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FACULTY OF PLANT PROTECTION AND AGROECOLOGY

DEPARTMENT OF AGROECOLOGY AND ENVIRONMENTAL PROTECTION

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RECOVERING THE LESSER KESTREL (*Falco naumanni*, Fleischer, 1818) AS A BREEDER IN BULGARIA

ABSRACT

OF A DISSERTATION FOR THE AWARD OF PhD DEGREE

Scientific specialty: Ecology and Ecosystem conservation

SCIENTIFIC SUPERVISOR

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The Dissertation is written on 112 pages and contains 24 Tables and 19 Figures. The list of References includes 114 sources, of which 27 in Cyrillic and 87 in Latin.

The Dissertation was carred out in the Department of Agroecology and Environmental Protection of the Agricultural University - Plovdiv in the period 2018-2021 within the Independent doctoral study. The field research and data collection were conducted in the period 2013 - 2018 together with the implementation of the project "Lesser Kestrel Recovery " LIFE11 NAT / BG / 360 implemented by the Green Balkans under the LIFE Program of the European Union.

The Dissertation was discussed and proposed for defense with a protocol № 14/16.11.2021 by an extended department council according to Order № RD 16-1235/08.11.2021 of the Department of Agroecology and Environmental Protection, Faculty of Plant Protection and Agroecology at the Agricultural University - Plovdiv.

The defense of the Dissertation will take place on ……. at …….., in auditorium……. of Agricultural University – Plovdiv in front of a specialized scientific jury, approved by an order of the Rector № RD 16 -1318 / 23.11.2021.

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„…and again, the silent shadows of the Kestrels draw invisible circles above them - as a memory of a past that flew away, as a warning that what was once in the wild nature sometimes can not be returned...“

Dimo Bozhkov, 1972 „Following the shadows of the Kestrels“

1. INTRODUCTION

Despite the self-suggestion that we have imposed on ourselves that Man is the most rational being, nowadays the development of human civilization is the reason for the daily extinction of various organisms from the Earth. Deforestation, wetland drainage, riverbed corrections, redevelopments, fires, chemical pollution. These are just some of the reasons that as a result of human activity lead to the direct extinction of species or the irreversible deterioration of their habitats. Every day we witness the extinction of various species of plants, invertebrates, fish, reptiles, amphibians, mammals. UNEP data show that between 150 and 200 different species of organisms disappear from the world every day. The WWF estimates that at least 10,000 species per year disappear from their natural habitat.

The world's leading conservation organisations are united in the mission to stop or at least slow down this negative trend - the constant extinction of wildlife species worldwide.

With this in mind, the Green Balkans - Stara Zagora NGO is taking the first steps for recovering the Lesser Kestrel as a breeder in Bulgaria.

At the end of the 19th and the beginning of the 20th century, the Lesser Kestrel (*Falco naumanni* Fleisher 1818) in Bulgaria is a species nesting everywhere and is a common species (Radakoff, 1879; Patev, 1950). In the past colonial-nesting Lesser kestrels were widespread and did not worry to build their nests near people and their settlements.

While in Greece and Turkey, our neighboring Balkan countries, are preserved some of the most numerous populations of the species in Europe, in

Bulgaria in the late 20th and early 19th century there is no definite data on nesting Lesser kestrels. The last registered nesting site of the species from members of the Green Balkans NGO in 1989 was in the Sakar Mountains. This territory is located near the area where the borders of Bulgaria, Greece and Turkey meet.

The extinction of the Lesser kestrel as a breeder in our country still has no unambiguous explanation. According to experts, the reasons are complex - change in land use, reduction of grazing livestock, short-sighted use of chemicals in agriculture, habitat destruction, large fragmentation between the colonies in the country and neighboring countries, and others. Purely biological and ecological reasons, such as interspecific competition and predation, as well as other factors influencing the overall population, which have led to a significantly shrinking of the species' range - from the periphery to the center, are also not excluded.

This paper is a result of the process of recovering of the Lesser kestrel as a breeding species in Bulgaria, and covers the period 2013 - 2018. It is part of the LIFE11 NAT/BG/360 "Lesser Kestrel Recovery " project, funded by LIFE program of the European Union, implemented jointly with the Green Balkans - Stara Zagora NGO.

2. RESEARCH AIM AND TASKS

The aim of this Dissertation is:

Study and summarizing the process of recovering of the Lesser kestrel (*Falco naumanni* Fleischer, 1818) as a breeding species in Bulgaria.

To achieve this we set the following tasks:

1. To analyze the methods and approaches used in the successful recovering of the Lesser Kestrel in the Sakar Special Protection Area (SPA) BG0002021;

2. Describe the structures and facilities used in the process of the recovering of the species' nesting;

3. To track the numbers, trends and dynamics of the population of the species at national level after its initial recovery;

4. To analyze the results achieved by the recovery of the species.

3. MATERIALS AND METHODS

3.1. Scope of the study

The present study covers the process of recovering the Lesser kestrel as a nesting species in Bulgaria in the period 2013 - 2018 on the territory of SPA Sakar BG0002021.

Viability studies and developed habitat models show that natural recolonization of the species in Bulgaria is impossible, although in Greece and Turkey (Bulgaria's neighboring countries) there are natural nesting colonies of this species (Kmetova, 2010; Kmetova et al. 2012). In this regard, in 2013 the Green Balkans NGO launched Reinforcement of the species, which is determined according to the 'Guidelines for reintroduction and other conservation translocations of species', prepared by the International Union for Conservation of Nature (IUCN/SSC 2013). Other authors describe this approach as ,,Re-stocking" - relocation of individuals in order to strengthen existing populations of the species (Armstrong & Seddon 2008).

Based on the developed habitat model and the assessment of the presence of similar species, as well as their abundance, as one of the most suitable areas for starting the process of recovering of the species as breeder in Bulgaria was selected the area of SPA Sakar BG0002021, part of the project area of the LIFE11 NAT/BG/360 'Recovering of the Lesser kestrel' project. Also, the last nesting ground of Lesser kestrel was registered by experts of Green Balkans NGO in 1989

in Sakar Mountain (DB - GB) (Gradev et al., 2019). This territory is close to the area where the borders of Bulgaria, Greece and Turkey meet. Today, the populations of the species in our southern neighbors are among the most significant in Europe (Kmetova et al. 2020).

3.2. Research methods

3.2.1. Direct release of birds in the wild

In the direct release of birds in the wild, an approach with development of a Lesser Kestrel Release and Adaptation Module (LKRAM) by DEMA on the system Colony environment (Antolín, 2001) was chosen. The methodology is based on a combination of two approaches - „hacking" (Sherrod, 1987) and „foster parenting" (Jones, 1996). The structure was built on the outskirts of the village of Levka, Svilengrad municipality, part of the Sakar SPA BG0002021.

3.2.2. Artificial nest boxes

In order to provide nesting places for the already released birds that have adapted and live independently in the area of the LKRAM, artificial nest boxes specially constructed for the purpose have been placed (Gradev et al., 2019). Different types of artificial nesting boxes are used, which are attached to the installation base in different ways - under-roof nest box, classic wall nest box, ordinary wall nest box (Green Balkans - Stara Zagora NGO, 2015).

3.2.3. Nesting parameters

The Cheylan (1981) classification was used to determine the nesting parameters, and the same was used to determine the nesting parameters of the Imperial Eagle in Bulgaria (*Aquila heliaca heliaca*) (Demerdzhiev, 2011).

Quantitative indicators are applied:

Clutch size – average number of eggs laid by a female;

Brood size – average number of hatched chicks in a nest;

Success Rate (SR) - the ratio of pairs that raised at least one chick and the total number of breeding pairs;

Productivity (P) - number of flying juveniles from the territories occupied by pairs;

Breeding Success (BS) - number of flying juveniles compared to the number of pairs with registered hatching;

Fledging Success (FS) - number of flying juveniles relative to the number of pairs that successfully raised at least one chick.

3.2.4. Statistics

The data for the nesting parameters are processed with specialized statistical software IBM SPSS Statistics (SPSS-Inc. 2019, SPSS Reference Guide 26 SPSS, Chicago, USA) and cover the period from 2014, when the first nesting was registered, until 2018.

A parametric T-test was used to compare the relationships between individual variables. This 5-year period covers 5 complete breeding cycles of the studied species in the area of the first recovered nesting colony of the species in Bulgaria.

3.2.5. Marking

In order to track the adaptation and independent life of the birds from the newly formed colony and in order to facilitate their individual identification, all released or hatched birds in the colony are marked with standard and specialized colored PVC rings. The rings were made in partnership with the Bulgarian Ornithological Center (BOC) at the Bulgarian Academy of Sciences (BAS). At international level for the country is defined orange color of the ring, combined with black letters and/or numbers, such as **BDS**, **BCK**, etc. (Yaneva et al., 2019). In Europe different combinations are applied between the background of the PVC rings and the colors of the symbols with which they are marked. There are 38 different combinations used in 7 different countries - Bulgaria, Greece, Spain, Italy, Portugal, France and Croatia, which cover almost the entire nesting area of the Lesser kestrel in Europe (Yaneva et al., 2020).

3.2.6. Tracking with radio and satellite transmitters

With the help of radio transmitters (2.38 gr. – PIP Ag393 Tag, produced by Biotrack) and high-tech satellite transmitters (5g Solar PTT-100 backpacks (Platform Terminal Transmitters PTTs - Microwave Telemetry) the first movements and the nesting territory of the birds from the newly formed colony are tracked. Both types of devices are attached to the back of the monitored individuals using a standard 'backpack' methodology (Garcelón, 1985). The total weight of transmitters and straps shall not exceed the permissible 4% of the weight of the bird, which ensures that the behavior of these diurnal migratory birds of prey will not be affected (Sergio, 2015). Similar studies of Lesser kestrels have

been carried out using different types of transmitters - radio transmitters in Greece (Vlachos et al., 2014), PTT satellite transmitters in Spain (Liminana et al., 2012), GiPSy-4 data-loggers (Gustin et al., 2014) in Italy.

3.2.7. Visual observations

The direct visual observations were performed with binoculars Zeiss Conquest HD 8x42, telescope SWAROWSKI 80HD, camera Nikon D 7100 with lens Nikon AF-S Nikkor 200-500 mm, as well as with the video surveillance system built especially for this purpose in the area of RAMLK. Geographic coordinates are established with a Garmin Montana 610 satellite data receiver, and the information collected in field is recorded in field forms.

4. RESULTS AND DISCUSSION

4.1. Analysis of the methods and approaches used in the successful recovery of the Lesser kestrel in SPA Sakar BG0002021.

4.1.1. Reinforcement of the population

The essence of the method for Reinforcement of the population is defined as the recovery of the population of a species by reintroduction into its typical habitat, when it is not completely extinct from this area. Although for the Lesser kestrel there are no definite data for nesting in Bulgaria, the species can be observed as passing or wandering in different parts of the country, which determines the adopted approach as “Reinforcemen”t and not as “Reintroduction” of extinct species.

4.1.2. Habitat model

In relation to the recovery of the population of the target species in the country, a viability study was conducted to assess the suitability of a given area. For this was used ‘Habitat Model for the Recovery of the Lesser kestrel in Bulgaria’ (Kmetova, 2010). If the suitability of an area for the recovery of the Lesser kestrel cannot be verified by the habitat model, then other species with similar ecological requirements can be used as indicators.

4.2. Results from the use of structures and facilities in the process of recovering of the species' nesting

The activities for recovery of the Lesser kestrel in Bulgaria and the direct release of birds in the wild started in 2013. It was made within the LIFE11 NAT/BG/360 ‘Greater chance for the Lesser kestrel (Falco naumanni) in Bulgaria - Recovering of the Lesser kestrel’ project, coordinated by Green Balkans - Stara Zagora NGO in partnership with DEMA (Spain) and EuroNatur (Germany).

4.2.1. Release Module for juvenile Lesser kestrels and Artificial nest boxes

Release modules for juvenile Lesser kestrels for recovering or establishment of a colony have been implemented in Spain, France and Portugal, some of which have even been constructed in purpose-built buildings/towers and have reached great development in every detail.

A series of improvements and additions have been made to the Natural Colony approach applied in Bulgaria (Antolín, 2001), which are based on the experience gained during the work on research and conservation of birds of prey, participation in other reintroduction projects for birds of prey and other species (Gradev et al, 2016). The essence is to place the juvenile non-flying birds in release boxes, from which they have open access to the environment through an opening suitable for their size.

The module accommodates juvenile Lesser kestresl, which are hatched in artificial conditions in the Breeding Center of DEMA, Spain and the Green

Balkans Wildlife Rescue Center - Stara Zagora. Juvenile birds from Spain were released. By using a HMC markers, it has been shown that there are no significant genetic differences between European populations of Lesser kestrel in different countries - Spain, France, Italy and Greece, but they differ from birds originating from Kazakhstan and Israel (Rodriguez et al., 2011).

A cage is installed in front of the release boxes in which there are adult birds that act as foster parents for the juvenile birds in the boxes, as well as free-range decoys for individuals of same or other similar species. The juveniles in the release boxes are separated from the adults by a net and have visibility to the landscape in the area of the module. Adult birds, showing a parental instinct, feed the juveniles through the net, thus increasing the stimulation of attachment (imprinting) of juvenile birds to the given place of release.

Around the release boxes and the cage with the foster parents there are artificial nest boxes in which the successfully overwintering birds released from the module in previous years breed (Gradev et al., 2019; Yaneva et al., 2021). In order to provide suitable nesting sites in the project territories, more than 80 nest boxes and 13 artificial perches have been installed.

The module is equipped with windows with one-way visibility, from which the individual identification of birds in the colony is performed. In addition, in order to obtain a simultaneous, general view for the situation in the different parts of the module, as well as to monitor what is happening in the nests, video surveillance has been installed (Gradev et al., 2016a), (Stamova et al., 2017).

The juvenile birds are transported and accommodated to the Release and

Adaptation Module at age of about 20 days, with each individual being marked with individual standard ornithological and colored rings (Yaneva et al., 2019).

When the juvenile birds leave the release boxes, they are fed on the roof of the adult birds cage. Both juvenile and adult birds are fed daily on specialized food (mice, insects and day-old chickens).

4.3. Abundance, breeding parameters, trends and dynamics of the population of the species at the national level after its initial recovery

4.3.1. Survival rates for released birds

The first direct release of birds took place in the summer of 2013. First 90 Lesser kestrels were released in the nature of Bulgaria. The following year 42 individuals (over 40%) returned to the Release Module in the village of Levka, part of the Sakar SPA, and formed the first nesting pairs. This is the first registered nesting of Lesser kestrel in our country, after for decades it was believed that the species has not bred successfully here.

The survival rates of the released birds are presented in Table 1. It varies from 26.82% for the birds released in 2015 to 52.22% for the juvenile Lesser kestrels released in 2013.

Table 1. Survival rates of juvenile Lesser kestrels in the first year of their release at the RAMLK

Year	Released juveniles	Returnees in 2014		Returnees in 2015		Returnees in 2016		Returnees in 2017		Returnees in 2018		Total survived 1st year	
год.	ind.	ind.	%	ind.	%	ind.	%	ind.	%	ind.	%	ind.	%
2013	90	42	46,66	5	5,55	0	0	0	0	0	0	47	52,22
2014	114			38	33,33	0	0	0	0	1	0	39	33,33
2015	82					21	25,61	1	1,21	2	2,42	24	29,24
2016	142							53	37,32	0	0	53	37,32
2017	156									54	34,61	54	34,61
2018	82												

The average survival rate of released birds after the first year of their life for the five-year study period is 37.34%.

4.3.2. Breeding numbers and breeding parameters

As a result of the high number of released birds (over 660 individuals) and the good percentage of surviving and returning birds to the colony, in the period 2014-2018 the number of pairs nesting in the colony gradually increased and reached a maximum of 40 pairs in 2018. The trends in the number of colony of Lesser kestrel and the number of pairs formed are presented below (Table 2):

Table 2. Number of nesting pairs by years

Year	Released juveniles	Registered released previous years	Adults resident in the home range-	Established pairs	Wild birds	Confirmed pairs with laid eggs	Incubating pairs	Pairs with hatched chicks	Pairs with a reared chick
2013	90	0	8	0	2	0	0	0	0
2014	114	42	20	8 to 9	4	8	7	5	5
2015	82	53	40	9 to 13	8	9	9	5	5
2016	142	43	25 - 30	10	15	10	10	9	9
2017	156	85	40 - 50	21 to 22	9 до 12	21	20	19	19
2018	82	120	60 - 80	34 - 40	4	34 - 39	22 - 34	13	12

The nesting parameters of the Lesser kestrel colony in the village of Levka in the Sakar region were assessed and analyzed according to Cheylan (1981) and the summarized data are presented in Table 3. During the study period 171 of the newly hatched birds flew successfully from the colony.

Table 3. Nesting parameters of breeding Lesser kestrels

Year	Eggs laid	Chicks hatched	Chicks reared	Clutch size	Brood size	Success Rate	Productivity	Breeding Success	Fledging Success
2013	0	0		0	0	0	0	0	0
2014	37	20	16	4,6 (n=8)	4 (n=5)	0,62 (n=8)	2 (n=8)	2,28 (n=7)	3,2 (n=5)
2015	41	17	17	4,5 (n=9)	3,4 (n=5)	0,55 (n=9)	1,88 (n=9)	1,88 (n=9)	3,4 (n=5)
2016	49	43	33	4,9 (n=10)	4,8 (n=9)	0,9 (n=10)	3,3 (n=10)	3,3 (n=10)	3,6 (n=9)
2017	87	74	70	4,1 (n=21)	3,9 (n=19)	0,90 (n=21)	3,3 (n=21)	3,5 (n=20)	3,7 (n=19)
2018	122	38	35	3,1 (n=40)	2,92 (n=13)	0,33 (n=40)	0,9 (n=39)	0,9 (n=39)	2,92 (n=12)

Table 4 presents statistically processed data on the key reproductive parameters - Success rate (SR), Productivity (P), Breeding Success (BS) and Fledging Success (FS). Statistically the most successful, in terms of some of the

nesting parameters, in the process of recovering of the species are 2016 and 2017. In these years, the number of confirmed pairs is 10 in 2016 and 21 in 2017, which is far lower than the confirmed pairs in 2018. In 2018, the maximum reported value for this indicator for the colony in the village of Levka is 34 - 39 (Table 2). At the same time, in 2018 the lowest values for the entire period of the study were registered for each of the four compared indicators - Fig. 1.

Table 4. Summarized mean values ± standard error with respect to breeding parameters

Year	SR	P	BS	FS
2014	0,62±0.18	2.00±0.71	2,29±0.75	3.20±0.66
2015	0,56±0.18	1,89±0.65	1,89±0.65	3.40±0.51
2016	0,9±0.10	3,30±0.40	3,30±0.40	3.67±0.17
2017	0,90±0.07	3,33±0.32	3,50±0.29	3.68±0.23
2018	0,32±0.08	0,90±0.25	0,90±0.25	2.91±0.38
Total	0,58±0.05	1,97±0.20	2,01±0.20	3.42±0.15

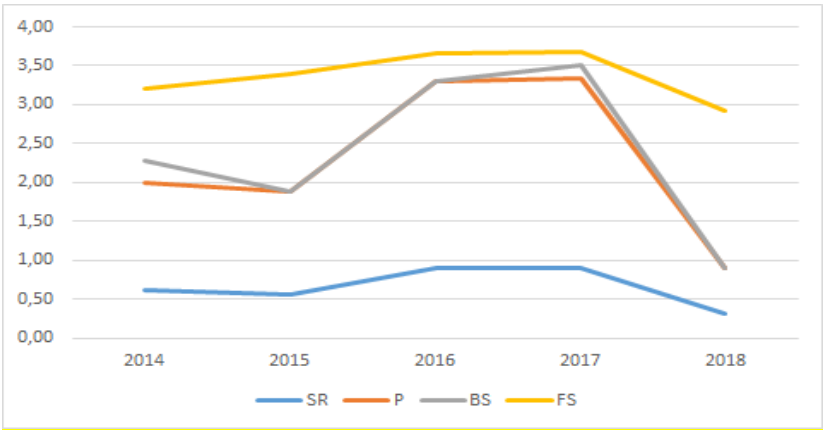

Figure 1. Dynamics of nesting parameters for the period 2014 - 2018

As a result of the conducted field research the following conclusions can be formulated:

- The size of the brood for the study period averaged 3,818 eggs, with a standard error of ± 0.166. The largest brood was reported in 2016 - 4,900 ± 0.179 (number of eggs laid), and the lowest values were reported in 2018 (Table 4);
- The largest brood was 3,894 ± 0.185 (2017) and 4,777 ± 0.277 (2016) (Table 4). The mean value of this nesting parameter was 3,764 with a relatively low standard error of ± 0.166;
- The Success rate (SR) ranges from 0.325 in 2018 to a maximum of 0.904 pairs in 2017, with an average value for the period of 0.579 and a standard error of ± 0.052 (Table 4).
- In the studied period, the average Productivity (P) was calculated at 1,965 flown juveniles with ± 0.202 standard error, with the highest values in 2016 (3,300) and 2017 (3,333) (Table 4).
- The average Breeding success (BS) for the period 2014 - 2018 is equal to 2.01 ± 0.204 standard error, and the Fledging success rate (FS) is on average 3.42 ± 0.154 (Table 4).

The standard error for the mean values of four of the studied key breeding parameters for the study period ranged from ± 0.05 to ± 0.20 (Table 4).

When comparing individual variables, the T-test shows statistical dependence between the variables mainly in 2016. It is most significant in the indicator Success rate (SR), where t {5}=3.27;p=0.01.

4.3.3. Assessment of national number and population dynamics

In 2014, another small colony of the species (4 - 6 pairs) was discovered, nesting on the territory of Lukoil Neftochim Burgas AD (Gradev et al., 2016). The discovery was made in partnership with employees of the company and assistance from the RIEW Burgas, who sent a bird of distress to the Green Balkans Wildlfie Rescue Center - Stara Zagora. This is only the second colony of the species registered in Bulgaria, since the first colony was established in the Sakar SPA (BG0002021), part of the Natura 2000 network. The number of the individuals in the newly discovered colony during the study period varies from minimum of 1 pair proven in 2014 to at least 8 breeding pairs in 2018 (Table 5) (Fig. 2):

Table 5. Number of the individuals in newly discovered colony in the Lukoil region

Year	Number of established pairs	Reference values
2014	min 1	1
2015	min 3	3
2016	3 to 5	4
2017	4 to 6	5
2018	min 8	8

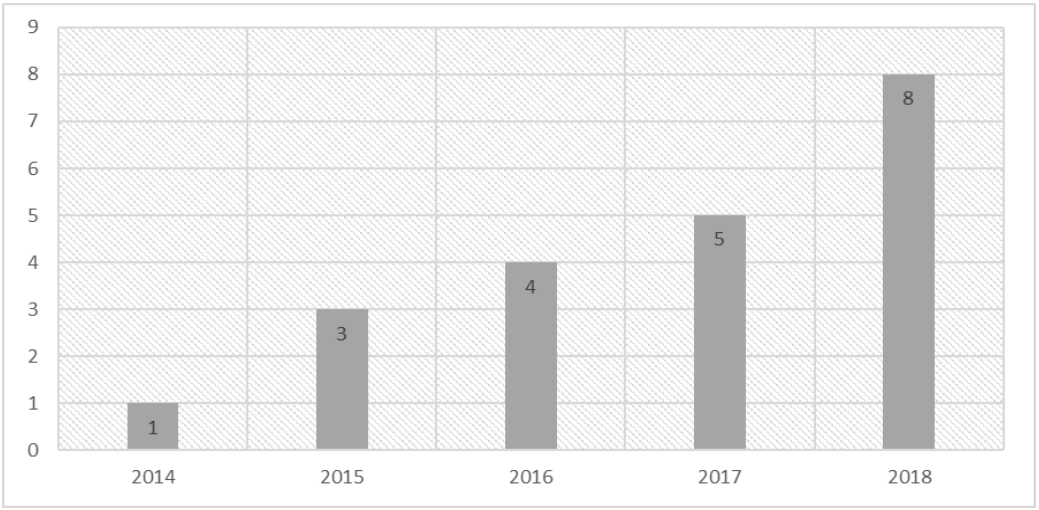

Figure 2. Dynamics of the number of individuals in the newly discovered colony in the Lukoil region

The estimated abundance of the nesting population of the Lesser kestrel at the national level for the period 2014 - 2018 has maximum values between 30 and 40 pairs, distributed in two known nesting sites (Table 6 and Figure 3). These are the years after the first registration of recovered nesting of the species in our country and the localization of the colony in Lukoil. The nesting colonies are located at an altitude of 8 (Lukoil) to 243 (Levka, Sakar) meters above sea level. In 2018 alone, more than 30 pairs were registered, which is mostly result of the large number of juvenile birds released into the wild in the previous 2016 (142 individuals) and 2017 (156 individuals).

Table 6. National abundance of the nesting population of the Lesser kestrel

Year	average number of pairs, LUKOIL	average number of pairs, RAMLK Levka, Sakar	total national number
2014	2	9	11
2015	3	13	16
2016	4	10	14
2017	5	22	27
2018	8	30	38

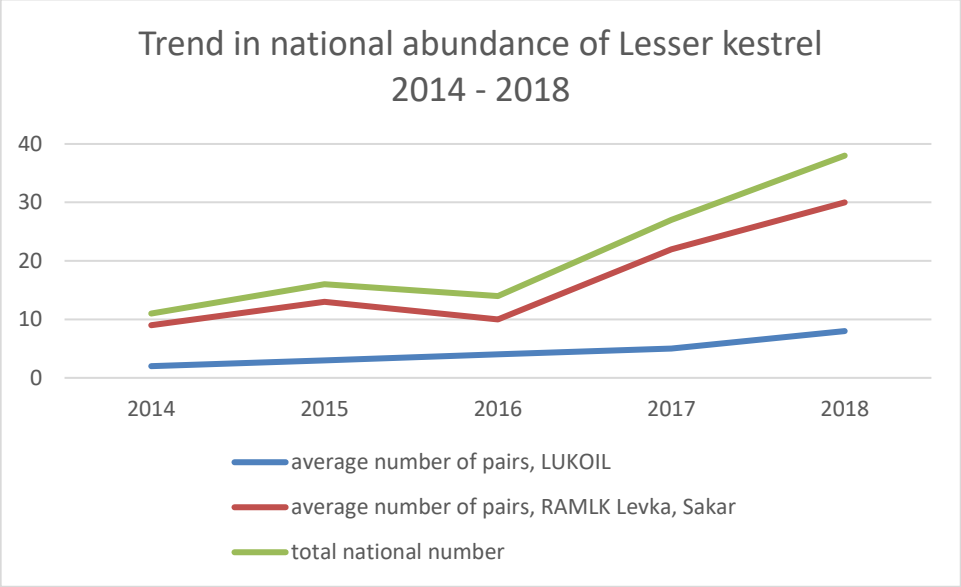

Figure 3. The national number of the nesting population of the Lesser kestrel

According to our estimate, the optimal number of the colony in Levka during the study period (2014 - 2018) is 21-22 pairs, in Lukoil about 8 breeding pairs and approximately 30 pairs of Lesser kestrels at the national level. In 2021 the national number reaches about 40 breeding pairs (Gradev et al., 2021), established in 4 or 5 colonies located in southern Bulgaria. Over 60% of known nesting pairs use artificial nesting boxes.

4.4. Analysis of the achieved results from the recovering of the species

In order to monitor the adaptation and individual behavior of birds from the newly established colony using standard and specialized colored PVC rings, a total of 671 birds were marked during the study period (including 10 individuals from the wild population that passed through the colony in Levka, were caught and ringed).

For more detailed and specialized studies have been installed radio transmitters on 6 birds, through which nesting areas of 2 male birds with size of 46.80 km^2 and 29.70 km^2 are identified. Thanks to the data from the transmitters, roosting sites and pre-migration agregations have been identified, located at 5 km

from the colony in 2014 and at 4.3 km in 2015 (Zhelev et al., 2016). Both places that birds use as roosting sites are metal pylons from the high voltage electricity network.

Based on the experience gained, high-tech satellite transmitters were used, with which 6 more Lesser kestrels have been marked. Such a study for this species is conducted for the first time for our country (Gradev et al., 2016b) and the data collected have been unknown so far:

For the first time in Bulgaria, radio and satellite transmitters are used to track the Lesser kestrels;

For the first time in Bulgaria, a study is being conducted on the wandering, migration and wintering of the Lesser kestrel. The Lesser kestrel breeding in Bulgaria does not use classic and well-known migration routes, such as *Via Pontica*, and does not follow the coastline during migration;

During the autumn migration, the marked birds cross the Mediterranean directly in a south/south-west direction;

During the spring migration, one individual (5N) was registered crossing the Mediterranean Sea through Libya, Italy, Montenegro and entering Bulgaria from the west through Serbia;

Data on migration and wintering from over 10 countries on two continents - Europe and Africa - were collected;

For the first time roosting sites, routes of pre-migration wanderings and aggregation sites of individuals from the Bulgarian population are established, both in Bulgaria and in the neighboring countries - Greece and Turkey.

In August 2015, by satellite tracking of a bird identified by ring code BSB (Marin et al., 2016) a pre-migratory aggregation of about 10 birds was registered in the Pangeo Mountains, near the city of Kavala, Northern Greece. This pre-migratory aggregation has not been described in the literature or known papers. The presence of nesting birds from the species of interest is not known in the area.

In addition, key resting sites for Lesser kestrel during migration period have been identified (Leua & Thompsonb, 2002), located in Turkey, Libya and Egypt

(Gradev et al., 2016c). To date, such data related to the Bulgarian population of the species are not known.

For the first time, the wintering grounds in Africa of the Balkan (in particular Bulgarian) population of the Lesser kestrel, about 4000 km away from the nesting sites (Gradev et al., 2016b), have been identified. These are the territories of Chad, Nigeria and Niger (central - eastern Sahel), which radically distinguishes the Balkan birds from the birds of the Iberian population wintering in the western Sahel (Sara et al., 2019).

Studies during the period confirm a clear phenology in certain individuals from the colony of Lesser kestrels (Sara et al., 2021). Same bird returns first from the winter migration at the same time in the period 2016 - 2019. This is a male bird BFZ, which from 2016 to 2019 returns almost at the same time - 2016 - 23.02., 2017 - 23.02., 2018 - 24.02., 2019 - 22.02;

For the first time a connection between the breeding populations of the Lesser kestrel in Bulgaria, Turkey and Greece is proved - in this wider area, known by the toponym Thrace, are located at least 26 breeding colonies with numbers estimated of at least 200-285 pairs (Gradev et al ., 2016d);

For the first time, a connection between the different nesting colonies of the Lesser kestrel in Bulgaria has been proven.

5. CONCLUSIONS

The following conclusions can be formulated as a result of the conducted field survey:

1. By applying the method „Reinforcement“of the Lesser kestrel (*Falco naumanni*) in the period 2014-2018 the species has been successfully recovered as nesting on the territory of Bulgaria.
2. The application of the method for recovery of the nesting of Lesser kestrel and strengthening the population of the species through direct release of birds in nature, by building a Release and Adaptational Module for Lesser kestrels under the “Colony environment” system is suitable both for the adaptation of birds bred in artificial conditions and for attracting birds from other colonies.
3. The first successful nesting of Lesser kestrel in Bulgaria was reported in 2014 in the village of Levka on the territory of Sakar SPA;
4. The number of the nesting population of the Lesser kestrel in Bulgaria for the period 2014 - 2018 is a maximum of 40 pairs, distributed in two known nesting sites in the southern part of the country;
5. The nesting colonies are located at an altitude of 8 (Lukoil) to 243 (Levka, Sakar) meters above sea level;
6. Over 60% of the known nesting pairs of Lesser kestrel prefer to breed in the artificial nests specially designed for this purpose;
7. The average reproductive success for the period 2014 - 2018 is 2.01 ± 0.204, and the most successful statistically proven is 2016 at $p = 0.48$. The same year is the most significant statistically for the indicator Success rate (SR) 0.9 ± 0.1 with $p = 0.01$;
8. For the period 2013-2018, a total of 671 birds were marked (including 10 from the wild population that passed through the colony in the village of Levka) with standard and PVC rings in order to track and study their behavior;

9. By marking 12 birds with radio and satellite transmitters nesting territories, roosting sites, the wandering, migration and wintering grounds of the Lesser kestrel have been identified;
10. The home range of 2 male birds with an areas of 46.80 km^2 and 29.70 km^2 respectively have been identified, which overlap to a significant extent, and are located in a southwesterly direction relative to the Release and Adaptation Modul for Lesser kestrels and the species' colony in the village of Levka;
11. Roosting sites and pre-migration aggregations are located at 5 km from the colony in the village of Levka in 2014 and at 4.3 km in 2015;
12. Lesser kestrels use as roosting sites the steel pylons of the high voltage network;
13. Satellite tracking has identified key resting sites in Turkey, Libya and Egypt during the migration of the Lesser kestrels;
14. Lesser kestrels breeding in Bulgaria do not use classic migration routes (eg *Via Pontica*) and do not follow the sea coasts, but directly cross the Mediterranean Sea in a southern or southwestern direction.
15. Outside breeding season, the Lesser kestrels of the Bulgarian and Greek populations spend winter in the same wintering grounds in Sahel;
16. A clear phenology has been established in certain individuals from the Lesser kestrel's colony. In 2016-2019 the first returning birds were observed in snow conditions (February) in the area of the colony.

5. CONTRIBUTIONS

Scientific contributions:

1. An estimate of the numbers of the species Lesser kestrel at national level was made;
2. The nesting parameters and the nesting success of the Lesser kestrel have been established;
3. For the first time have been established the wintering grounds in Africa of the Bulgarian population of the Lesser kestrel;
4. For the first time in Bulgaria the wandering, migration and wintering of the species Lesser kestrel has been studied;
5. The connection between the breeding populations of the Lesser kestrel in Bulgaria, Turkey and Greece has been proved for the first time;

Scientific applications

6. The methods and approaches used in the successful recovery of the Lesser kestrel as a breeding species in Bulgaria are summarized and analyzed;
7. The structures and facilities used in the process of recovering of the nesting of the species are described;
8. For the first time in Europe the process of recovering of the Lesser kestrel as a nesting species have been described in a country where the species has been completely extinct as a breeder.
9. For the first time in Bulgaria, satellite and radio transmitters were used to track the Lesser kestrel;
10. The roosting grounds, the routes of pre-migration wanderings and the agregation sites of individuals from the Bulgarian population in Bulgaria, Greece and Turkey have been established for the first time.

6. SCIENTIFIC PUBLICATIONS REGARDING THE DISSERTATION

Krastev N., M. Popova, **G. Gradev**, R. Petrov, 2020. Using of Karakachan horses for management of grassland habitats as hunting grounds of Lesser Kestrel and Imperial Eagle. Agricultural University – Plovdiv, Scientific Works, vol. LXII, issue 1, 157-167, DOI: 10.22620/sciworks.2020.01.018. ***in Bulgarian***

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6. PARTICIPATION IN SCIENTIFIC CONFERENCES

1. **National Student Scientific Conference 'Ecology and Environment' 9. Plovdiv University Paisii Hilendarski 2017.** Stamova S., I. Klisurov, **G. Gradev,** S. Yaneva. Implementation of a video surveillance system in the monitoring of Lesser kestrel (*Falco naumanni*) in the process of recovering the nesting of the species in Bulgaria.
2. **Student Scientific Conference 'Bioeconomics, Agriculture and Turism for better life'. 2019. Agricultural University – Plovdiv.** Krastev N., M. Popova, **G. Gradev,** R. Petrov. 2020. Use of Karakachan horses for management of grassland as hunting grounds of Lesser kestrel and Imperial eagle. Scientific works, vol. LXII, vol. 1, 157-167, DOI: 10.22620/sciworks.2020.01.018.
3. **International Conference "European Green Belt – Biodiversity, Culture and History". 2021**. **Gradev G.** 2021. Introduction Report - Europen Green Belt Initiative. 2021. "Green Balkans – Stara Zagora" NGO. Abstract book of International Conference "European Green Belt – Biodiversity, Culture and History". Svilengrad, Bulgaria. p. 2-4.
4. **First National Conference of Reintroduction of Conservation-reliant Species**. **Sofia, 2016. Gradev G.,** S. Marin, P. Zhelev, J. Antolin. 2016. Recovering the Lesser kestrel (*Falco naumanni*) as a breeder in Bulgaria, First National Conference of Reintroduction of Conservation-reliant Species, University Press "St. Kliment Ohridski": p. 136-144.
5. **International conference on zoology and zoonoses. Hissar, Bulgaria. 2016. Gradev G**., S. Marin, P. Zhelev, P. Karpuzova, S. Yaneva, P. Mihtieva, D. Marinov. 2016. Tracking methods for Lesser Kestrel (*Falco naumanni*) used in the course of the species' recovery as a breeder in Bulgaria. p. 55.
6. **Third scientific conference on ecology „On the occasion of the 30th anniversary of Department of Ecology and Environmental Conservation", Faculty of Biology, University of Plovdiv "Paisii**

Hilendarski“ November 2nd-3rd 2018, **Plovdiv**. **Gradev G**., S. Yaneva, S. Marin, T. Bileva. 2019. Revew of colour ring schemes applied for individual marking of birds in Bulgaria.

7. **International Scientific Conference on Recovering of Conservation-Reliant Species and Habitats (ResConf 2020). Faculty of biology Sofia university “St. Kliment Ohridski” November 5-7, 2020**. **Gradev G.,** S. Marin, S. Dalakchieva, T. Bileva, Y. Vasileva, S. Yaneva. 2020. The numbers and distribution of Lesser kestrel (*Falco naumanni*, Fleischer, 1818) after recovering in Bulgaria.
8. Scientific conference with international participation: 100 years Higher Agricultural Education in Bulgaria. Faculty of Agriculture, Trakia University, Stara Zagora, Bulgaria. 27 - 28 May, 2021. Yaneva S., T. Bileva, **G. Gradev,** S. Marin. 2021. Overview of nest box types used by Lesser Kestrel (*Falco naumanni*) after being recovered as a breeder in Bulgaria.
9. **VIII International Congress on the conservation of the Lesser Kestrel. Extremadura 29 de junio - 2 de julio 2021. Gradev G.,** S. Marin, S. Dalakchieva, R. Petrov, Y. Vasileva, S. Yaneva. 2021. The abundance and distribution of Lesser Kestrel after recovering in Bulgaria up to 2021. Actas, VIII Congreso International sobre la conservacion del Cernicalo primilla, LIFE - ZEPAURBAN pp. 65-67.

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