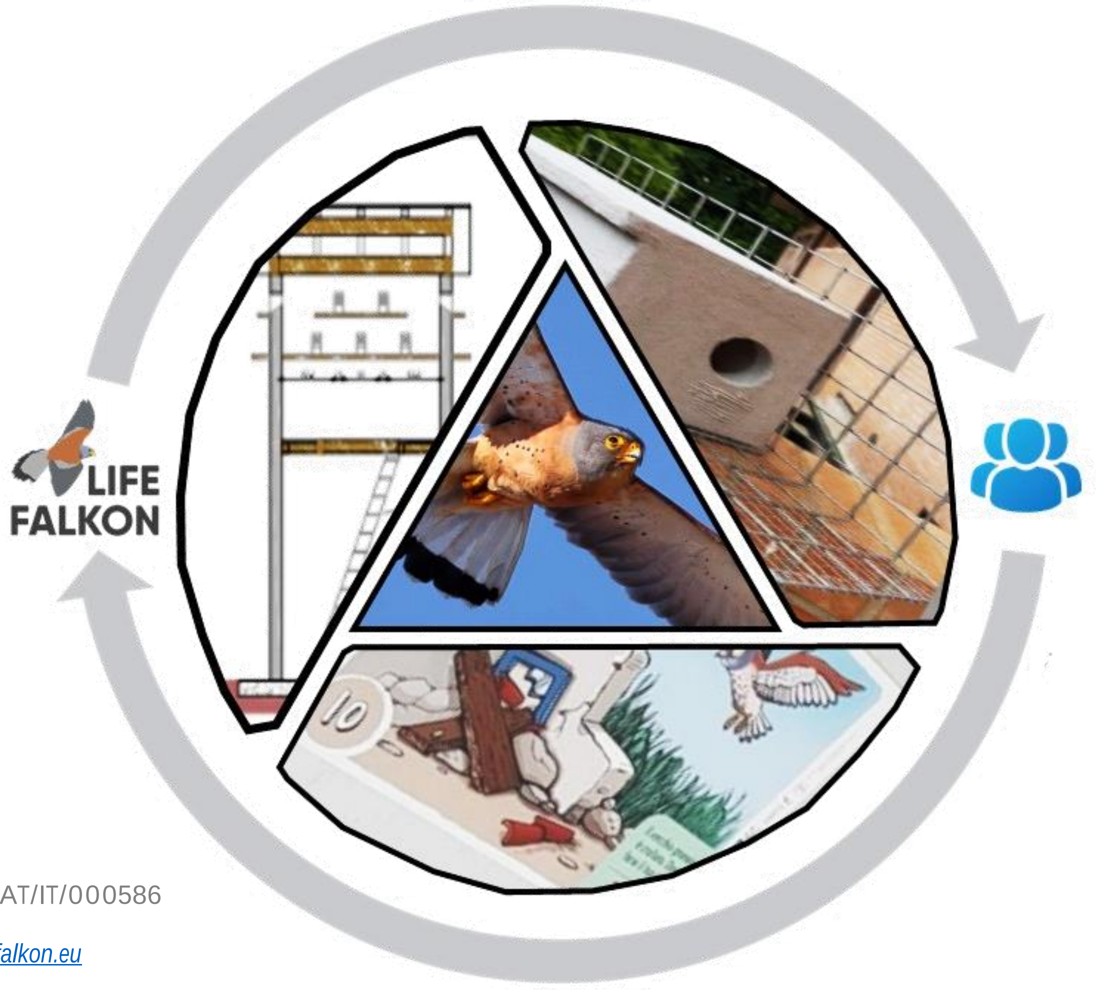
DELIVERABLES

ACTION E.5

LIFE FALKON HANDBOOK FOR TRANSFERABILITY AND REPLICABILITY

DECEMBER 2023



LIFE17 NAT/IT/000586

www.lifefalkon.eu

Partner responsible for the action:

CNR-IRSA Consiglio Nazionale delle Ricerche – Istituto di Ricerca sulle Acque

Partnership:

Report compiled by:

Michelangelo Morganti[1], Nikos Tsiopelas[2], Diego Rubolini[3], Andrea Pirovano[1], Alejandro Corregidor-Castro[1], Alessandro Berlusconi[1], Alessia Marzotto[4], Roula Trigou[2], Gaia Bazzi[5], and Jacopo G. Cecere[5]

1: CNR-IRSA, Consiglio Nazionale delle Ricerche- Istituto di Ricerca Sulle Acque, Italy: Università degli studi di Milano, Italy; 2: Hellenic Ornithological Society, HOS-Birdlife, Greece; 3: Università degli Studi di Milano, Italy; 4: ALDA Association for Local Democracy, France/Italy; 5: ISPRA Istituto Superiore Protezione e Ricerca Ambientale, Italy.

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About the project:

The activities described in this report were carried out under the framework of action E5 of the LIFE project "LIFE FALKON" (LIFE17 NAT/IT/000586, www.lifefalkon.eu), further referred to as either "the LIFE project" or "LIFE FALKON", funded by the European Commission, co-funded by the Green Fund and Fondazione Cariplo and implemented by the CNR-IRSA, the Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA), the Sistema Nazionale per la Protezione dell'Ambiente (SNPA), the University of Milano, the Hellenic Ornithological Society (BirdLife Greece) and the European Association for Local Democracy (ALDA).

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Summary

The purpose of this manual is to facilitate the transfer of the outcomes and accomplishments of the LIFE FALKON Project to stakeholders at both the national and European levels. This transfer aims to make the best practices cultivated within the project readily replicable.

What sets LIFE FALKON apart is its groundbreaking focus. Unlike traditional projects geared toward safeguarding the Lesser Kestrel within its core living areas, this initiative targets newly colonized regions. These areas, spurred by ongoing climate shifts, have become suitable for the species, leading it to expand into previously uncharted territories.

The significance of transferring and replicating the project's results and solutions becomes evident when considering that, in the not-so-distant future, research groups and environmental organizations will encounter the Lesser Kestrel in areas where it has never existed before. As a consequence, there is a dearth of established knowledge on how to conserve the species in these novel habitats.

The technical manual comprehensively outlines the methods and best practices employed throughout the project for the protection of the Lesser Kestrel. This includes techniques for identifying new breeding sites, the operative projects and installation methods of nest boxes and nesting towers to support reproduction, monitoring approaches for assessing box occupancy and reproductive success, and tools for engaging a diverse array of stakeholders

SECTION A - Long-term monitoring of wild colonies and survey of new potential breeding sites

A.1. Census and Long-term monitoring of lesser kestrel colonies. Proposed methodology and relevant advices.

Implementation of systematic surveys and censuses at the reproductive colonies of lesser kestrels (*Falco naumanni*) is crucial for (a) quantifying the breeding population (b) assessing the population's trend in the long-term and (c) detecting changes and identifying their possible causes.

Identification and quantification of the occurrence of breeding pairs in the framework of LIFE18/NAT/IT000586 followed a methodology partially developed during the LIFE 11 NAT/GR/001011, integrated with the suggestions of Ursúa (2006) and adapted to the different terrains of the various Project Areas (see also Action A1 final report). Thus, in the case of colonies being localised in individual isolated buildings (as in PA1) demanded a different approach regarding the survey methodology used, in comparison to reproductive colonies being scattered on a wider area such as a village or a town (as in all Greek PAs).

More in detail, the proposed survey techniques are:

A1.1. Surveys in colonies concentrated in isolated buildings or nest boxes.

Colony surveys are conducted by at least two operators. Once in proximity to the colony, the operators stop the vehicle at a distance of at least 150-200 meters - in order to avoid disturbance - and wait for about 5 minutes. During this time, they attempt to spot and identify adult lesser kestrels in flight or perched near the nesting site using binoculars and/or spotting scopes. Subsequently, one surveyor approaches closer to the colony while the rest remain at a greater distance in order to record any alarmed individuals. In response to a potential predator approaching the colony, lesser kestrels typically put in place a mobbing behaviour characterised by repeated flights at small altitudes accompanied by an unmistakable alarm recall. Despite the fact that the intensity of this behaviour can highly variate among different breeding areas and it can potentially be dependent on colony size and breeding stage (i.e. more intense in bigger colonies and during the chick-rearing phase), in most of the cases a simple approach to the colony triggers this reaction, thus confirming the occurrence of breeding pairs of lesser kestrel. As a result, the approach to the colony causes a disturbance thus enabling the other observer to easily count the total number of birds, identify their sex and obtain an estimate of the number of breeding pairs locally occurring. When possible, the observers should move around the building maintaining the distance, in order to visually scan the sides of the building that were not visible from the first observation point. Alternatively, a greater number of spotters (if available) can be deployed all around the building covering all possible sides. This option can reduce bias from double-counting when performed in a simultaneous and rapid manner. The entire procedure must be completed within a maximum of about 15 minutes, in order to cause the least possible disturbance to the colony.

Particular attention should be paid to the movements of the adults, in order to determine the location of the nests. This is usually possible by identifying the entry and exit points of the individuals under the eaves and other cavities of the buildings hosting the colonies.

A1.2. Surveys in colonies expanding over wider areas (villages or towns).

In areas where the lesser kestrel colonies are distributed widely within a defined area such as a village or town, (as in all Greek PAs) the survey should be focused on detecting the presence of active nests /pairs by implementing a methodological approach divided into two consecutive steps.

The first step is based on the use of vantage points sited within each colony. For at least 30 minutes, the observers try to locate nesting sites using binoculars and telescopes. For this purpose, a detailed scanning of the roofs at regular intervals, or alternatively, a monitoring of the flights of adult birds carrying food to the nests was conducted. The aim of this preliminary work is to locate as many nesting sites as possible, in order to map them and before moving at the stage of nesting sites survey by systematically walking in the settlements. It is advised that this step takes place at mid-day and - if possible- more than one vantage points should be used.

The second step consists of the recording and mapping of active nesting sites by systematically walking in the settlements and checking, if possible, all the buildings / potential nesting sites. Occupied nests are located and recorded where either an incubating adult is flushed from the nest and an adult is seen entering or leaving the same entrance (at least twice) or adults are seen carrying food to the nest. The rest of adult observations close to the nesting sites (e.g females supervising their nest from a post, pole or top of the roof) are only informative for the census of occupied nests and should not be used on the final census and mapping of the colony.

It should be noted that, depending on the size and the morphology of the colony / settlement, the first step can be skipped whether for simplification of the census procedure (when a village is very small) or because no appropriate vantage points are present in the area.

In the case artificial nests such as nestboxes are present within the area under survey, they are treated in the same way as described in A.1.1. in the present document.

A1.3. Subsequent Actions

Once the possible nests are located the collected sites must be geo-refernced mapped, preferably using digital mapping tools such ArcGIS or similar. Photos of the buildings and individual nest entrances should be also collected and provided as supplementary info to the mapping.

Subsequently, the presence of eggs and/or chicks inside should be checked, at least for the ones for which the existing information is not sufficient for certifying occupancy. To check the occupancy status of the natural or artificial nesting sites, two different approaches can be used, depending on the accessibility and structural characteristics of the various sites. When the potential nests are not situated too high (less than 5 meters), they can be inspected by an endoscope fixed on a telescopic rod (or similar) inserted through the entrance or other openings. The images provided by the instrument are easily viewed in real-time by the operators while photo captures and video recordings can be provided as well. In other cases, when the potential nesting site is situated in a greater height, it is necessary to reach the nest box using a ladder for direct inspection. Under all circumstances, all required safety measures (helmets, protective goggles) should be taken by the field workers.

A.2. Survey of new potential breeding sites

Climate warming has been favouring the northward expansion of lesser kestrels towards new breeding areas. In this context, climate change has favoured the northernward breeding expansion of the lesser kestrel in the Po Plain, with the first breeding attempt in 2000. The distribution of lesser kestrel was poorly known until 2018 in the Po Plain, with a few exceptions: a total of 23 lesser kestrel breeding occurrences (grouped in 17 colonies). Scattered in small colonies, mostly of 2-4 pairs concentrated in abandoned rural buildings, where common kestrels are very abundant, most of the lesser kestrel colonies were likely to have been overlooked.

To overcome this issue, from 2019 to 2021 we visited all those rural buildings (~2,000) that were likely to host lesser kestrels, in a buffer of ~20 km of radius from the known colony sites in the study area, since the distribution of lesser kestrel colonies is normally aggregated at a landscape scale (see i.e. Ursúa-Sesma 2006).

Preliminary identification of the buildings was performed through observation of satellite imagery using QGIS software (version 2.18.13) (QGIS Development Team, 2018) on a satellite map sourced from Google Satellite Hybrid, last updated in 2018, with the Quick Map Service Plug-In. We selected remote farmhouses that appeared abandoned and dilapidated in satellite photos, situated in rural areas far from cities, forests and rivers. In total, our search identified more than 2,000 farmhouses potentially suitable for occupation (Figure 1).

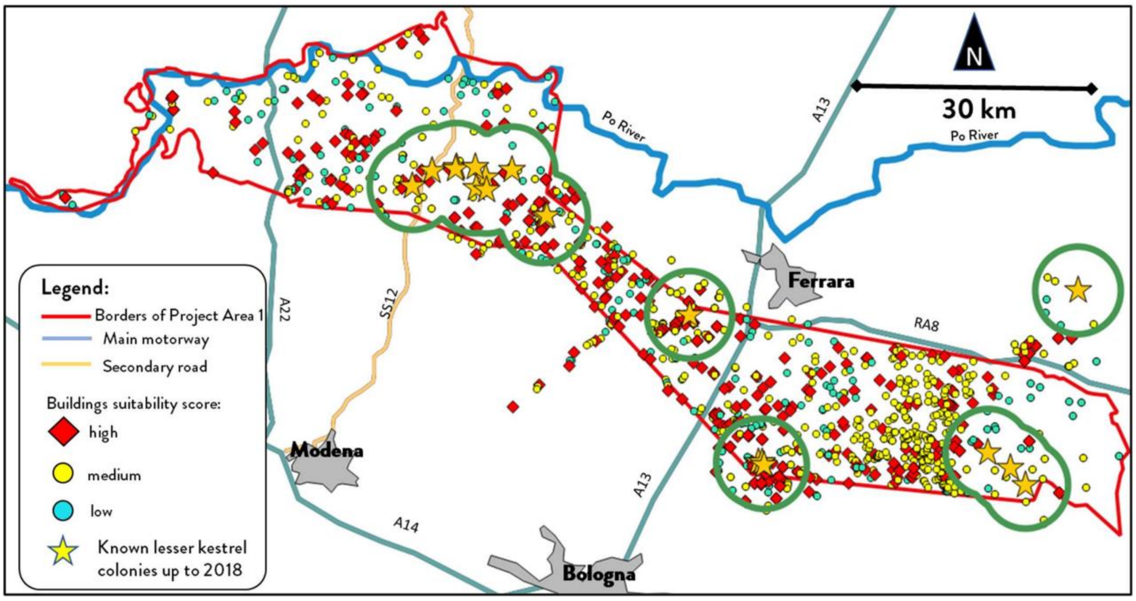

Figure 1. Distribution of the buildings identified as potentially suitable to host Lesser Kestrel colonies in preparation of the survey season 2019 in Project Area 1. Buildings were classified with a score of suitability. The survey was initially concentrated with a 20 km² buffer (green circles) around the known colony sites.

We conducted the survey through a standardised method, based on those proposed for lesser kestrel census by Ursúa-Sesma (2006) and implemented within the framework of the LIFE FALKON project, which proved to be also efficient in detecting breeding pairs of common kestrels (*Falco tinnunculus*) and rollers (*Coracias garrulus*), that frequently breed in rural buildings as well. Two observers approached the farmhouse in a car at a distance of approximately 50-100 metres. Initial observations were conducted at this range for 10 minutes. Then, the first observer remained in observation using binoculars and a scope, while the second approached the structure. They observed the birds in flight to determine their species.

All surveys were conducted between May and June, a period when pairs have already formed in the Po Plain, and the choice of nesting sites has already been made. Nevertheless, this survey practice, despite potential invasiveness and disturbance, does not compromise the breeding of kestrels, given their high territoriality degree and colony defence. Surveys were carried out on days without wind or rain to minimise meteorological disturbance affecting the observability of individuals.

Due to the high number of points to be checked, priority was given to farmhouses located within a 6 km radius of known colonies, discovering 74% of total new colonies. Subsequently, surveys extended to points outside the buffer areas, initially prioritising buildings with the highest suitability and gradually including those with lower suitability, until the end of the designated time period.

During the 2019-2021 surveys, we found 27 new buildings hosting breeding lesser kestrels, grouped into 19 new colonies.

A.3. Conclusions section A

In this context of global changes and populations shifting, Spatial Distribution Models (SDMs hereafter) represent an effective tool to define the eco-climatic variables that quantitatively describe the spatial niche of a given species, study of the biological responses to climate change, and eventually investigate current and future suitability areas and potential distribution of the studied species. SDMs are based on the association between spatially explicit information on species occurrence with maps representing the variability of ecological, climatic or land-use factors to gather an ideal range of values in which the species is likely to occur, allowing to estimate habitat suitability also over areas that could not be directly censused.

Moreover, research on foraging and breeding habitat selection at a finer scale is to be favoured, in order to consider specific context-dependent selection in the considered area. Overall, vegetation height and structure strongly influenced foraging habitat selection of lesser kestrel, more than crop types. However, due to the high dynamism of intensive agricultural ecosystems, crop types and vegetation height change drastically during the breeding season. Agricultural practices positively influenced foraging activities of the three species.

All these findings should be considered when planning conservation initiatives for the lesser kestrel in the Po Plain as well as in other intensively cultivated areas of its (northward expanding) breeding range. This would provide more comprehensive knowledge to foster the long-term conservation of the lesser kestrel (as population boosting utilising nest-boxes), as well as of other species with similar ecological requirements, in intensively cultivated agroecosystems.

SECTION B - Projects and building plans of nesting towers and nestboxes

B.1. General advices on artificial nests for lesser kestrels

The artificial nest designs were developed in the framework of Action A2. To do so, the team revised the available scientific literature on the topic, underwent a thorough market research of all the available models produced in Europe and built some prototype nests that were tested in active lesser kestrel colonies. Accordingly, three typologies were promoted for use and were consequently purchased/constructed and installed (Action C1): one suited for the installation on buildings (produced in three different colours to better match the different architectural styles of the study areas), one suited to be deployed on electric poles and one dedicated for the nesting towers. Additionally, LIFE FALKON developed 'smart' nestboxes (allowing videorecording the nest and remote captures) and roof-adapted nestboxes that have been deployed on the towers.

Permits for their installation on buildings or other structures were obtained where necessary.

In Italy the main providers of nestboxes have been DEMA PRIMILLA and CISNIAR, both of which have extensive experience in construction of artificial nests for the species in Spain and Italy respectively. The material of construction was the main differentiation factor of the nestboxes, with the basic design remaining similar in a great degree. Two nestboxes' types (building and tower types) were made by cement-based materials and one (pole type) was made by wood.

In Greece, the majority of the nestboxes were constructed "in house" by a contracted carpenter, based on the designs used and proposed by the LIFE11NAT/GR/001011 project, while also 20 DEMA PRIMILLA nests were installed for assessment purposes. Moreover, in Greece, establishment of nest-complexes (constructions containing multiple nests) took place at selected localities. This is a way to maximise the carrying capacity of a nesting site when the locality is highly suitable but the available space is rather limited (such as water towers).

All nestboxes have some common features:

- shape: elongated, 60 x 30 x 30 cm;
- hole entrance size: ca. 6.5 mm;
- anti-predation structure: small barrier in front of the entrance hole, implanted on the lateral wall;
- chinks at the bottom (nor present in wooden nests)
- ventilation splits.

The experience gathered during the years of the Project has highlighted some problems and solutions related to the use of nestboxes for the conservation of Lesser Kestrel. Following we present the most important of these:

B1.1. Nest temperature regulation.

The projected future increases of summer temperatures and heatwave frequency could become a considerable problem, as we observed a heavy impact of high temperatures inside nestboxes on reproductive success. In 2 consecutive years (2021 and 2022), non-shaded nestboxes showed a widely increased hatching failure, rising above 50% when maximum nest temperatures exceeded 44°C. Moreover, nestlings from non-shaded-nesboxes showed higher mortality during heatwaves and those that survived further showed impaired morphological growth (Corregidor-Castro et al., 2023). Future conservation projects should consider the following advice during nestboxes installation.

- Construct nestboxes with materials that improve insulation.
- Install nestboxes on the most shaded walls of buildings.
- All nestboxes should have ventilation openings and free air-circulation should be achieved.
- Extra devices for temperature decrease (shades, covers etc) should be used when possible.
- Placement of nestboxes internally on roofs should be avoided when there is direct contact with ceramic tiles or metal sheets, since this can induct high temperatures in the inner side of the box.
- Avoid placement of nestboxes near emissions of heat, such as A/C fans, kitchen ventilation ducts, motors, electric appliances and so on.

B1.2) Nest substrate.

Another action that has proven beneficial is to place a substrate on the bottom of the nestboxes, such as organic (peat) or sand. In fact it emerged that nest substrate is a key driver of nest-site choice in Lesser Kestrels. "Dirty" nestboxes were strongly preferred, being occupied earlier and more frequently than clean ones. Moreover, hatching success in dirty nestboxes was significantly higher than in clean ones, suggesting a positive effect of organic nest material on incubation efficiency (Podofillini et al., 2018). Also, given than nestboxes are made of new, completely flat materials such as wood, the presence of a substrate is also important because it does not let the eggs roll uncontrollably. Chinks at the bottom should be resent in order to avoid excessive accumulation of faeces and food remains on the bottom of nestboxes. Over accumulation of these materials can make the nests unusable in some years, cause damaged because of humidity absorption (for wooden structures) and also increase presence of ectoparasites (mites, flies etc.).

B1.3. Anti-predation and avoidance of occupancy by other species.

Anti-predation structure, as described previously should be incorporated in the artificial nestboxes' design in order to minimise the possibility of brood loss by predators. For this reason, proper installation must also take into account the presence of external structures that could allow terrestrial predators (cats, martens etc.) to reach the nestbox. These structures include water pipes, electricity cables, branches, balconies, ramps a.o. Finally, the nest boxes should not be placed too close to the roof since a predator could jump on them from above.

The entrance hole should be no larger than 7.5 mm and ideally around 6,mm in order to deter entrance of other species of birds. These can either occupy the nest or incur the loss of a brood due to predation by some species such as the Eurasian Magpie (*Pica pica*).

The artificial nests installed in all 4 Project Areas, along with the nesting towers constructed in Italy and the nest-complexes in Greece, are expected to play a decisive role to the conservation of the species. Furthermore, they are expected to assist the northward expansion of the lesser kestrel in the two countries, thus enabling the species to withstand the future impacts of climate change. Lastly, the increased availability of access to a significant number of nests can further promote research efforts on the species. This can provide a new insight on the ecological and biological aspects of the life of the lesser kestrel thus improving ornithological knowledge.

B.2. Nesting tower projects

The sites for towers (Project Area 1) have been identified by Action A.1 through intensive field survey and profiting by the solid relations with landowners (either private or public bodies) developed during the initial phase of the LIFE project. Official agreements with landowners were signed and the authorization processes for building were activated in synergy with the appropriate municipalities and authorities. The construction took place from 20.02.2020 to 24.04.2021.

Towers were built according to the blueprints defined within the framework of action A2. They are 5 m high, with a 3 x 3 m base. External holes allow birds to enter into nestboxes placed inside the tower. Each tower hosts 22 nestboxes that can be easily inspected from the inside (Figure 2). They were designed to offer safe nesting sites and minimise the risk of nest predation, while respecting the local architectural style. The design of the LIFE FALKON nesting towers is besides easily replicable, allowing reuse for constructing new towers in the coming years in Italy and Greece.

Figure 2. One of the five LIFE FALKON nesting towers. The image below shows the interior of the nesting tower, where the 22 nestboxes can be inspected.

Three nesting towers were built within Natura2000 sites and the remaining two outside the Natura 2000 network but in strategic positions for increasing the connectivity of the network and improving the expansion of the species, hopefully, throughout the network. In particular, three nesting towers are located in close proximity to Lesser Kestrel colonies, settled in old decaying rural buildings that will likely be demolished in the near future.

Nesting towers were designed thinking of the birds needs and especially those of the chicks during the pre-fledging phase when they are most vulnerable to accidents and predators. LIFE FALKON team thus conceived a continuous wide shelf on the lowest nest-entrance level. This shelf reduces the risk of falling for chicks while offering them the possibility to move around the tower and accessing the various nesting cavities and thus sheltering from potential predators. The nesting cavities are accessed by a small ramp with 45° slope, thereby preventing the use of the entrance cavity as a nesting site of feral pigeons (Columba livia domestica) which are very common in the study areas. Nest sites heights (3.5 m for the lowest level) and distances among entrances were conceived to reduce the probability of conflicts among neighbouring breeding pairs while maximizing the number of nesting cavities offered in a single tower.

High-resolution tables of the executive plans of the nesting towers are available at the following link, both for the four normal nesting towers and for the one that hosts the cage where the hacking project has been realized (See Action C.2 of the Project Plan for details). For details and procedures of identification on the nesting towers building sited in Project Area 1 please refer to the Deliverable of action A.1.

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The 20 nestboxes deployed in each nesting tower were designed by LIFE FALKON together with Ornis Italica, an NGO specialized in the camera-filming of wild birds at the nest. These nestboxes are protected from weather-induced damages as they are placed inside the tower. They can thus be built in marine ply with no need of further isolation. Moreover, these boxes have been structured to offer the possibility to associate a camera to each box, which could be used for both dissemination or research purposes (e.g. behavioural observations or tests).

For the roof of the nesting towers, DEMA-Primilla proposed special nestboxes (Figure 3) deployed under hand-made special tile with an entrance hole to the nest. We opted to acquire 10 of these nestboxes, in order to deploy 2 in each nesting tower.

Figure 3. Roof-adapted nestboxes produced by DEMA, to be deployed on the roof of the nesting towers. The angle and the colour of the special tile has been produced specifically for LIFE FALKON nesting towers.

B.3. Nestboxes

B3.1. Designs of LIFE FALKON nestboxes suitable for electric poles

Pole nestboxes (Figure 4 and Figure 5) have a reduced length to improve stability when deployed on the pole while not reducing the total internal space available for nesting. Sizes are 27x30x56 cm, while the hooking pole is 40 cm long. The overall weight is around 7 kg and the structure is made of wood. We placed the entrance in the longer side of the nestboxes and created a frontal 'balcony' for the birds to rest, which is especially suited for pre-fledging nestlings. This platform has been perforated to avoid the accumulation of faeces, ensuring longer durability of the boxes with no or very reduced need of maintenance. The roof is covered with a special varnish that should preserve its condition over the years. For monitoring activities, the little door on the front side can be used if the nestbox is reachable with a ladder; otherwise, an endoscope can be inserted through the ventilation holes on the sides.

A local manufacturer (CISNIAR) in Mirandola (MO) produced 100 of these nestboxes, which were deployed in Project Area 1 by the technicians of the italian public company ENEL-Distribuzione, owner of the low-voltage electric power poles.

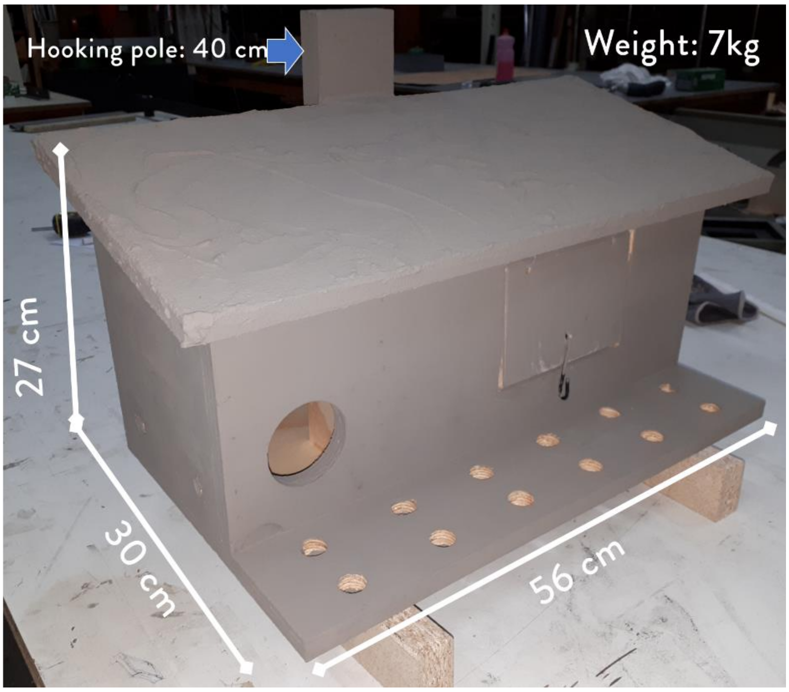

Figure 4. Nestboxes designed by LIFE FALKON and produced in a carpentry in Mirandola (MO), to be deployed on low-voltage electric power poles in P.A.1.

Figure 5. On the left: nestboxes deployed on low-voltage electric power poles in P.A.1. On the right: adult male of Lesser Kestrel flying out of a nestbox.

B3.2. Designs of LIFE FALKON nestboxes suitable for buildings

Concrete nestboxes

For concrete nestboxes suitable for buildings we relied on the DEMA standard model, with some modifications (Figure 6 and Figure 7). These boxes have been produced in three different colours: white (30 for buildings in Greek Project Areas), light grey (60 for agricultural buildings of P.A.1) and light reddish (30 for buildings/private houses of P.A.1). Offering nestboxes of different colours also facilitated the agreements with the landowners. The entrance of all these nestboxes is lateral, as well as the little door usable for monitoring activities if the nestbox is reachable with a ladder; otherwise, an endoscope can be inserted through the ventilation splits on the sides Nestboxes placed on buildings are potentially exposed to a higher risk of extra-warming and this can lead to reduced reproductive success. So, it is of utmost importance that the construction material of the nests has good insulation properties. We therefore opted for the lime-cork mix proposed by DEMA. The 90° metal grid located on the side adjacent to the wall of the building and on the basal side has the function of supporting the nestbox, attaching it to the wall and providing a sill just outside the entrance hole. The grid structure also allows faeces and food remains to fall under the nest.

A total number of 109 concrete nestboxes of this type were used in P.A.1. In italy, and 20 more were installed in total, in the Greek PAs.

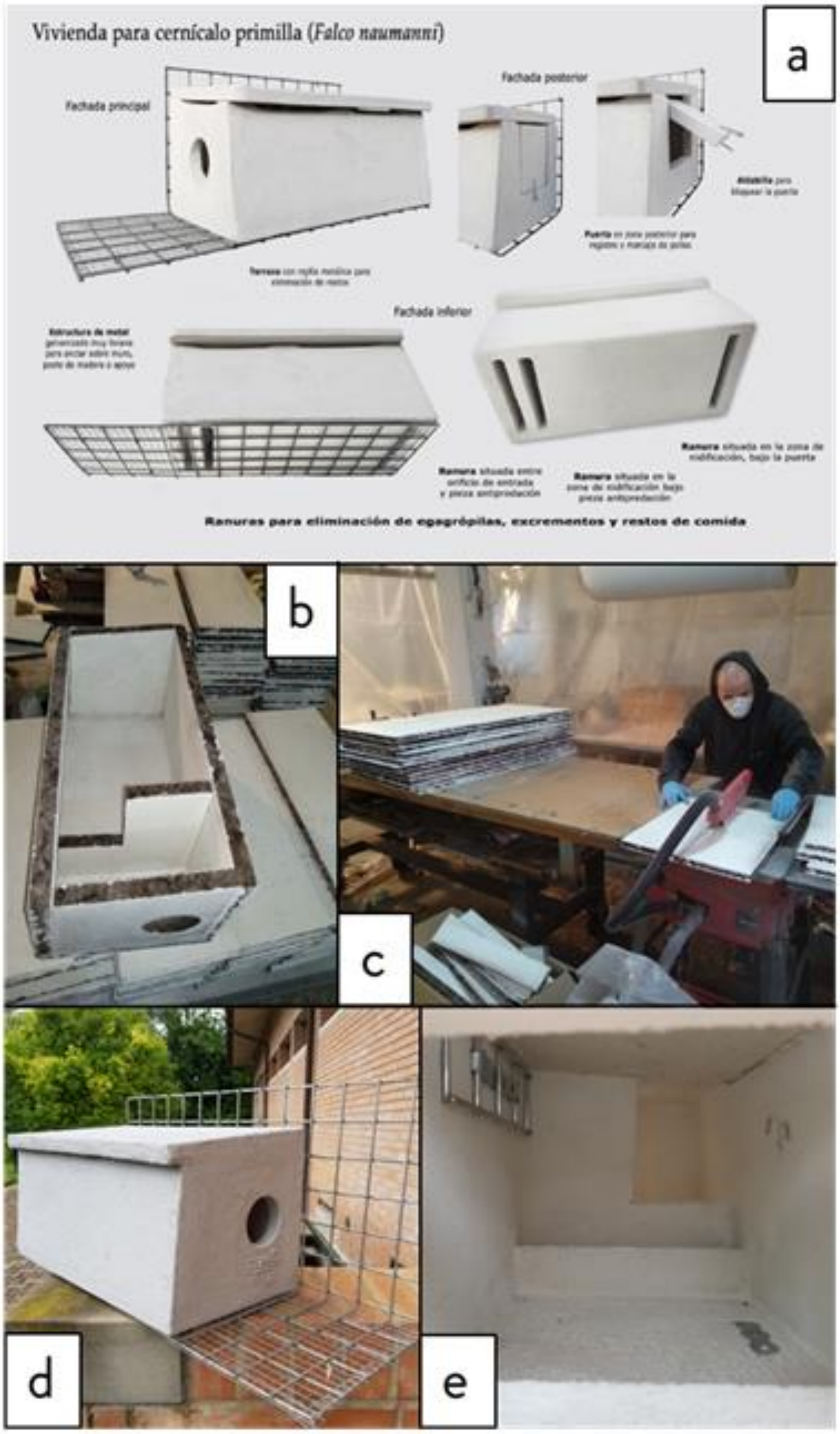

Figure 6. Nestboxes designed by LIFE FALKON and produced by DEMA to be deployed on buildings. Nestboxes have been produced in light grey, white and light reddish colours to adapt to the different architectural styles of the study areas. In the figure: a) general appearance and main structural elements of the nestboxes; b) internal section in front view of a nestbox under construction; c) construction of the walls of the nest box in lime-cork mix; d) completed nestbox with a view of the side entry hole; e) interior of a completed nestbox seen from the side door.

Figure 7. Occupied nestbox -DEMA type

Wooden nestboxes

Regarding wooden nestboxes, the model design that was used on buildings was based on the blueprints produced during the LIFE 11 NAT/GR/001011 project (Figure 8). Wooden nestboxes were installed on buildings only in the Greek project sites. In comparison to the older versions of wooden nestboxes used in other Greek conservation projects, the nests installed in the framework of LIFE FALKON, had the following improvements:

- Improved ventilation, by the creation of wider gaps on the ceiling of the nest
- Anti-predation device installed internally in the nest, consisting of a "Γ" shaped wall. This practically created another obstacle for larger birds, or terrestrial predators, to enter the internal chamber where egg laying is normally taking place.
- Sliding door for the entrance hole. The purpose of the sliding door is to (a) enable trapping of the lesser

kestrel inside the nest (for scientific purposes) and (b) blockage of the nest's entrance during the winter in order to avoid occupation by other species.

Wooden nestboxes mounted on buildings were quite similar to the respective concrete ones with the most significant difference being the absence of the self-cleaning openings on the floor of the nest.

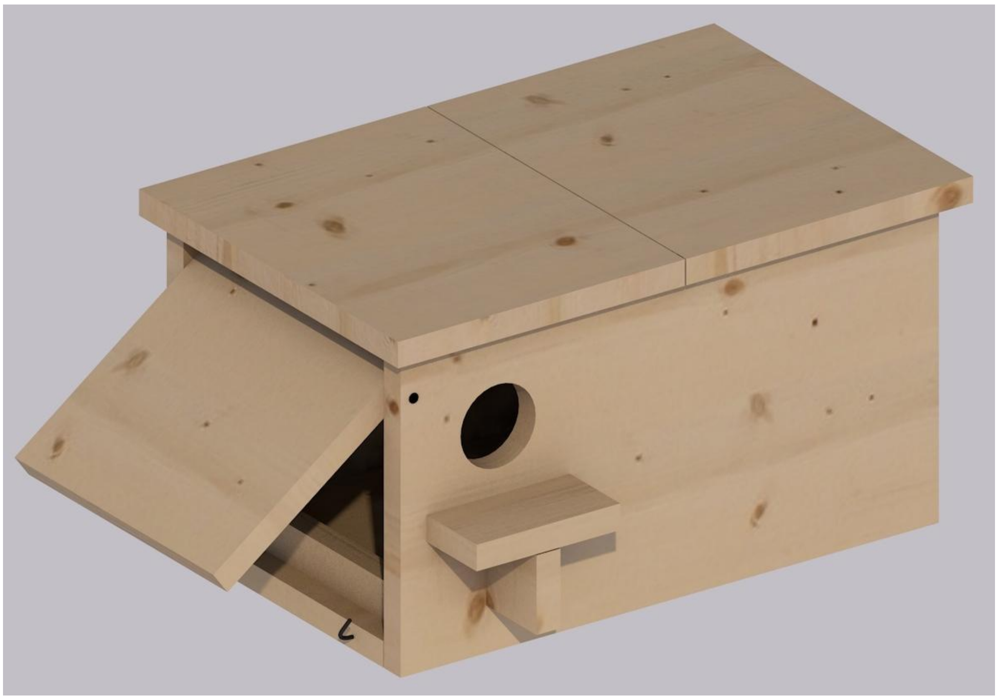

Figure 8. Prototype of wooden Nestbox used by LIFE FALKON

Other types of wooden nestboxes included:

Complex of nest-boxes (wall type & under roof)

These types of artificial nests (Figure 9) are used to a lesser degree, mostly because of the complexity of the structures and the subsequent technical procedures needed, as well as the lack of suitable sites where these complexes can be installed. Nest-complexes provide several advantages in comparison to the nestboxes. Firstly, their occupation rate seems to be higher, as suggested by previous projects. In addition, the maintenance effort they require is less and the overall durability of these structures surpasses the equivalent of the nestboxes. Moreover, this type of artificial nests is far less visible from the human perspective, thus enabling them to mingle aesthetically with buildings where architectural restrictions are placed. Finally, they give the opportunity to occupy confined spaces in a more productive way, since they can fit more than double the nests in a certain area when compared to nestboxes.

Due to their complex design and increased technical capacity required, the nest complexes cannot be constructed in many places. Also, their complexity accounts for a greater cost per nest in comparison to nestboxes. These costs will eventually be equalised by the less maintenance requirements and the greatest durability but the initial investment remains high. Lastly, in some occasions special permits are required for their construction. In total, 124 wooden nestboxes of the 3 types have been installed in the 3 Greek PAs.

Figure 9. Above: architectural cross-section and photo of wooden nestboxes installed under roof - inside a building. Below: Wooden nest complex (wall type) constructed in the PA of Komotini, Greece (inner and outer views).

B3.3. Comparative table with other models of lesser kestrel nestboxes.

Based on the experience gained by the LIFE FALKON as well as from current and previous projects that implemented activities of artificial nests' installation, the following table (Table 1) was compiled, in order to collect all available information on they different values of each type of artificial nests for lesser kestrels.

Table 1. Comparative table of nestboxes types.

NEST TYPE	CODE	COST (€)	DURABILITY (years)	NEED OF MAINTENANCE	INSULATION	VENTILATION	OCCUPATION RATE	"TERRACE"
Concrete (DEMA)	CD	120	20+	LOW	GOOD	GOOD	MEDIUM	YES
Concrete (CISNIAR)	CC	X	20+	LOW	GOOD	GOOD	MEDIUM	YES
Wooden (for poles)	WP	X	5-10	HIGH	BAD / MEDIUM	MEDIUM	MEDIUM	YES
Wooden (HOS)	WH	80	5-10	HIGH	BAD / MEDIUM	MEDIUM	MEDIUM	YES
Clay (HOS)	CH	120	30+	LOW	BAD	BAD	MEDIUM	NO
Nest complex (brick wall)	NCB	X	?	LOW	GOOD	MEDIUM	HIGH	NO
Nest complex (wooden wall)	NCW	40 Per nest	15+	MEDIUM	MEDIUM	MEDIUM	HIGH	YES
In-roof (wooden)	R	80	20+	LOW	GOOD / MEDIUM	BAD	HIGH	NO
PVC (new model BG)	PVC	X	?	LOW	GOOD	GOOD	Unknown	NO

B3.4. Selection of suitable areas for artificial nests and installation guidelines

In addition to habitat suitability, various other elements must be taken into consideration during the selection of the sites (buildings, poles a.o.) where the nest boxes are going to be installed. Moreover, even after the installation site has been decided, the way the nestboxes are installed can play a vital role on their occupancy rate. The factors mainly taken into consideration during the selection of suitable areas for installation of artificial nests for lesser kestrels were the following:

Proximity to existing or historic colonies

Given the colonial habits of the lesser kestrel as well as its philopatry, a tendency of the species to create dense, geographically restrained colonies has been observed. As a result, there are many occasions where occupancy of artificial nests is very low or none, despite the suitability of the nesting and foraging habitats. This can be attributed to the fact that the lesser kestrels tend to remain in proximity to the existing colonies. For this reason, priority must be given to sites located near pre-existing colonies, both active and inactive. The provision of artificial nests in these areas can make possible (a) the recolonisation of areas that despite being suitable had been abandoned due to the loss of nesting sites and (b) the expansion of the existing breeding nuclei.

Some sites were then searched in the areas between two pre-existing colonies, in order to connect the nesting sites by forming a sort of stepping-stones.

Protected areas

When possible, sites belonging in protected areas of Natura 2000 Network should be selected. However, this is not always possible as most protected areas are habitats such as wetlands, that are not suitable for the lesser kestrel, or do not include buildings within them. A particular case concerned the SPA IT4060008 “Valle del Mezzano”, characterised by a vast area (18863 ha) suitable for the species, but with presence of buildings without cavities and therefore unsuitable for nesting. In this case, the positioning of the nest boxes gave the possibility of future nesting of the species in a suitable area that would otherwise be unusable.

Type of Building

Since the objective is to increase the number of suitable breeding sites for lesser kestrels and to provide "safe" nests, ruined and abandoned buildings were not taken into consideration, as they can already be naturally occupied by the species and they are under the risk of collapse. We therefore considered recently constructed buildings which, due to their structural features, did not offer cavities and niches useful for the species to nest in. Furthermore, landmark buildings, state-owned buildings and frequently visited areas should be considered as priority sites for nestboxes installation, as they are able to support communication activities and to magnify the overall impact of the action in the general public. Lastly, buildings of educational institutions such as schools and universities or environmental organisations can largely help disseminate the project's message to specific target-groups (pupils, students etc).

Case study: In PA1 (Po Plain, Italy) a search was first carried out using orthophotos in a 5 km buffer around the colonies known from the previous breeding seasons. A three-category suitability score was then assigned to the buildings, based mainly on the criteria presented in this chapter, and on the site-level characteristics of the identified structure: score 1 (maximum value) for buildings apparently in good condition, isolated and surrounded by open fields, without trees around the walls and away from roads (even dirt ones); score 2 for buildings apparently in good condition but close to dirt roads, or with some trees around; score 3 for buildings whose orthophoto vision showed signs of decay, or the presence of several surrounding trees or the proximity to an asphalt road (secondary and in any case with little traffic). This made it possible to mark approximately 2000 buildings and to give priority in research to the most suitable ones.

An element considered important during the search for suitable sites concerns the motivation of the building owners in participating in the Project and their interest in the conservation of the species. Being a long-term project, it is indeed crucial that the installed boxes are not removed after a few years, especially if occupied by the species. This need was therefore underlined right from the start, describing together with the aims of the Project also some situations which could create the disappointment of the owner: impossibility of renovating/repainting the walls involved during the reproductive period, possible presence of excrement on the walls, use of nestboxes by some other species such as Starling (*Sturnus vulgaris*) etc. The owners were therefore asked to sign a written commitment to keep the nest boxes in the chosen position for at least 20 years from placement, also guaranteeing access to them for monitoring activities.

Type of Poles

As regards the search for suitable sites for the placement of the nestboxes on poles, since these are not visible in orthophotos, they were identified directly in the field according to the criteria described previously (environmental suitability, proximity and connection between colonies, proximity to colonies settled in unsafe or already demolished buildings, protected areas). Harmless low voltage electric power poles with elicord cable were selected, preferring isolated rows of poles in an open field and away from busy roads.

Arrangement of nest-boxes

Since the Lesser Kestrel is a colonial species, the nest boxes were placed in the chosen sites in groups of 4-12. Those positioned on buildings were installed at a height from the ground between 3 and 4.80 m (average of 3.96 m) and at a distance from the top cornice of 0.3-5 m (average of 1.5 m). The nestboxes installed on poles were instead positioned at a height of 3.5-4.8 m from the ground (average of 4.11 m). In general, the nestboxes were not positioned too high to allow monitoring activities.

SECTION C - Suggestion and advices on a proper monitoring protocol for nestboxes

Nestboxes monitoring activities vary in relation to the phases of the reproductive cycle of Lesser Kestrel in the study area:

1) During exploration of suitable breeding sites, courtship and mating (2nd week of April – 2nd week of May), nestboxes are monitored at a distance (~150-200 m) with binoculars and telescope by at least 2 operators for about an hour, avoiding the hottest hours of the day. At the end, a quick check is carried out at the base of the nestboxes for food remains, pellets and/or feathers.
2) During the laying/hatching phase (3rd week of May – 2nd week of June), nestboxes are checked individually with the aid of a ladder and/or endoscope where possible, otherwise an observation session is dedicated as for the previous phase. Nestboxes located inside nesting towers are monitored from inside the towers.
3) In the chick-rearing and chick-fledging phase (3rd week of June – 3rd week of July), occupied nestboxes are checked individually with the aid of a ladder and/or endoscope, avoiding cases with chicks older than 20-25 days, as it may result in premature fledging and nest failures. Nestboxes located inside nesting towers are monitored from inside the towers.

Figure 10. An adult male of Lesser Kestrel brings food for the female in a pole type nestbox.

Direct inspections of nestboxes are carried out through a small opening on the side of nestboxes, designed to reduce disturbance to breeding individuals and/or nestlings. The endoscope is instead inserted through the ventilation holes/splits and its use is preferable to reduce the stress of individuals that cannot see the operator directly. Furthermore, it is a useful tool where it is not possible to use a ladder to reach the nestbox. However, its use often increases the operators' stay below nestboxes by some minutes: depending on the model, the adjustment of the camera angle may not be immediate and often occurs by trial and error. Furthermore, often all the internal corners of the nest are not visible through the camera and the check is generally less immediate. Finally, some small traces of presence may escape inspection through an endoscope, such as crumbled pellets or feathers hidden by the substrate present in the nest. In this regard, it is advisable to take into account that ventilation holes could be used in a practical and efficient way with an endoscope when designing nestboxes.

For each check, a field form is compiled reporting the following data: species, food remains/feathers, number of eggs/chicks, age of the chicks and activity of the individuals near nestboxes (observations of bird perched on nestbox; observation of bird entrance/exit into/from nestbox; observation of mate; observation of the male and female exchanging each other at the nest for brooding; observation of nestling feeding; observation of nestlings showing up at nestbox entrance). For phenological and reproductive success studies it is important to obtain the laying date of the first egg, the number of eggs laid, those hatched and the number of chicks fledged.

For observations at a distance, it must be considered that, during the hatching period, individuals can remain inside the nestboxes without being seen even for long periods before receiving the change at the nest by the partner. Furthermore, the latter could be hunting in fields distant from the site of the nestboxes and therefore the area could appear unfrequented. In general, since observation sessions can last several minutes or hours, it is recommended to carry them out at a distance of no less than 100 meters, as individuals could be discouraged from approaching the nest and this could lead to nesting failure.

Monitoring protocol should also include data collecting of other species that use nestboxes. In Project Area 1, for example, data from Little Owl (*Athene noctua*) and European Roller (*Coracias garrulus*) were also collected. Little Owl presence was frequent in installed nestboxes (21-66 nestboxes per year with its presence between 2021 and 2023) and often the same pair used more than one nestbox for food storage. European Roller was less frequent (3-6 nestboxes per year with its presence between 2021 and 2023), and the fact that it uses nestboxes is a good result as it is a species considered Vulnerable (VU) for the Italian IUCN Red List.

Nest boxes are also suitable for behavioural studies and monitoring carried out through camera-trap and webcams. The use of cameras for remote and live-monitoring allows for an efficient way to understand the different natural behaviours individuals perform, and can have many different applications, from studying different phases of reproduction to understanding the influences of key nest element designs. The most common cameras used in wildlife ecology for monitoring individual's behaviour are camera traps, and long-feed cameras (or webcams).

Camera traps are one of the preferred monitoring elements due to their high resistance to the elements (water and heat), and their autonomy in terms of battery life (specially the ones equipped with solar panels), being only limited in terms of registration capacity, highly dependent on the model and SD card provided. As a rough estimate, considering a high activity in the focus of the camera trap, but highly depending on the modality of data collection (image or videos), SD cards ought to be changed every 5 to 7 days. As a major downside, current user camera taps present limitations in terms of trigger cooldown (that is, the time spent from one recording to the next, even when triggered). Originally thought to avoid an overloading of the SD cards when events happening close in time, this can lead to the loss of important information if the length of the video does not cover the duration of the behaviour itself. Nonetheless, the position of the camera trap in front of the nest box, always at a distance of at least 1.5 meters, allows to register value information regarding the individuals diet but also information about the nest (occupancy, prospection events), that otherwise would require from high intensity field work.

On the other hand, webcams permit for a continuous feed that allows for the registration of both real-live and constant video, providing a more accurate depiction of the natural behavior of the individual. However, these cameras require direct connection to the electrical power, or alternatively power banks or external batteries (but then being limited by a reduced battery life). In addition, these power elements are usually quite sensitive to environmental hazards (such as water), and tend to overheat, so additional structures ought to be placed to safeguard these elements. In general, the placement of these devices inside the nest does not elicit any negative responses from the occupants, neither if placed during the incubation, or in later stages of reproduction, and habituation to these elements occurs within minutes.

Furthermore, in the framework of E.4 Action (Networking), LIFE FALKON Project has been actively collaborating in the MERCURIO Project since 2022. MERCURIO Project is a multinational research group of experts on the lesser kestrel, aiming to collect and analyse data on the ecology of the species. For this purpose, some added parameters - in comparison to the LIFE FALKON initial dataset - have been taken into account, and as a result some additional data have been collected by the team from the 2022 breeding season onwards. These include morphological data and samples of dietary samples from lesser kestrels.

SECTION D - Suggestions for supporting a lesser-kestrel-friendly agricultural management

D.1. Lesser kestrel and agricultural landscapes

The lesser kestrel in Southern Europe is tied to traditional agricultural landscapes, including semi-natural grasslands and dry cereal pseudo-steppe habitats (Bustamante, 1997; Kmetova et al., 2020), although was locally shown to thrive in more intensive agroecosystems, as in the case of the Po Plain (PA1), suggesting an unexpected ability to adapt (Assandri et al., 2022; Berlusconi et al., 2022).

The studies conducted in this area in the framework of the LIFE-Falkon showed that the colonies of the species are located in a narrow belt between the Province of Parma and Ferrara. This area largely overlaps with the production district of the Parmigiano Reggiano, whose strict production specification favoured the cultivation of hay crops (mostly alfa-alfa) and thus the persistence of crop rotation. Crop rotation determines the co-occurrence of hay crops, winter, and summer crops, which in turn enhance the compositional heterogeneity granting food availability and accessibility through the entire breeding cycle of the species (Assandri et al., 2023). The lesser kestrel tracks vegetation height favouring short sward, which is likely to maximise prey accessibility. Given this, it selects alfalfa during the early breeding season, while winter cereals are selected during the nestling-rearing phase. Summer crops (e.g., maize, sorghum) are selected during the early breeding season, after sowing, but significantly avoided later. Frequent hay crop mowing (4-5 times per year) represents a further factor favouring the species, enhancing prey accessibility (Cioccarelli et al., 2022).

Finally, is worth noting that the areas selected by the lesser kestrel to establish colonies largely coincide with areas with clay soils (vertisols), which favour the cultivation of herbaceous crops and have reduced urbanisation and infrastructure-induced fragmentation (Assandri et al., 2023).

D.2. Good practices for the farmers

Creating and maintaining hedgerows

Maintaining hedgerows on the edge of crop fields provide refuge for agrobiodiversity. In that way hedgerows, in an immediate way, provide the lesser kestrel with better foraging opportunities Moreover, when the hedgerows are consisting of tall trees they can become perches for the lesser kestrel, especially in places where there are no alternatives.

Maintenance of uncultivated land strips

Strips of uncultivated land at least a meter wide should be maintained around the fields. The uncultivated strips are considered as biodiversity corridors and also have the role of buffer zones for the effluents from agricultural practice. Lesser kestrels can get advantage of their presence, especially during the months when the main cultivation is not established or has been harvested. In the same way, natural and semi-natural vegetation islets within the field serve as reservoirs or refuges for agrobiodiversity and high prey numbers for lesser kestrels are retained there.

Minimisation of inputs

In order to ensure sustainability, lower carbon emissions and reduce the relevant costs of agriculture, producers are advised to optimise the agricultural input. Agricultural inputs (consumable) include any external source added in the cultivation in order to improve the yield. The most significant inputs are Fertilisers, Water, Fuel, Pesticides and Insecticides.

The optimisation of agricultural input can be achieved by:

- Keeping track of the inputs used and putting thresholds to the amounts consumed
- Choosing to cultivate local varieties that are proven to be better adapted to local requirements
- Applying precision farming techniques
- Applying minimal soil disturbance practices
- Conserving agro-biodiversity

On the other hand, the farmer benefits from the natural pest control that a complex and close to natural ecosystem is providing. Hedgerows are part of the natural and aesthetic connectivity of the rural mosaic and it is essential that we preserve and expand them.

Common Agricultural Policies: opportunities to funding interventions

The CAP 2023-2027 (Common Agricultural Policy) incorporates measures aimed at promoting environmental protection and biodiversity support within the agricultural sector. Here are the key elements of the 2023-2027

CAP that are closely related to biodiversity conservation:

- Enhanced Cross-Compliance: CAP beneficiaries will be subject to more rigorous mandatory requirements, linking payments to compliance. For instance, each farm is required to allocate a minimum of 3% of arable land to biodiversity and non-productive elements, with the potential to receive support through eco-schemes to reach up to 7%. Wetlands and peat bogs are also safeguarded.
- Eco-Schemes: A minimum of 25% of the budget for direct payments is allocated to eco-schemes. These schemes provide stronger incentives for agricultural practices and approaches that are climate- and environmentally friendly, including organic farming, agroecology, and carbon reduction, among others. Additionally, eco-schemes promote improvements in animal welfare.
- Rural Development: At least 35% of the funds are directed toward measures that support climate, biodiversity, environment, and animal welfare within the rural development framework.
- Climate and Biodiversity: A significant portion of the CAP budget, specifically 40%, is earmarked for climate-related initiatives and is strongly aligned with the broader commitment to allocate 10% of the EU budget to biodiversity objectives by the conclusion of the multiannual budget framework period (MFF) of the EU.

Farmers in each EU country are expected to adhere to their respective national CAP Strategic Plans, which draw from the Rural Development Programme (RDP) tailored to each specific region. A minimum of 30% of funding for each RDP is dedicated to measures relevant to environmental protection and addressing climate change. Much of this funding is allocated through grants and annual payments to farmers who transition toward more environmentally friendly practices, with a focus on nature conservation and biodiversity preservation. Key measures within this framework that are crucial for the conservation of lesser kestrels include:

- Conversion of arable land to meadows and pastures.
- Management of permanent meadows and pastures.
- Active management of ecological infrastructures.
- Reduction in the use of pesticides.

SECTION E - Communication advices

Previous LIFE experiences have demonstrated that communication efforts targeting stakeholders have been successful in improving both nesting and foraging habitat quality for the lesser kestrel.

Within the LIFE FALKON project, communication and dissemination activities were foreseen.

The floor Game

The floor game created for the project (Figure 11) has targeted young children and school students, aiming to educate younger generations on the life conducted by lesser kestrels and on the importance of its protection and preservation. It is structured as a goose game, where the participants have to throw a dice to move forward in the game. Through the game, it is presented the life of the lesser kestrel. The floor game was produced in Greek and Italian for a total of 400 copies and was mostly disseminated in schools, EE centres and to teachers, during LIFE FALKON events.

Figure 11. The floor game.

The Graphic Novel

The LIFE FALKON graphic novel was released in the format of a comic book (Figure 12). The number of copies was of a total of 8,000, where 3,000 were produced in Greek and 5,000 in Italian. The result was a 32 coloured-page A5 comic: the objective was to enable children and adults to discover the lesser kestrel and the project activities. Moreover, the game aimed to promote the initiative of supporting lesser kestrel lives in Italy and Greece, by involving citizenship in protecting the species. The graphic novel is understood as a dynamic communicative tool which can reach a wide target audience. Through its easy and direct language, the comic book managed to educate its readers on the importance of the actions taken by the LIFE FALKON team, for the survival of the lesser kestrel.

Figure 12. The graphic novel.

Promotional Video

The promotional video, "Life on the move" is a short documentary directed by award-winning documentary filmmaker, Aurélien Prudor. It aims to show the life of the lesser kestrel in the area of Matera and Po Plain, Italy, and the study area of the project, in the provinces of Mantua, Modena, Bologna and Ferrara. The documentary shows how in southern Italy the species struggles to survive due to increasingly frequent heat waves, caused by the climate emergency, and is therefore forced to move to where the climate is more favourable. In the Po Valley nesting sites are threatened due to the demolition of farmsteads damaged by the earthquake and restoration work that closes the cavities in which the cricket nests. The documentary reports the actions taken by the LIFE FALKON team to preserve the Lesser Kestrel: installing nest boxes and nesting towers, but also involving the local population – and in particular the youngest – through conferences, guided tours, activities in schools and educational games. The documentary had a huge success and was displayed at LIFE FALKON conferences and on the 10th of March 2023 was shown at the Centro Congressi CNR (MI). The documentary contributes to the comprehension of the project actions and can be considered a replicable tool for future LIFE projects.

CoI (Community of Interest)

ALDA worked together with the other partners to create a big community of interest for the LIFE FALKON project: the community of interest aimed to promote and update the members on the activities carried on by the

LIFE FALKON team and to create a large lasting network of stakeholders interested in the conservation of the lesser kestrel. The Community of Interest involves scientists and professionals, representatives of municipalities, associations, farmers but also ordinary citizens who care about the conservation of the lesser kestrel, in Italy and Greece and in other countries where the species is present.

The first part of the activity consisted in recruiting possible stakeholders and researchers who work on the lesser kestrel all over Europe. Then, as a consortium, we established the material and events we wanted to share with them and we created a Memorandum of Understanding, which is an agreement between the consortium of the project and the single associations or individual researchers. Moreover, by signing the provided Memorandum of Understanding, the potential members of the CoI could choose on what they wished to be updated on:

Webinar/workshops of a technical or scientific nature on the lesser kestrel;

Technical and scientific material concerning the conservation of the lesser kestrel ;

Educational and popular material concerning the lesser kestrel;

Meetings with other members of the Community of Interest, aimed at exchanging good practices and knowledge.

We were able to get 22 Memorandum signed back, by contacting the members by email and introducing them to the Community of Interest during our networking events and workshops.

Workshops with relevant stakeholders and schools

The LIFE FALKON project has created a number of workshops with specific stakeholders, with the aim to spread awareness and discuss with them best practices for lesser kestrel conservation. More precisely, the LIFE FALKON team has worked with architects, farmers, public authorities and planners, but also with primary and secondary schools. These workshops create opportunities for experts to educate participants and talk about important topics, such as: conservation, biodiversity, and promote the adoption of species-friendly practices, inform stakeholders about current wildlife regulations and technical solutions to resolve human-wildlife conflicts. With the students, besides theoretical presentations, study visits were also organised in the areas of the project, like the Mirandola Municipality, showing the progress made by the LIFE FALKON project.

The 'lesser kestrel' Beer.

The lesser kestrel beer was produced with the collaboration of the LIFE FALKON project and the Milvus Brewery, located in Potenza, Italy. The decision to collaborate with this specific brewery was connected with their experience in hand-crafting beers since 2016. Moreover, the name Milvius is the scientific name of the red kite (Milvus milvus), a raptor originally from the Lucanian region. All the beers produced by the brewery are inspired by a different species of birds, and now the lesser kestrel too is added to their offer.

The production of the drink is used to vehiculate the project's messages through an original instrument, that aims to make the public reflect on how our actions can impact the lesser kestrel lives. In fact, through the creation of this beer, the LIFE FALKON team invited people to consider how the way we produce food can shape the planet and how farming practices play a central role in moving towards a sustainable economy that considers nature conservation as one of the central points of the sustainable economy's conceptualization.

Comments on school activities

From 2020 to 2023, environmental education interventions were carried out in primary and secondary schools in the provinces of Mantua, Modena and Bologna, to raise students' awareness of the issues of biodiversity conservation and the LIFE FALKON project. Overall, 1,012 children and 38 classes were contacted directly (Primary School: 14 classes - 420 children; Secondary School 24 classes - 592 children). 689 children participated in the "Un falco per amico" project which consisted of 2 hours in the classroom and 4 hours in the field to observe the wetlands managed by the Modenese Ornithological Station (S.O.M) and the Lesser Kestrel nesting tower.

Communication advices

Central in the LIFE FALKON communication activities has been social media posts (on Facebook and X) and our newsletter. In this regard, we would like to share some advice to those who will join future LIFE projects.

Social Media recommendations: make sure your posts stay short, since most people would not spend more than a few seconds reading social media posts. Moreover, use simple and direct language to communicate your message, to reach a wider audience and make your description understandable to stakeholders that do not have familiarity with the project's language. Engage people by using pictures, which can draw their interest. Invite partners to share the posts made in the project's social media pages in their own social media pages too, to create a larger following of the project's pages and awareness around the work you are doing. Do not forget the use of appropriate emoji to attract the readers' attention.

Newsletter recommendations: the LIFE FALKON team produced a total of 10 newsletters. In our writing experience, we learned the importance of using simple and direct language, but differently from social media posts. In fact, newsletters are an opportunity for sharing in more detail the project's progress and discussing significant topics. Therefore, while writing the newsletter, the team should not consider the accuracy of the language and the news itself of secondary importance. The team should choose five or six updates to share with the public. Moreover, the single news should not be very long and should have an engaging title and front picture to capture readers' attention. Make sure every partner participates in writing the news, by writing it themselves or sharing accurate data/information if others are appointed to the writing process.

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