, the forest density has continuously evolved because of human activity.
In this context, the Montseny area has historically relied on agriculture, livestock farming, and forestry as its main economic activities. Nowadays, the main economic activities within the massif are related to tourism. Currently, urban land represents about 3%, forest 83%, and 14% consists mainly of meadows and pastures (Els ocells del Montseny, 2014).

Due to the reduction of land dedicated to crops and pastures, forest cover has increased, primarily forming young forests. This expansion promotes the spread of forest species, although it remains limited by the lack of cavities in mature trees.

Birds play a crucial role within forest ecosystems through a variety of ecological interactions. Some examples are, regulating the population dynamics of many forest insects. They also contribute significantly to seed dispersal, spreading plant seeds through their droppings.
Furthermore, birds facilitate the propagation of wood-decomposing fungi and contribute to the forest nutrient cycle.
Birds also create shelters for other animals. Certain species, such as the great spotted woodpecker (*Dendrocopos major*), excavate nesting cavities that are later reused by other animals once abandoned.
Finally, as integral components of food webs, birds themselves serve as prey for higher-level predators, including mammals and birds of prey, thereby maintaining ecological balance within forest ecosystems (nius.cat).

To breed, all birds have to achieve the same major objectives: find a partner, build or find a good location for the nest, incubate the eggs and raise and feed their young successfully.

In this report we will focus on their breeding phenology and reproductive biology through the reproductive cycle, which is influenced by climate change. By using nest boxes which provide a safe shelter to breed and compensate for the lack of natural cavities, we can determine which species use which habitat during their breeding season. To achieve this goal, eight sub-objectives were defined and are presented in detail in the methodology section.

Materials and methods

The study area

The area is split into 6 different habitats; they are classified per altitude:

- Turo de l'home (CaHi): Deciduous Forest in high altitude (around 15000 m above the sea level)
- Avetosa and Plana Amagada (CoHi): Coniferous Forest at high altitude
- Santa Fe (CaMi): Deciduous Forest in the middle altitude (around 1000 m above sea level)
- Upper Fontmartina (CoMi): Coniferous Forest in the middle altitude
- Fontmartina (EsMi): Sclerophyll Forest in the middle altitude
- Montnegre (EsLo): Sclerophyll Forest in low altitude (around 500 m above sea level)

Code	**Habitat**
Ca	The nest box is in a deciduous forest, such as beech, oaks or chestnut trees
Co	The nest box is in a coniferous forest, such as silver fir, Douglas fir, spruce or pine trees
Es	The nest box is in a Sclerophyll Forest, such as holly oak or olive trees
Code	**Altitude**
Lo	The nest box is on low altitude for our project, around 500 m above sea level
Mi	The nest box is on middle altitude for our project, around 1000 m above sea level
Hi	The nest box is on hight altitude for our project, around 1500 m above sea level

Table 1: Habitat code of the study area.

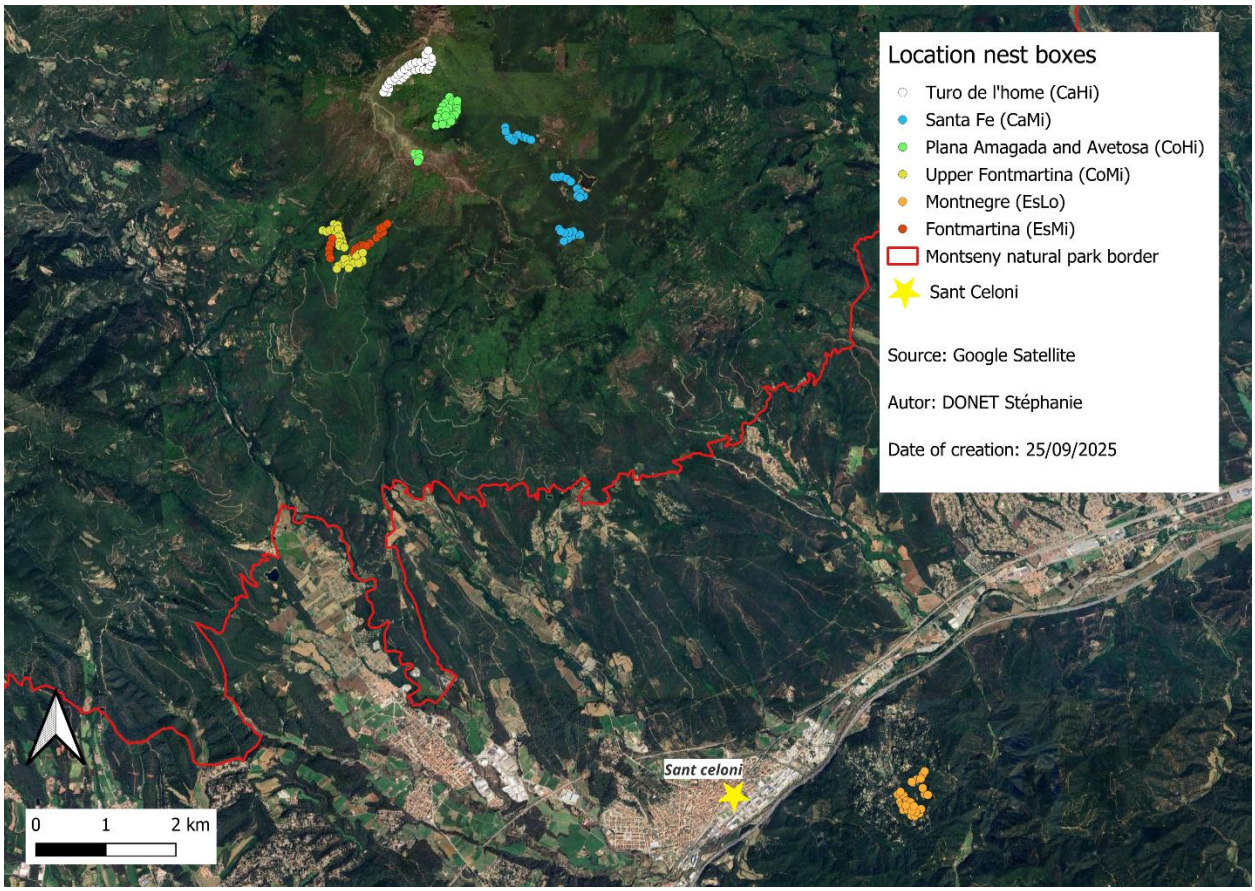

Figure 1: Location of the nest boxes, each colour represented a different habitat, the Montseny natural park limit is represented by the red line, and the star is the location of Sant Celoni.

Methodology

For 4 years the ICO ESC volunteers have been monitoring 176 nest boxes in the Montseny Natural Park area.
This year, the monitoring began on April 17 and ended on August 25.

To understand the breeding phenology and reproductive biology, it was necessary to monitor all stages of the breeding cycle using different methods at each stage, and split them in nine different objectives:

- **What is the date of the first egg**: Check during nest building following this protocol

Nest building step	Definition	Next check
Empty	No evidence of the nest box being used	2 weeks
Little	Little moss or other nest material	1 week
Bottom	Most of the bottom is filled with nest material	4 days
Cup	Nest material showed a cup shape on the top	2 days
Lining	Lining material (ex: feathers)	Every day until the first egg

Table 2: Nest boxes checking protocol

- **How many eggs were laid per clutch**: From the first egg laid, nest boxes were checked five days after until incubation began. During this period, an endoscope was used for the first time to minimise disturbance to the birds. Once incubation started, the nest was uncontrolled for 14 days, corresponding to the average incubation period. Afterwards it was checked every day until the first chick hatched.
- **What is the date of the first hatching chick**: Last year, a chick guide was created specifically for the Great Tit, Blue Tit, and Coal Tit, for which the date when the chicks would reach 16 days old was calculated in advance. For all other species, daily checks were conducted throughout the entire growing process.
- **What is the date of fledging's**: Check every day when Great tit, Blue tit and Coal tit are 16 days old, and every day for the other species until they fledged.
- **How many chicks fledged**: The maximum number of chicks observed on the last day.
- **What outcomes do the birds experience**: All notable events that could affect breeding, such as nest box replacement, nest box fall, predation, or abandonment were reported.
- **Which species are doing a second brood**: The nest box is used for a second time and continue monitoring in the same way.
- **Is the chick guide accurate**: In continuity with the four years of monitoring, the chick guide created last year for Great tits, Blue tits, and Coal tits was tested.
  To evaluate its accuracy, four volunteers were asked to use the guide to estimate the age of chicks whose exact hatching date was already known. This allowed us to compare the observers' estimates with the actual ages.
- **How does this year's data differ from previous years**: compare the collected data for four years.

Figure 2: Pictures of the endoscope and demonstration of how to use it to reduce disturbance to birds incubating.

Results

The species identified for this forest lab project were five species belonging to the tit family: Great tit (*Parus major*), Blue tit (*Cyanistes caeruleus*), Coal tit (*Periparus ater*) Crested tit (*Lophophanes cristatus*) and Marsh tit (*Poecile palustris*). And two other species: the Nuthatch (*Sitta europaea*) and Short-toed Treecreeper (*Certhia brachydactyla*).
This year for the first time a Marsh tit occupied a nest box.

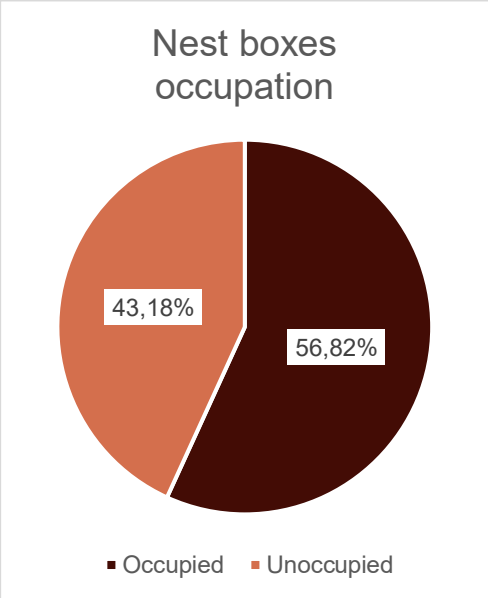

Figure 3: Percentage of nest boxes occupied and unoccupied

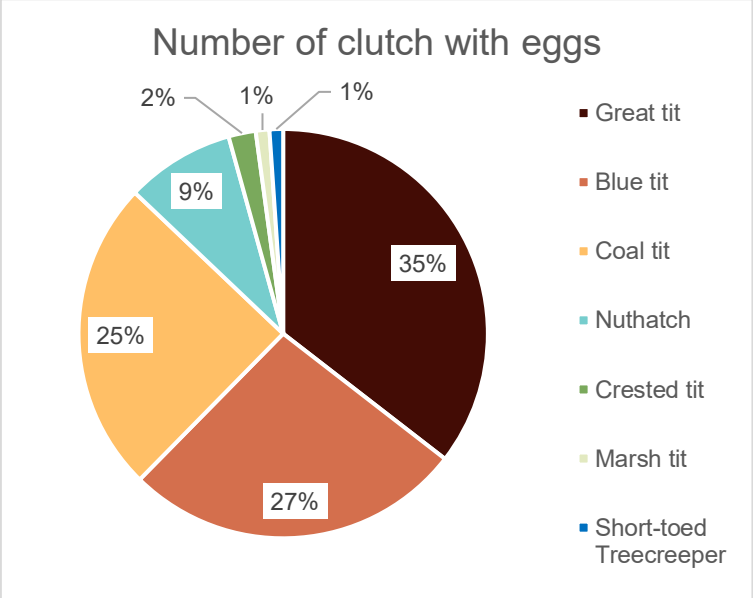

Figure 4: Percentage of clutch per species where birds laid at least 1 egg.

All clutches containing at least one egg were included to determine the percentage of occupied nest boxes, regardless of breeding success or failure. During the 2025 breeding season, 56.82% of the nest boxes were occupied (Figure 3). This percentage includes all seven species observed, with the majority of nest boxes occupied by Great Tits (35%), while Crested Tits

(2%), Marsh Tits (1%), and Short-toed Treecreepers (1%) represented the least frequent occupants (Figure 4).

Occupancy per altitude

To explore occupancy patterns across different altitudes and forest types in greater detail, only data from the Great Tit, Blue Tit, Coal Tit, and Nuthatch are presented, as these were the only species that provided consistent data.

Nest boxes occupancy per altitude					
Total of nest boxes	Altitude	Great tit	Blue tit	Coal tit	Nuthatch
60	High altitude	6,67%	0%	8,33%	0%
90	Medium altitude	21,11%	17,78%	20,00%	7,78%
26	Low altitude	38,46%	34,62%	0%	3,85%

Table 3: Percentage of nest boxes occupied by Great Tit, Blue Tit, Coal Tit, and Nuthatch at each altitude. The table highlights the most and least represented species, with grey boxes indicating unoccupied nest boxes.

Concerning occupancy across altitudes, the main findings are that the Blue Tit and the Nuthatch did not use nest boxes at high altitude, while the Coal Tit did not use those located at low altitude.

Based on this season's observations, the 60 nest boxes installed at high altitude were occupied by Coal Tits (8.33%) and Great Tits (6.67%) (Table 3).
At medium altitude, where 90 nest boxes were available, all four species used them, with the Great Tit showing the highest occupancy rate.
At low altitude, as observed at medium altitude, the Great Tit occupied the largest proportion of nest boxes, representing 38.46% of the 26 available.

Occupancy per forest

Regarding occupancy by forest type, the nest boxes in Deciduous forests were not used by the Nuthatch.

Nest boxes occupancy per forest					
Total of nest boxes	Forest	Great tit	Blue tit	Coal tit	Nuthatch
60	Caducifolious	18,33%	11,67%	8,33%	0%
60	Coniferous	10,00%	5,00%	20,00%	5,00%
56	Sclerophyll	28,57%	26,79%	10,71%	8,93%

Table 4: Percentage of nest boxes occupied by Great Tit, Blue Tit, Coal Tit, and Nuthatch at each forest. The table highlights the most and least represented species, with grey boxes indicating unoccupied nest boxes.

Among the 60 nest boxes installed in Deciduous forest, the Great Tit showed the highest occupancy rate (18.33%), followed by the Blue Tit (11.67%) and the Coal Tit (8.33%) (Table 4).
In coniferous forests, all four species used the nest boxes. The Coal Tit showed the highest occupancy (20%), followed by the Great Tit (10%), and only 5% by both the Blue Tit and the Nuthatch, out of a total of 60 nest boxes.
A similar trend was observed in sclerophyll forests, with 56 nest boxes in total. All four species occupied the nest boxes, but the majority were used by the Great Tit (28.57%) and the Blue Tit (26.79%), while the Coal Tit (10.71%) and the Nuthatch (8.93%) were less observed.

Breeding phenology

For the breeding phenology, only data from the Great Tit, Blue Tit and Coal Tit, will be presented, as these were the only species that provided consistent data.

The weeks shown in all graphs correspond to the weeks of the civil calendar, which means week 13 start March 24 and week 29 finish the July 20.

All clutches and broods containing at least one egg and one live chick were included, regardless of their success or failure. The fledging date was determined based on daily nest checks starting from day 16 for the three tit species, continuing until the nest was found empty. The day before the empty nest was observed was recorded as the fledging date, based on the number of chicks present during the last check.

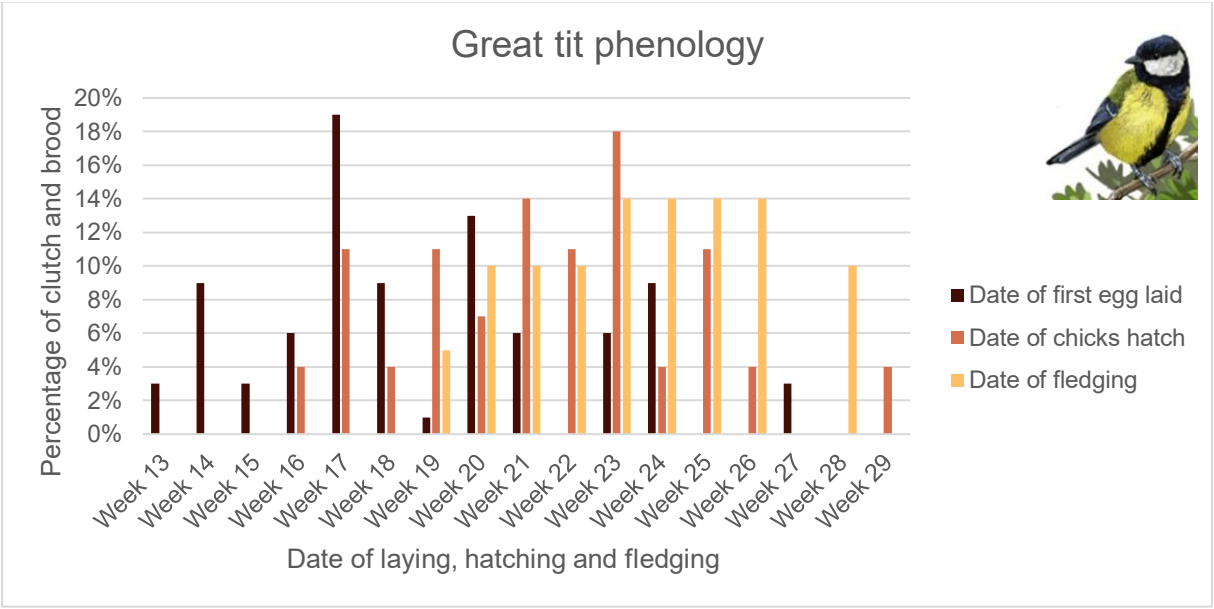

Figure 5: Not cumulative percentage of clutch when the Great tit laid the first egg, when the chicks hatch and when they fledged per week over the civil calendar in 2025, revealing the peaks of laying period, hatching and fledging.

As shown in figure 5, the first egg-laying peak occurred during week 14 (31 March to 6 April). A second peak was observed in week 17 (21 to 27 April), followed by a decline in breeding activity throughout the rest of the season.

Approximately three weeks after the egg-laying peaks, the corresponding chick-hatching peaks were recorded.
According to nius.cat, Great tits lay between 5 to 8 eggs on average. In our case, we found an average of 6 eggs, typically one per day, followed by an incubation period of about 14 days. In total, there was about a three-week interval between the laying of the first egg and the hatching of the first chick.

According to Figure 5, the first Great Tit chicks hatched on 17 April (week 16), and the last on 20 July (week 29).
Finally, the fledgling peaks occurred approximately three weeks after the hatching peaks, since chicks fledge at around 20 days of age on average, based on this season's data. The first Great Tit fledglings were recorded on 7 May (week 19) about six weeks after the eggs were laid and the last fledged on 12 July (week 28).

Overall, Blue Tits began using nest boxes about three weeks later than Great Tits and stopped about three weeks earlier.

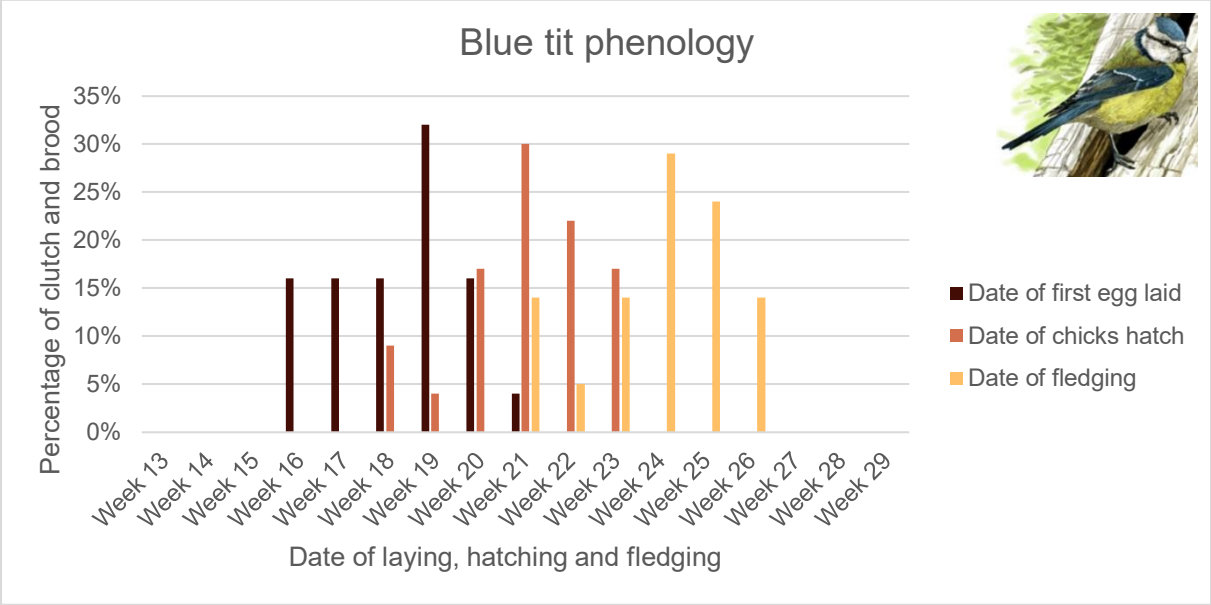

Figure 6: Not cumulative percentage of clutch when Blue tit laid the first egg, when the chicks hatch and when they fledged per week over the civil calendar in 2025, revealing the peaks of laying period, hatching and fledging.

According to Figure 6, the Blue tits first egg-laying peak occurred in week 16 (14–20 April) and remained stable until the second peak in week 19 (5–11 May), after which breeding activity declined at this elevation.

Approximately three weeks after the egg-laying peaks, the corresponding chick-hatching peaks were recorded. According to nius.cat Blue tits lay between 6 and 8 eggs. In our case, we found an average of 6 eggs typically one per day, followed by an incubation period of about 14 days. The first Blue Tit chicks hatched in week 18, and the last in week 23.

Similarly to the Great tit, the fledging peaks occurred about three weeks after the hatching peaks, showing a clear breeding dynamic for this species (Figure 6).

Coal Tit began using nest boxes at the same time as the Blue Tit but continued breeding two weeks longer.

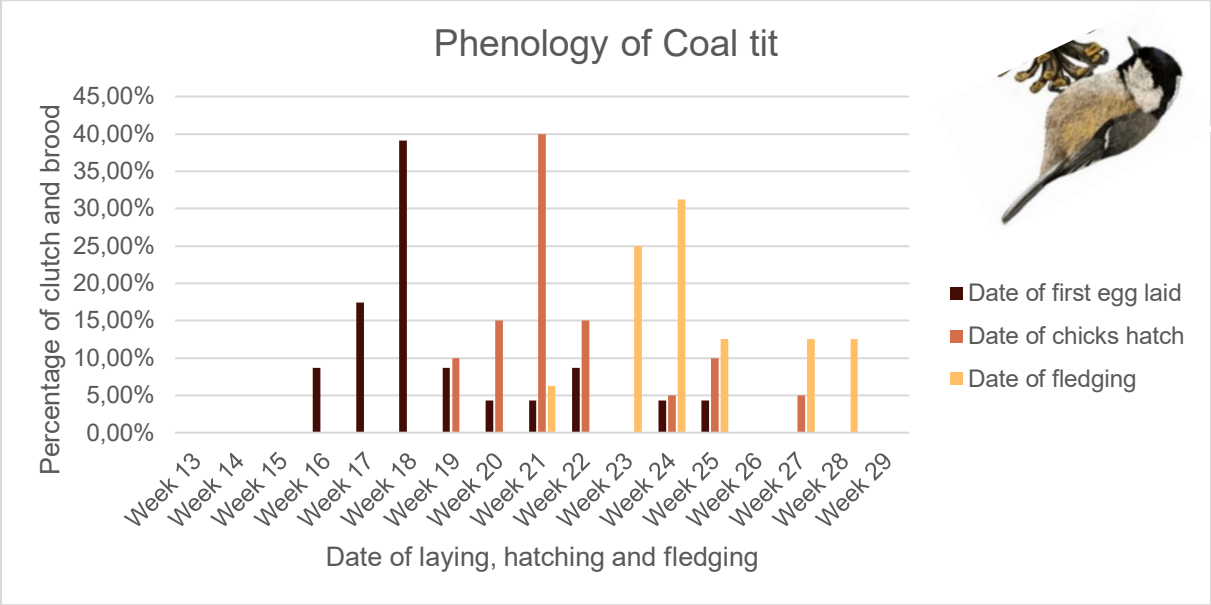

Figure 7: Not cumulative percentage of clutch when Coal tit laid the first egg, when the chicks hatch and when they fledged per week over the civil calendar in 2025, revealing the peaks of laying period, hatching and fledging.

The figure 7 illustrates that the first egg-laying peak occurred in week 17 (21–27 April). A second peak was observed in week 18 (28 April–4 May) (Figure 1: habitat CoMi and CoHi), followed by a decline throughout the season.

Approximately three weeks after the egg-laying peaks, the corresponding chick-hatching peaks were recorded. According to nius.cat, Coal tits lay around 6,6 eggs. In our case, we found an average of 6 eggs typically one per day, followed by an incubation period of about 14 days. The first chicks hatched in week 19, and the last in week 27.

Similarly, the fledging peaks occurred about three weeks after the hatching peaks, showing a clear breeding dynamic for this species (Figure 7).

Productivity

To assess productivity, data from the Great Tit, Blue Tit, Coal Tit, and Nuthatch are presented. The three tit species provided the most consistent datasets, while the Nuthatch data, although less abundant, still offer valuable insights.

The percentage of broods indicates cases where at least one chick was alive, regardless of whether the brood succeeded or failed. A brood is considered successful when at least one chick fledges.

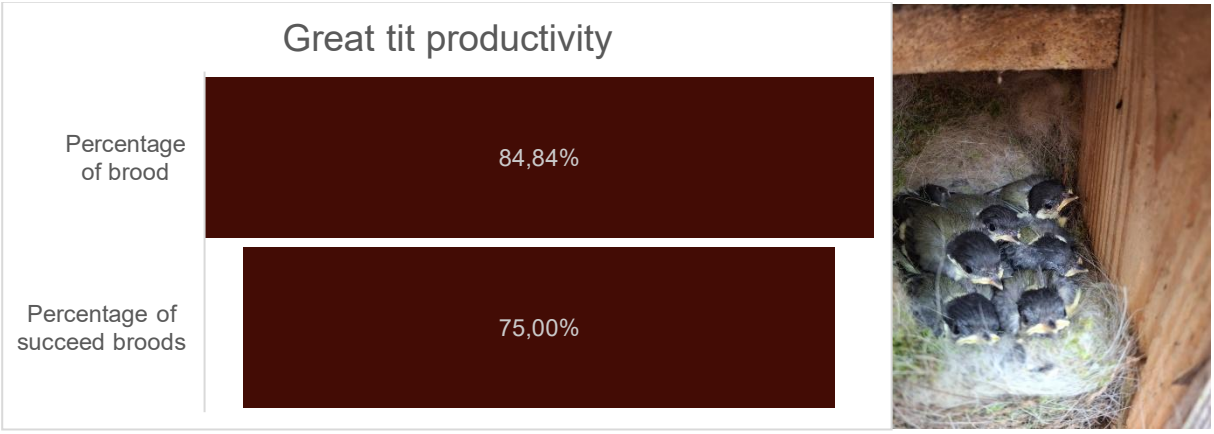

Figure 9: Funnel chart: The percentages are calculated hierarchically. The percentage of broods is calculated from the Great Tit clutches. And the percentage of successful broods is calculated from the total number of broods. This stepwise representation highlights the productivity of this species.

As shown in Figure 4, 35% of all clutches belonged to Great Tits.
Within this group, the results presented in Figure 9 indicate that 84.84% of clutches produced at least one live chick (represented as the percentage of broods), and 75% of these broods were successful, reaching the fledging stage.

The Blue tit presents a higher percentage of brood and successful brood than the Great tit.

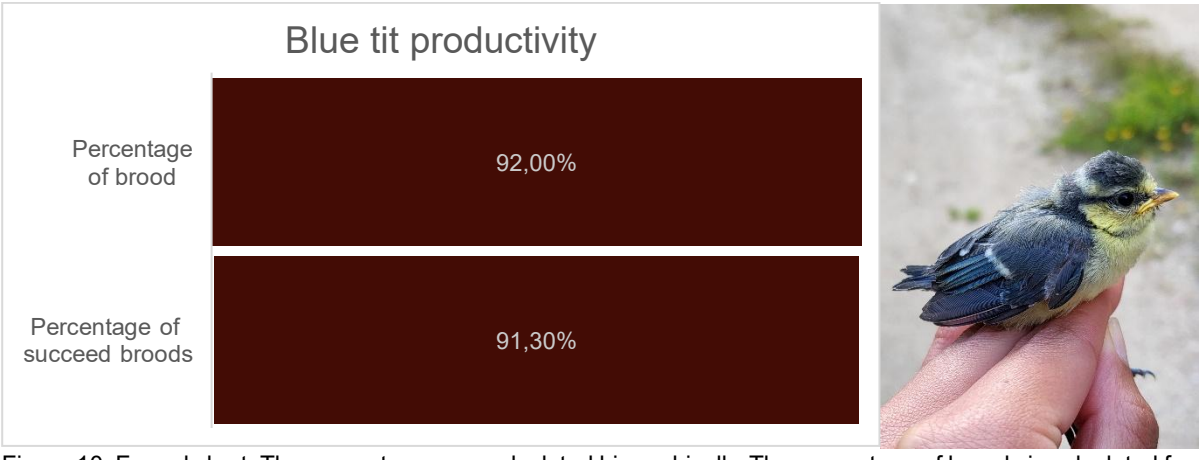

Figure 10: Funnel chart: The percentages are calculated hierarchically. The percentage of broods is calculated from the Blue Tit clutches. And the percentage of successful broods is calculated from the total number of broods. This stepwise representation highlights the productivity of this species.

Of all clutches, 28% belonged to Blue Tits (Figure 4).
Within this group, 92% of clutches contained at least one live chick (represented as the percentage of broods), and 91,30% of these broods were successful, reaching fledging.

The Coal tit presents the same percentage of successful broods as the Great tit.

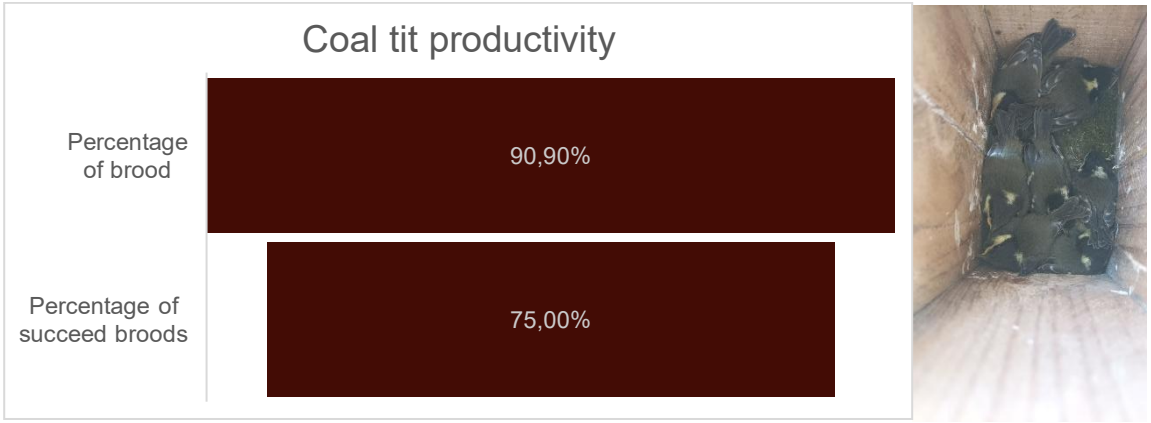

Figure 11: Funnel chart: The percentages are calculated hierarchically. The percentage of broods is calculated from the Coal Tit clutches. And the percentage of successful broods is calculated from the total number of broods. This stepwise representation highlights the productivity of this species.

Of all clutches, 24% belonged to Coal Tits (Figure 4).
Within this group, 90,90% of clutches contained at least one live chick (represented as the percentage of broods), and 75% of these broods were successful, reaching fledging.

All the Nuthatch broods succeed.

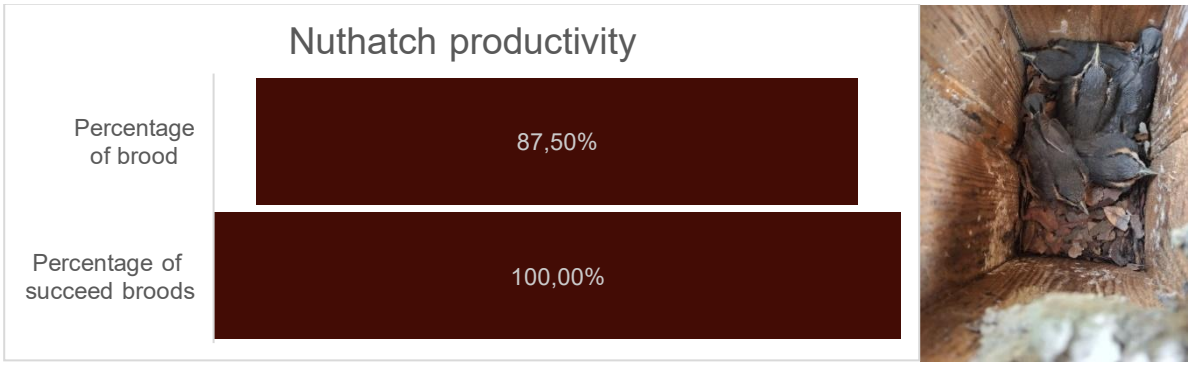

Figure 12: Funnel chart: The percentages are calculated hierarchically. The percentage of broods is calculated from the Nuthatch clutches. And the percentage of successful broods is calculated from the total number of broods. This stepwise representation highlights the productivity of this species.

Of all clutches, 9% belonged to Nuthatches. Within this group, 87,50% of clutches contained at least one live chick (represented as the percentage of broods), and 100% of these broods were successful, reaching fledging.

Outcomes

As nests are an integral part of the biodiversity cycle, some broods succeed, as shown in the previous section, while others fail due to various factors such as predation, weather conditions, or nest abandonment.

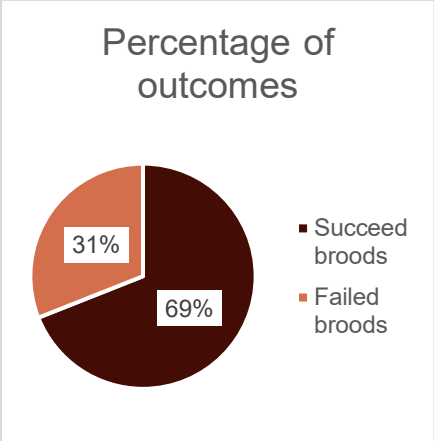

Figure 13: Percentage of success and failed broods.

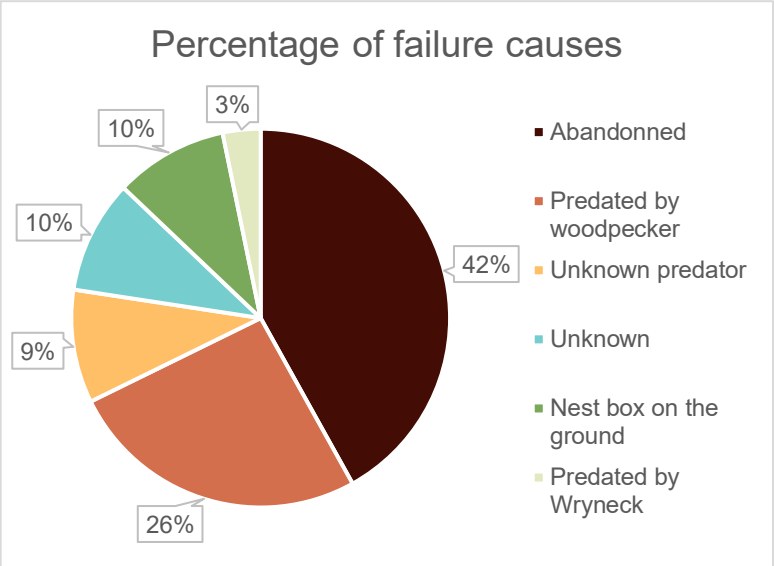

Figure 14: Percentage of each failure cause relative to the total number of failed broods observed across all species along the monitoring.

From the laying of the first egg to the fledging of the last chick, 31% of clutches and broods failed (Figure 13).

In these 31%, six different causes of failure were observed:

- 42% were abandoned, meaning the brood failed without an apparent reason.
- 26% were predated by Great Spotted Woodpeckers, as confirmed by camera trap evidence and the hole made in the nest boxes.
- 9% were predated by an unidentified predator.
- 10% could not be assigned a clear successful or cause of failure due to time constraints and, as the nests did not show signs of abandonment or predation.
- 10% of the nest boxes fell to the ground.
- 3% were possibly predated by a Wryneck, based on observations during the first check: eggs were present without nesting material, and some eggs were found on the ground; however, this remains a hypothesis.

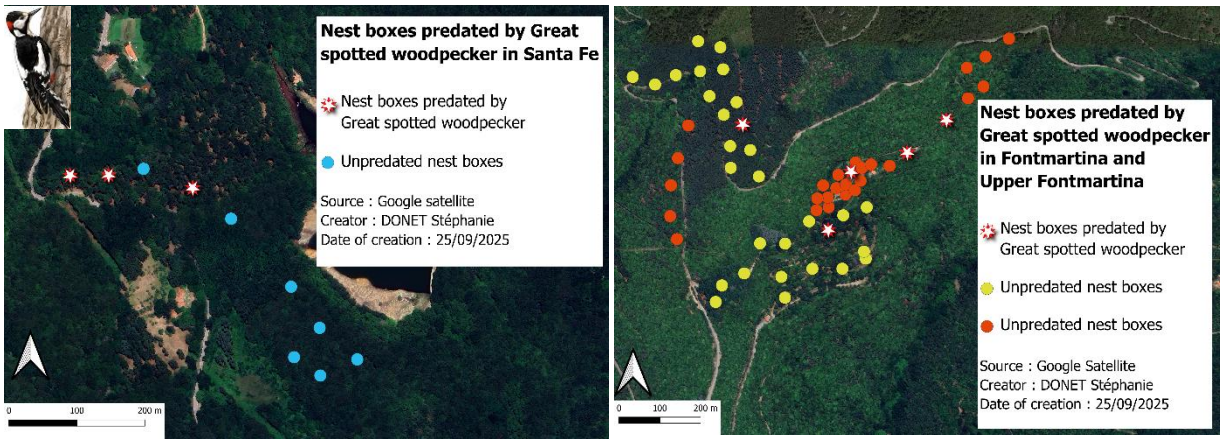

Figure 14: Maps representing the location of the predations by Great Spotted Woodpecker.


Figure 15: Nest box predated by a Great Spotted woodpecker

The Great Spotted Woodpecker predated three nest boxes located close to each other in Santa Fe; these nest boxes contained between three and six chicks. It also predated five nest boxes in the Fontmartina area, which contained between five and seven chicks.
All these predation events occurred between week 22 and week 25. This pattern suggests a potential risk that some individuals may learn to search for food in nest boxes. Fortunately, the predation activity later ceased and can be considered part of normal ecological dynamics, as chicks naturally form a component of the forest food web.

Second brood

A brood was considered a second brood when a nesting attempt was found after a previous one in the same nest box and by the same species. This means that an unknown proportion of second broods may have been identified as first broods if the birds decided to use a different nest for their second brood.

During the 2025 breeding season, only two species produced second broods, for a total of eight cases: five by Great Tits and three by Coal Tits. Among these, only three Great Tit broods were successful, all located in sclerophyll forest two at low altitude and one at medium altitude with an average of six fledglings, similar to that of the first broods. Only one Coal tit brood succeeded in Deciduous forest at medium altitude with five chicks.
These second broods represented 7% of the total broods recorded. In comparison, no second broods were observed in 2022 and 2023, and only one was recorded in 2024. According to nius.cat data, the Great Tit is known to produce one or two broods per season, whereas the Coal Tit is generally reported to produce only one.

Comparison with previous years

In 2025, nest box activity began earlier than in previous years. The first chick hatched on 17 April 2025, compared to 28 April 2024, 27 April 2023, and 13 May 2022, the first year of monitoring. This trend can suggest a progressive advancement in breeding phenology over the four years and is likely influenced by favourable environmental conditions.

Every year, an increase in the use of nest boxes is observed compared to the previous year. In 2022 and 2023, only Great Tit, Blue Tit, Coal Tit, Crested Tit, and Nuthatches were recorded. In 2024, the Short-toed Treecreeper was first observed breeding in nest boxes, followed by the Marsh Tit in 2025.

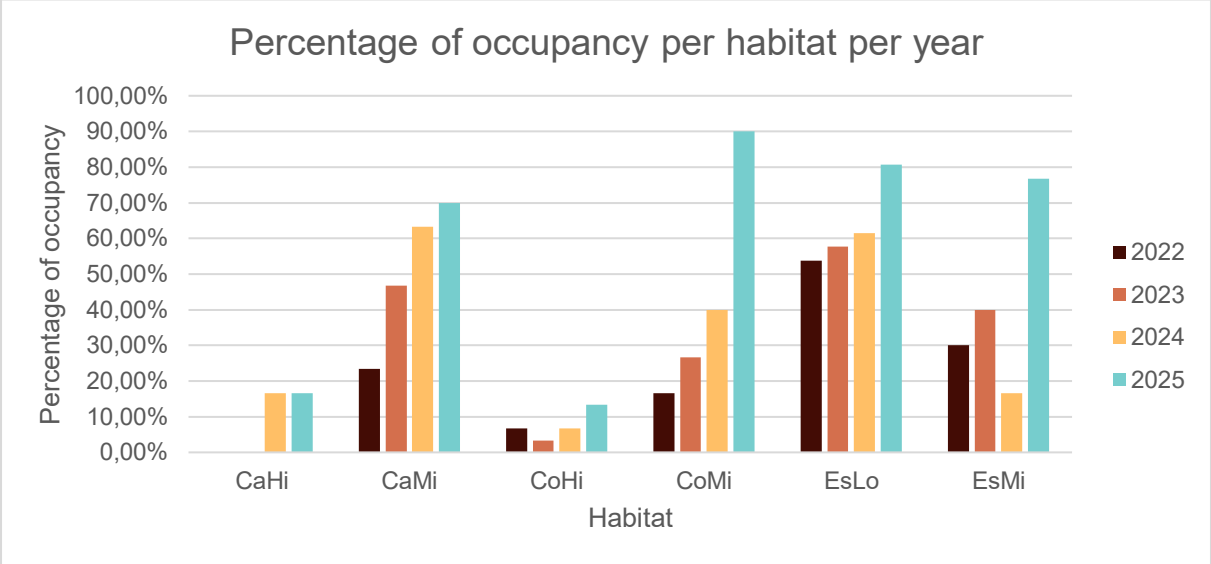

Figure 16: Non-cumulative percentage of nest boxes occupied in each habitat across all the species during every monitoring year.

Each habitat shows a distinct dynamic. As seen in Figure 16, more nest boxes were occupied in 2025 than in previous years across all habitats.

In greater detail, in 2022 and 2023 the nest boxes in CaHi (Figure 1: Turó de l'Home) were not used, but occupancy appeared at the same percentage (16.67%) in both 2024 and 2025.

Occupancy increased steadily every year in CaMi (Figure 1: Santa Fe), from 23.33% in 2022, to 46.67% in 2023, 63.33% in 2024, and reaching 70% this year. A similar trend was observed in CoMi (Figure 1: Upper Fontmartina), with 16.67% in 2022, 26.67% in 2023, 40% in 2024, and a peak of 90% in 2025. In EsLo (Figure 1: Montnegre), 53.85% of the nest boxes were occupied in 2022, 57.69% in 2023, 61.54% in 2024, and 80.77% in 2025.

For CoHi (Figure 1: Plana Amagada), occupancy remained lower and more variable than in other habitats, with 6.67% in 2022, 3.33% in 2023, 6.67% in 2024, and 13.33% in 2025. EsMi (Figure 1: Fontmartina) also showed notable year-to-year fluctuations, with occupancy of 30% in 2022, 40% in 2023, a drop to 16.67% in 2024, and a strong increase to 76.67% in 2025.

Across all habitats, the percentage of broods followed the same general trend as occupancy, although at lower values, since some nests failed before hatching and no chicks emerged. Since nest box occupancy was higher in 2025, this explains the greater number of broods recorded across all habitats compared to previous years. According to our data in CaHi, broods were recorded only in 2025.

Regarding breeding success, Figure 17 clearly shows a completely different pattern.

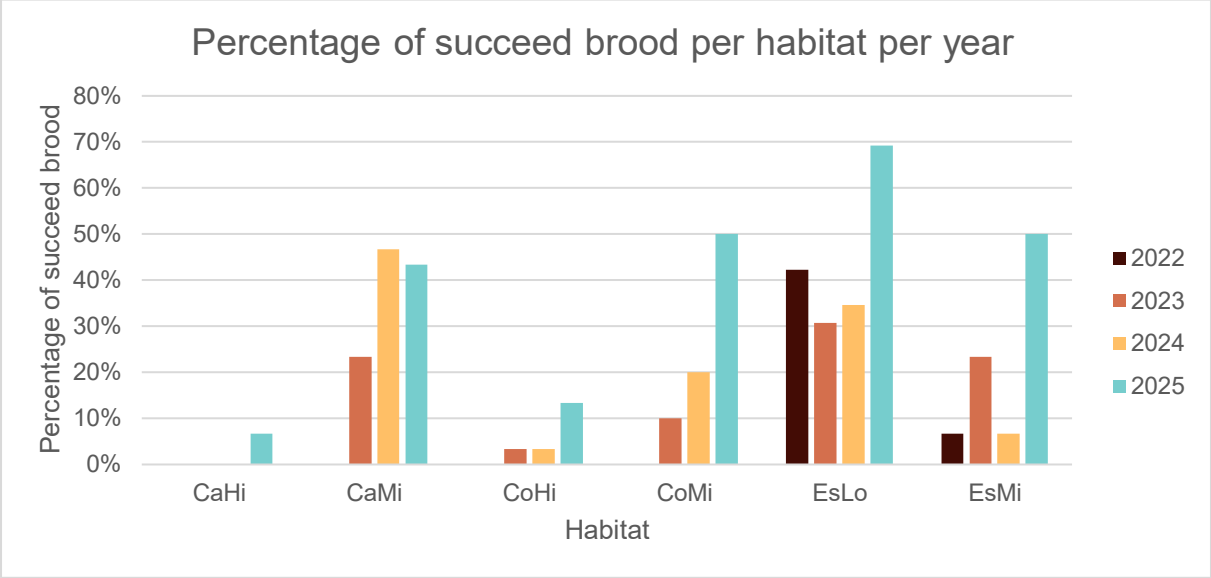

Figure 17: Non-cumulative percentage of successful broods recorded in each habitat during every monitoring year, illustrating both the habitat used and annual breeding productivity across all the species.

In 2022, no successful broods were recorded in four habitats (CaHi, CaMi, CoHi, and CoMi). While 2025 still shows overall higher success rates, CaMi is an exception, with a slight decrease from 47% in 2024 to 43% in 2025. In contrast, CoHi, CoMi, EsLo, and EsMi show a marked increase in the proportion of successful broods in 2025.

Chick guide evaluation

Last year, a chick development guide for Great Tit, Blue Tit, and Coal Tit was developed and tested during the current breeding season. Each evaluation was executed by a volunteer who visited a nest box without knowing the actual age of the chicks, to avoid bias. Using the guide, the volunteer estimated the chicks' age, which was then compared with the actual age known by the project leader.

Out of 34 evaluations, only 10 were inaccurate, and among these, 8 were differed by just one day (Table 5). This indicates that the chick development guide is reliable and accurate and can therefore be used in future breeding seasons.

34 evaluation (5 observer)		
24 Right	10 wrong	
	Number mistake	Days difference
	1	3
	1	2
	8	1

Table 5: Chick guide evaluation involving five observers, showing the number of correct and incorrect age assessments. For the incorrect ones, the table also indicates the difference in days between the estimated and the real chick ages.

Conclusion

This breeding season was particularly productive. The abundant food resources provided by a wet spring and the favourable weather conditions likely contributed to the high occupancy rates and successful broods observed across all habitats.

However, despite these positive outcomes, there is still insufficient data to evaluate the long-term impacts of climate change on breeding patterns. Most bird species in temperate regions such as Catalonia tend to synchronise their breeding period with the peak of food availability, which typically occurs from spring to early summer, when daylight hours and insect abundance are at their highest.

Overall, this season provided valuable insights into the breeding dynamics of the Great Tit, Blue Tit, and Coal Tit, and reinforced the importance of long-term monitoring to better understand how environmental conditions influence reproductive success in different habitats. It is also important to note that this project is managed each year by a different volunteer, pursuing different objectives, which may introduce methodological biases and help explain variations in the results between years.

From a methodological point of view, this was the first season using an endoscope to inspect nest boxes, which proved to be highly efficient, as the birds remained calm and did not abandon their nests during the incubation period.

Finally, all collected data are available on nius.cat, a citizen science initiative dedicated to monitoring bird nesting. Its main objective is to gather information on where, when, and how birds breed including the location of nests, breeding phenology, and reproductive biology.

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