The Greater and Lesser Spotted Eagles in the Center of European Russia

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Abstract. This article presents new data on the number and distribution of the Greater and Lesser Spotted Eagles (Aquila clanga and A. pomarina) in 9 regions located in the central part of European Russia. The area under surveys is 415,900 km². The results of surveys carried out in the Nizhny Novgorod region (76,900 km²) in 2014-2020 allow us to characterize the level of underestimation of the Greater Spotted Eagle in the region in previous periods, as well as estimate the degree of knowledge of the species in adjacent regions and calculate the probable number of the Greater Spotted Eagle in the study area (about 500 breeding pairs). In the central part of the Russian Plain, the important areas for the Great Spotted Eagle have been identified, which are very significant for the species conservation. The activities to protect the Greater Spotted Eagle are discussed. They should combine the establishment of protected areas and regulation of nature management aimed at the conservation of breeding habitats. The Lesser Spotted Eagle expanding its home range rapidly to the east has been shown. The relevance, great theoretical and practical significance of the study of the Lesser Spotted Eagle population, developing in the center of European Russia has been demonstrated.

1. Introduction
The Greater and Lesser Spotted Eagles (Aquila clanga and A. pomarina) are rare and poorly studied species of the European part of Russia. Both of them are listed in the Red Book of Russia (category 2 and 3, respectively). The Greater Spotted Eagle also has a globally rare status and is listed in the IUCN Red List as VU (Vulnerable: the taxon is facing a high risk of extinction in the wild in the medium-term future). Until recently, there was poor information about these species in the central part of European Russia; however, recent studies allow a new assessment of the number and distribution and of spotted eagles in this area. In this article, we present new data obtained mainly on the territory of the Nizhny Novgorod region, located in the geographical center of the Russian Plain, and compare them with modern data from adjacent regions. We evaluate the degree of study of spotted eagles and the knowledge of their real number in the study area. The data obtained is extremely important for developing strategies and tactics for the protection of species listed in the Red Data Books.
2. Materials and methods
Analysis of the number and distribution of spotted eagles has made for 9 regions of RF located in the central part of Russian plain (figure 1). The area under surveys is 415,900 km$^2$. The results of surveys carried out in the Nizhny Novgorod region (76,900 km$^2$).

Figure 1. The surveyed area

Until 2014, the study of the Greater Spotted Eagle in the Nizhny Novgorod Region and in the adjacent territories consisted mainly on the registration of nesting sites based on the encounters of adult birds; found nests were very rare and occasional. A regular survey of the breeding habitats of the species in order to find nests was not carried out. Special studies aimed at finding nesting sites and nests of spotted eagles were carried out in the region in the period 2014-2020.

The analysis of information on nesting sites, found nests and records of adults of the database of the Nizhny Novgorod branch of the Russian Bird Conservation Union was carried out. Also we analyzed the suitable habitats of the species with use of satellite images and the QGis and ArcView GIS-software. We set up a network of routes, running through alder bogs and floodplain meadows along the Volga, Oka and Vetluga rivers, as well as along the territory of the Kama-Bakaldino mires. Moving between key points and surveying the meadows by vehicle we made the pedestrian routes through wetlands. The total length of vehicle routes was more than 11,000 km, pedestrian ones – more than 800 km. The share of the surveyed territories of the total area of suitable habitats was about 30%.
Surveys were conducted from March to November. We were searching for nests in alder forests in March, April, October and November. We were finding the breeding territories from May to September, nesting sites were identified by occupied and empty nests, observations of fledglings guarded by parents (reliable nesting) and records of adult birds during the breeding season in breeding habitats (probable nesting). To search for nests, in addition to direct visual identification, forest areas were examined with use of DJI Mavic Pro quadcopter controlled from a smartphone. The area of floodplain forests examined in this way was 80 km². All bird encounters and found nest were mapped with use of Garmin GPS and were imported in GIS.

To estimate the number of spotted eagles we have analyzed our own data on bird records made outside the Nizhny Novgorod region and publications on adjacent regions. Also we carried out the GIS-analysis of the suitable habitats in these regions. Based on this information we have estimated the degree of knowledge of the Greater Spotted Eagle in the studied regions of the Russian Federation. Using the density values obtained in the most studied regions, the probable number of the species in the study area is evaluated as well.

Rates of the Lesser Spotted Eagle expanding its home range are also analyzed.

3. Results

The Greater Spotted Eagle has status A (Endangered) in the Red Book of the Nizhny Novgorod Region. The Lesser Spotted Eagle is mentioned in the Appendix to the regional Red Data Book (Information on Bird Vagrants) basing on a record of young birds in September 1995 [1].

A total of 23 nesting sites of the Great Spotted Eagle were found in 12 districts of the Nizhny Novgorod region in 1990-2014 (figure 2). The nests were found in 6 of them. The main breeding population was identified in the Ramsar site “Kama-Bakaldino Mires” with adjacent territories (8 nesting sites) and in the Northern Trans-Volga region (9 sites), two registrations were made in the Sura river floodplain, single observations – on the Oka, Pyana, Seryozha and Alatyr rivers [2-3].

A total of 33 new breeding sites were discovered and 4 known nesting sites were confirmed in 12 districts of the Nizhny Novgorod region during surveys carried out in 2014-2020 (figure 2). We identified 11 sites as a result of actually discovered nests, and 26 sites were revealed according to the adult birds recorded in suitable habitats during the breeding season. All identified sites were located in floodplain ecosystems. Nests were found in damp woodlands with birch and alder predominating. In Ten nests were built on birches and one - on the black alder. The height of the nest location ranged from 7 to 14 m. Hunting birds were observed in various habitats – floodplain meadows, peatbogs and swamps, fields and pastures, but always near floodplain forests suitable for nesting. Most of the nesting sites (24) were found in the Volga floodplain and in the Kama-Bakaldino Mires. In addition 5 records were made in the Oka floodplain, other observations were accidental and in different districts of the region.

The current data on the Greater Spotted Eagle in the adjacent regions were analyzed. There are 4 populations on the territory of the Republic of Mordovia: in the Vad river valley (8-9 pairs, 1500 km²), in the Moksha river valley (12-14 pairs, 800 km²), along the Sura river (3-4 pairs, 250 km²) and the Alatyr river (2-3 pairs, 200 km²). The total species number in the region is estimated at 25-30 pairs [4, 5]. In Ryazan region, the total number of the Greater Spotted Eagle is about 20-25 pairs. Of these, 4-6 pairs inhabit Central Meshchera, up to 9 pairs – the Oksky Nature Reserve [6]. In the Vladimir region, most of the known records of the Greater Spotted Eagle was made mainly in the Meshchera and Balakhna lowlands, in addition, some populations were noted in the Klyazma river valley (between these two territories) and in the Nizhneokskaya lowland [7]. The total number of the species in the region is 10-20 breeding pairs [8]. On the territory of the Ivanovo region, the majority of known nesting sites of the Greater Spotted Eagle belong to the Klyazma-Luhk population, the total number of the species is estimated at 15-20 breeding pairs [9]. In the Kostroma region, nesting sites were found near the Kostroma and Gorky reservoirs; in 2000, the number was estimated at 6-8 pairs [10]. In the Kirov region, the main habitats of the species are located in the floodplains of the Vyatka and Cheptsza rivers [11], and rather large population seems to breed along the Pizhma river [12]. The total number
of the species in the region is estimated at 10-15 breeding pairs [1]. According to the Red Data Book of the Republic of Mari El [13] single adults were noted extremely rare and no nests are known. However, according to our estimates 4-6 pairs bred only in Kuplong IBA (706 km$^2$) in 2003. In the Republic of Chuvashia, it is mainly found in the Sura region, but the number is consistently low and is estimated at 1-3 pairs [14].

![Image](image-url)

**Figure 2.** Nesting sites of the Greater and Lesser Spotted Eagles in the Nizhny Novgorod Region.

Until 2014, only a vagrant adult of the Lesser Spotted Eagle was observed in the Nizhny Novgorod Region. However, the species breeding was assumed in the region due to it inhabiting adjacent regions: Moscow, Vladimir, Ivanovo, Ryazan and Kostroma regions [6-15] and the species range expanding to the east.

The number of registrations of the Lesser Spotted Eagle has rather increased in the region since 2014 until now. An adult having caught a viper and carrying it into the forest was observed at the edge of the forest near the river in the Sergach district on May 26, 2020. In azimuth, an occupied nest of the Lesser Spotted Eagle was found, and an empty nest was 150 m apart. Both nests were located on black alders in a narrow fragment of flooded forest with alder and poplar predominating. The next day, May 27, two nests of Lesser Spotted Eagles were found in the same forest area on the territory of the Pil’na District, 9 km from the first site. The nests were built in a damp forest on old birches, 180 m from each other and 300 m from the system of reservoirs of depleted peat extractions. Also in 2014-2020, eagles
hunting were observed at 7 sites, in two of which birds were observed for two consecutive years, which also allow us to suggest nesting sites locating here.

Two sites of the Lesser Spotted Eagle in the Kstovsky district are located close to the sites of the Greater Spotted Eagle (5 and 3.5 km). Besides in 2019, in the Lyskovsky District, the Lesser Spotted Eagle was observed only 2 km from the point where an adult of the Large Spotted Eagle was recorded in 2018. These data suggest a high probability of hybridization of the two species in the region [16]. Hybridization facts are known for the adjacent Ivanovo region [17].

4. Discussion

In the first edition of the Red Data Book of the Nizhny Novgorod Region, the number of the Great Spotted Eagle was estimated at 10-15 pairs [18], in the second edition – at 25-30 pairs [1]. The data obtained in recent years allow us to re-evaluate the population number at 90-100 pairs [19]. These figures can be taken as evidence of the species number having grown almost ten times for 25 years. Indeed, there has been an increase in numbers since the deep depression of the 1980s. This depression was caused by large-scale logging, pesticide use in agriculture and forestry and direct pursuit of birds of prey, which occurred in the 1950-70s. At the same time, the change in the estimated numbers, first of all, is explained by the better study of the species at the present time and the underestimation in the past.

Estimates of the area of suitable habitats for the Greater Spotted Eagle, its total number and density in regions are presented in Table 1.

Table 1. Estimation of the area of suitable habitats, total number and density of the Greater Spotted Eagle in the center of European Russia.

| Region of RF | S, km² | S of suitable habitats, km² | Number, breeding pairs | Average density in the region | Density, pairs/100 km² in suitable habitats | Projected number |
|--------------|--------|-----------------------------|------------------------|--------------------------------|---------------------------------------------|-----------------|
| N. Novgorod, 2003 | 76900  | 7200  | 10-15 | 0.02 | 0.17 | 70-80 |
| N. Novgorod, 2014 | 76900  | 7200  | 25-30 | 0.04 | 0.37 | 80-90 |
| N. Novgorod, 2020 | 76900  | 7200  | 90-100 | 0.12 | 1.31 | 90-100 |
| Republic of Mordovia | 26200  | 2700  | 25-30 | 0.1  | 1.02 | 30-35 |
| Ryazan | 39600  | 3100  | 20-25 | 0.06 | 0.72 | 40-45 |
| Vladimir | 29000  | 3800  | 10-20 | 0.05 | 0.39 | 50-55 |
| Ivanovo | 21800  | 1700  | 15-20 | 0.08 | 1.02 | 20-25 |
| Kostroma | 60100  | 5700  | 6-8 | 0.01 | 0.12 | 70-80 |
| Kirov | 120800 | 8600  | 10-15 | 0.01 | 0.14 | 110-120 |
| Republic of Mari El | 23200  | 4100  | 4-6 | 0.02 | 0.12 | 45-50 |
| Chuvash Republic | 18300  | 1300  | 1-3 | 0.01 | 0.15 | 15-20 |
| Total | 415900 | 38200 | - | - | 1.12 | 470-530 |

The data in Table 1 allow us to distinguish three levels of study of the Greater Spotted Eagle: low – in the Nizhny Novgorod region until 2003, in the Kostroma and Kirov regions, the Republics of Chuvashia and Mari El; medium – in the Nizhny Novgorod region in 2014 and in the Vladimir region; high – in the Nizhny Novgorod region at the present time, in the Ivanovo region and the Republic of Mordovia. The estimated numbers of the Greater Spotted Eagle in the regions with a high level of knowledge seem to be close to the real ones. There is a significant underestimation in other regions. The total number of the Greater Spotted Eagle is projected about 500 breeding pairs in the study area (table 1).

Locations of known places of the Greater Spotted Eagle reliable and probable breeding is shown in figure 3.
Following the available data we can outline the large important area of the Great Spotted Eagle range, including the Balakhninskaya, Volgo-Vetluzhskaya and Mariiskaya lowlands. More than 30% of the nesting sites known in the area under surveys are located on this territory. The Meshchera lowland is also recognized as an important area. Habitats in the floodplains of the Unzha, Vetluga, Pizhma, Vyatka and Kama rivers are of great importance for the conservation of the species. These important areas are currently poor surveyed. However a great number of nesting sites can be assumed here.

![Map of European Russia showing known places of the Greater Spotted Eagle reliable and probable breeding]

**Figure 3.** Known places of the Greater Spotted Eagle reliable and probable breeding in the center of European Russia.

Our data have shown the number the Greater Spotted Eagle in the study area significantly exceeding the earlier estimates. As a result the task of the species protection cannot be solved only with the help of the system of protected areas. Additional mechanisms should be involved to protect the nesting sites. These mechanisms should combine the establishment of protection zones around individual nests and prohibition of logging in the riverside forests, where spotted eagles habit to nest. In addition, a general decline in agriculture poses a potential threat to the species, leading to a reduction in the area of hayfields and pastures in floodplains. If old-growth swampy forests are important for the species nesting, open spaces are the hunting habitats for the Greater Spotted Eagle.
The Lesser Spotted Eagle has been regularly observed in the Nizhny Novgorod region only in the last 5 years of observations. It has appeared in more western regions earlier. Now the species is recorded breeding in the Nizhny Novgorod region. Considering the Lesser Spotted Eagle breeding in Chuvashia, a pair recorded in the Republic of Mari El [20] and a new breeding group registered in the Vladimir Region [7], we can confidently declare the increase in the species range expanding to the east and project the Lesser Spotted Eagle population growing in the Nizhny Novgorod region, as well as we expect the species observed in Tatarstan.

In the Nizhny Novgorod Region, the Lesser Spotted Eagle population is currently estimated at 10-12 breeding pairs with an upward trend. This species should be added to the general list of the Red Data Book of the Nizhny Novgorod region with status “Endangered” (category A).

5. Conclusion

Surveys carried out in 2014-2020 allow us to re-evaluate the number and distribution of the Greater and Lesser Spotted Eagles in the Nizhny Novgorod region and adjacent regions.

The low numbers of the Greater Spotted Eagle are mainly due to the underestimation as a result of the lack of special surveys. We project about 500 pairs of the Greater Spotted Eagle breeding on the territory of 9 regions of the Russian Federation (415,900 km²).

The Balakhninskaya, Volgo-Vetluzhskaya and Mariyskaya lowlands, Meshchera lowland, as well as the floodplains of the Unzha, Vetluga, Pizhma, Vyatka and Kama rivers are recognized as important areas of the Greater Spotted Eagle range in the central part of the Russian Plain. These areas are emphasized of urgent concern for the conservation of the species.

The protection of the Greater Spotted Eagle should combine the establishment of protected areas, and protection zones around individual nests and prohibition of logging in the riverside forests, where spotted eagles habit to nest. It is also important to conserve the floodplain meadows, which have traditionally been maintained through hay making and pasturing.

The Lesser Spotted Eagle quickly spreads to the east. It has become a new regular breeding species in the territory of the Nizhny Novgorod region. Several birds were registered in the Republics of Mari El and Chuvashia. Further study of the Lesser Spotted Eagle population developing in the center of European Russia is of great theoretical and practical interest.

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