Journal of Life Sciences 14 (2020) 14-21
doi: 10.17265/1934-7391/2020.01.003

Booted Eagle *Hieraaetus pennatus* (J. F. Gmelin, 1788) in Armenia: Update on Conservation Status

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Abstract: The monitoring of the Booted Eagles *Hieraaetus pennatus* in Armenia, conducted during 2003-2019 shows that the species breeds in northern, north-eastern, central, southern, and south-eastern regions, inhabiting various deciduous and mixed woodlands at elevation range 1,200-2,300 m above sea level. The area of occupancy makes 5,110 km^2. According to the last estimation, there are 48-72 breeding pairs of Booted Eagles in the country. The population trend during 2003-2019 demonstrates stability ($p > 0.05$, $n = 21$). Among 24 cases of three nests observed during 2011-2018, in 20 cases (83%) the nest consisted of two hatchlings, however in 11 nests out of those 20 (55%) the older and stronger nestling was killing the younger and weaker one. The average breeding success makes 1.33 ± 0.28 fledglings per occupied nest. Our questioning of hunters shows that poaching can be a threat for the species due to low level of education of local hunters. The present conservation measures are not enough. The conservation status of the species should remain the same: Vulnerable D1, but the proposed conservation measures should include: (1) nation-wide educational program on raptors; (2) increase of punishments for illegal hunting and trapping of the species; (3) setting up a state exam for the hunters to check their knowledge; (4) strengthening of Inspectorate for Nature Protection and Mineral Resources; (5) assisting farmers and pigeon breeders to improve facilities for protection of domestic birds. The continuous monitoring of the species remains essential to track its further population trend, and to indicate the efficiency of undertaken conservation measures.

Key words: Booted Eagle, *Hieraaetus pennatus*, Armenia, conservation status, population dynamics, threats.

1. Introduction

Armenia is located at the South Caucasus between Black and Caspian Seas. It is relatively small (29,743 km^2), landlocked mountainous country, where elevation varies from 375 to 4,090 m above sea level. In such an altitudinal gap, the various climatic conditions determine many different landscapes, including semi-desert, juniper woodland, deciduous forest, mountain steppe, and sub-alpine area. However, these landscapes are not uniformly spread across the country. Thus, deciduous forests are mainly located at northern, north-western and south eastern areas of the country (see the map on Fig. 1), although some residual patches remain from larger forest areas in central and southern Armenia. Also, forests are presented in riparian areas of arid zone [1]. The forested regions are quite sufficient for Booted Eagle *Hieraaetus pennatus*, which breeds in the woodlands, while hunts in both: forests and open areas. The Booted Eagles are patchy-distributed from South-Western Europe and North-Western Africa through Eastern Europe, Asia Minor and Caucasus to Central Asia, including Pakistan, India and Nepal; also isolated population breeds in South Africa [2, 3]. It is classified as Least Concern in IUCN Global Red List, although it has an unknown population trend [4]. In European scale it is also considered Least Concern showing increasing population trend [5].

Interestingly, despite the number of isolated breeding populations, the species is considered monotypic [2, 3]. In Armenia the species is considered as an inhabitant of deciduous forests [6]. Despite in some publications the detailed assessment of the species has not been conducted at the national scale. That is why in 2003 the country wide monitoring program was launched for a number of species including the Booted Eagle.

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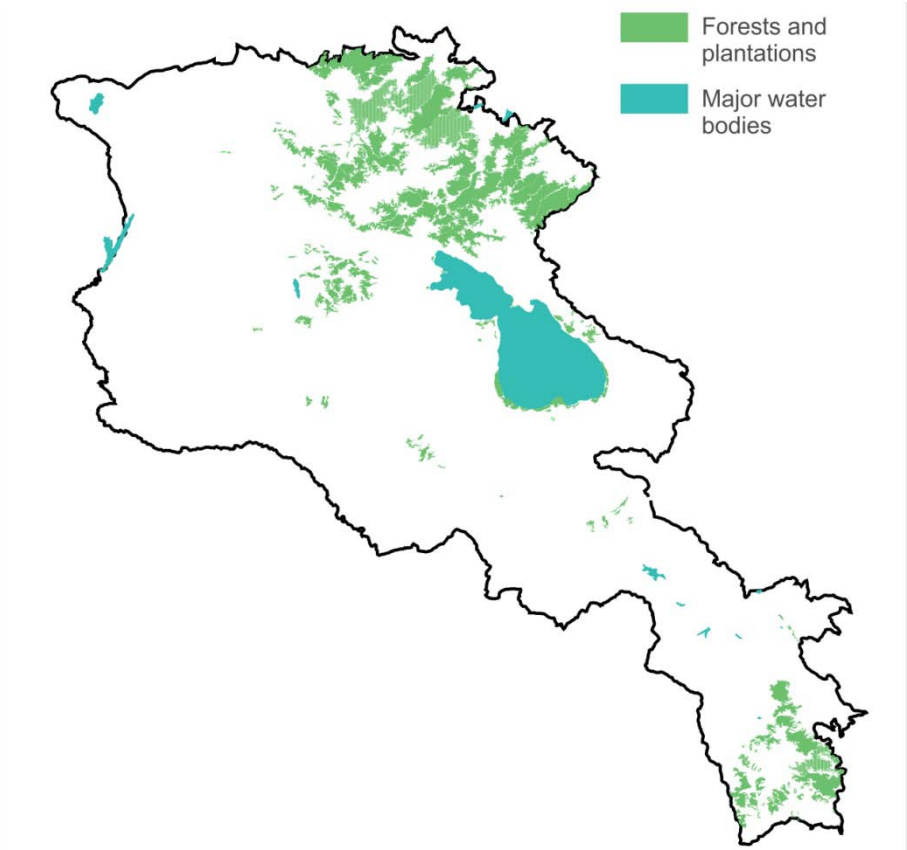

Fig. 1 Map of forests in Armenia.

Some preliminary results have been used for *Red Book of Animals of Armenia*, where the Booted Eagle was evaluated as Vulnerable VU D1, with rough estimation of population from 60 to 80 breeding pairs [7]. Also, the data were used for assessment of Emerald Sites in the country [8]. Now, after over 15 years of monitoring it is necessary to update the situation with the species, especially considering the upcoming *Red Book of Animals of Armenia*, planned for implementation in 2020-2022. That is why the current communication is aimed at describing the modern state of Booted Eagles in Armenia, including its population trend during 2003-2019, some local biological peculiarities not well known for the country, threats for Booted Eagles, as well as existing and needed conservation measures.

2. Material and Methods

By the beginning of focused data collection on the species, there was only one known nest of the species in Armenia, found in 1960s [9], although records on the species were quite numerous [6] and also three other territorial pairs have been localized in south-eastern district of the country at the southern slopes of Meghri Mountain ridge [10]. In 2003 we have started systematic data collection on Booted Eagles along with other birds of prey in Armenia. Monitoring of the species was implemented via count of the territorial pairs (the pairs which have constantly been observed at certain area, or those which have been displaying, mating, constructing the nests, carrying food for nestlings and so on), or when it was possible—through occupied nests.

To estimate the number of breeding pairs in Armenia, we initially calculated the distances between neighboring pairs and assumed the half of that distance as a radius of the territory occupied by a pair. After, we have modelled the distribution of the species

taking into account the records of adult birds in breeding season, average measured distance between neighboring breeding pairs and necessary characteristics of the area: existence of the woodland patch of a minimal size (5.4 km^2, see Section 3), existence of the trees at least 6 meters tall (again see Section 3), existence within the possible breeding territory of the open grasslands, which should make at least 50% of the breeding pair's area, and a possibility to locate the nest at least at two-kilometer distance from the nearest settlement.

The monitoring of 21 breeding pairs was performed annually during April-May. In June and July of each year, we have been visiting the occupied nests again, to record the number of fledglings. It allowed us to obtain some general pattern of the breeding success—number of fledglings per occupied nest and number of fledglings vs. number of hatchlings. In addition, we have collected the data on location of each nest, which was including type of the location (tree species, tree height, nest location's height, placement), as well as recorded the construction of the nests. To understand some peculiarities of the species' feeding we have been making long-term observations of the hunting behavior of Booted Eagles observed in the field. In total over 40 people participated in the study, which covered almost entire Armenia.

To calculate population trends, we used multi-year data series and processed them using TRIM 3.0 Software [11]. For the purpose the Collated Index was calculated using log-linear poison regression; then the deviations are calculated and presented as a linear function, showing populations growth or decline. Statistically significant change is stated on the level $p < 0.05$, otherwise the population was considered stable. The mapping is implemented using ArcGIS 10.0 Software. To estimate the threats, we have conducted surveys of hunters and pigeon breeders, also we visited the main online and offline market places where the mounted specimens of raptors could be sold; also we have conducted questioning of farmers about stealing of their chicks and pigeons and their attitude and perception towards the species. In addition, an interview with the State Inspectorate for Nature Protection and Mineral Resources was conducted, aimed at identification of their potential in implementation of control over poaching.

3. Results

3.1 Distribution and Biological Peculiarities in Armenia

Our investigations show that in Armenia the species breeds in northern, north-eastern, central, southern, and south-eastern regions (see Fig. 2). Booted Eagle inhabits various deciduous and mixed woodlands. Those include true deciduous mountain forests, residual forests, woodlands located at the riparian zone, and some of the tree plantations (see Fig. 3). The elevation range occupied by breeding pairs makes from 1,200 to 2,300 m above sea level. The total area of occupancy was calculated as 5,110 km^2, and the distance between neighboring nests was measured from 9.1 to 11.2 (mean ± standard error is 10.16 ± 1.02, $n = 9$). In Armenia the species is a complete migrant, which returns to the country in April and starts the breeding season in May. Booted Eagles nest only on the trees, selecting rather tall ones—from 6 to 10 meters high, among available at the area (see Fig. 4). They place the nest at the last third of the tree, in a twig, closer to the tree trunk. Among six examined nests all of those have been located at the proximity to the forest edge: either upper timberline or next to forest clearings, fragmented forest areas and so on. The smallest woodland patch occupied by the species has an area of 5.4 km^2. The incubating birds have been observed since late April, but usually from beginning of May. The downy nestlings have been observed in June, while the first flight of the fledglings was recorded on mid to late July, sometimes at the beginning of August (see Fig. 5).The Booted Eagles have mostly been observed hunting at open grasslands on the ground animals, such as rodents and lizards,

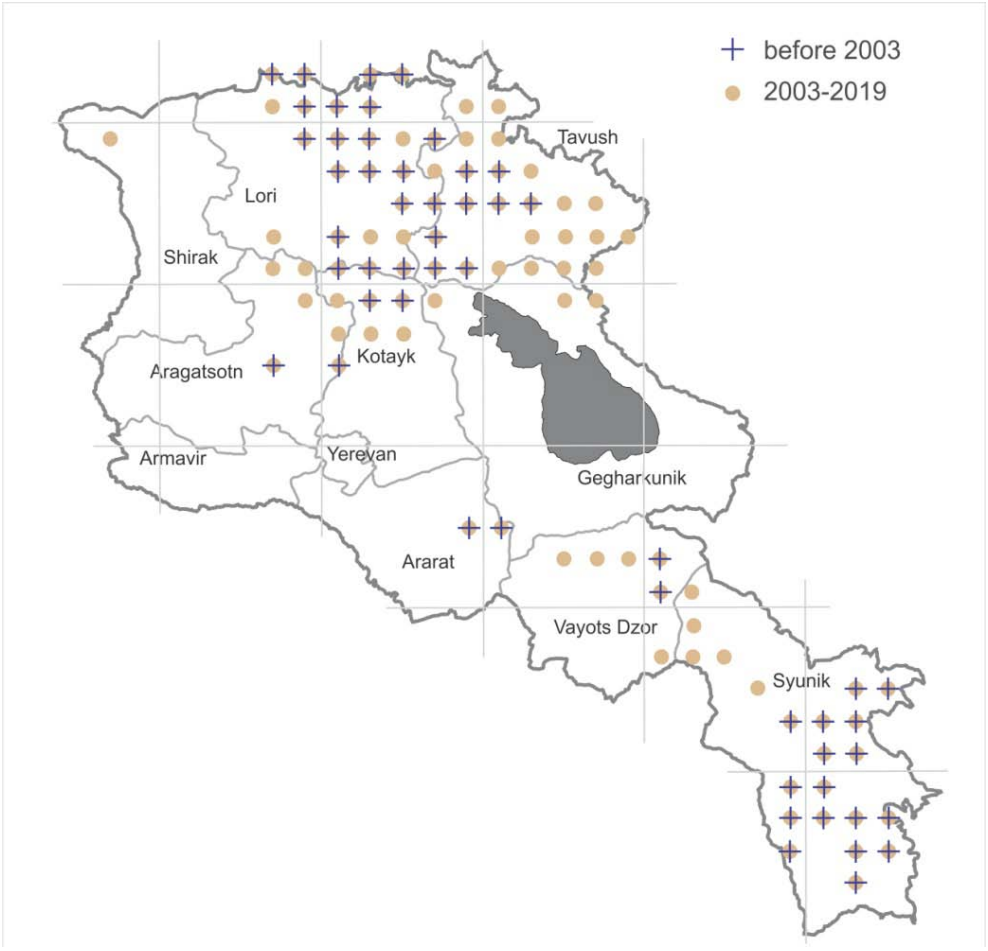

Fig. 2 Distribution of booted eagle in Armenia.

Fig. 3 Typical habitat of the booted eagle at the slopes of Aragats Mountain.
Source: Photo by K. Aghababyan.

Fig. 4 Location of the booted eagle's nest on the hornbeam tree.
Source: Photo by H. Stepanyan.

searching for them from the elevation 30-50 meters from the ground. During 24 nest visits the found remains have been mainly belonging to passerines, however, due to lack of feathers further identification was not possible. Also, the domestic pigeons, domestic chicks, Grey Partridge *Perdix perdix*, and Eurasian Jay *Garrulus glandarius* have been found. Remains of rodents have not been observed.

3.2 Population Dynamics

According to the last estimation, there are 48-72 breeding pairs of Booted Eagles in the country. The population trend during 2003-2019 demonstrates stability ($p > 0.05$, $n = 21$), as it is shown in Fig. 6. The pattern of breeding success studied on three nests shows that among 24 cases of three nests observed in the period of 2011-2018, in 20 cases (83%) the nest consisted of two hatchlings. Among those 20 cases in 11 nests (55%) the older and stronger nestling was killing the younger and the weaker one. Thus, in total the average breeding success was making 1.33 ± 0.28 fledglings per occupied nest. In other nine cases, when both nestlings survived, the measurements show that the older nestling was a male, and thus was smaller, while the younger was a female, and therefore – bigger.

Our questioning of 200 hunters shows that 84 of them (42%) are committed that they have seen the species in the nature although most of them do not know what the species is: among the same 200 hunters only three (1.5%) knew the name of the species. Among the questioned hunters 27 (14%) mentioned that during their life they have been trying to shoot the bird considering it as a domestic chicken and pigeon stealer. Other 64 of the hunters (32%) mentioned that this is a "white falcon", which could be expensively sold to Arabic countries for falconry. None of the hunters knew about occupied nest of the species. Our survey of main markets shows that the species is not represented at the illegal trade neither alive, nor as mounted specimen. Our survey of 30 pigeon breeders, who live close to the distribution range of Booted Eagles shows that the species often steals domestic pigeons. Among the questioned pigeon breeders, only one stated that he has shot the species, the others, however mentioned their wishing to exterminate the

Fig. 5 Fledgling of booted eagle on 23rd July, which is almost ready to leave the nest.
Source: Photo by H. Stepanyan.

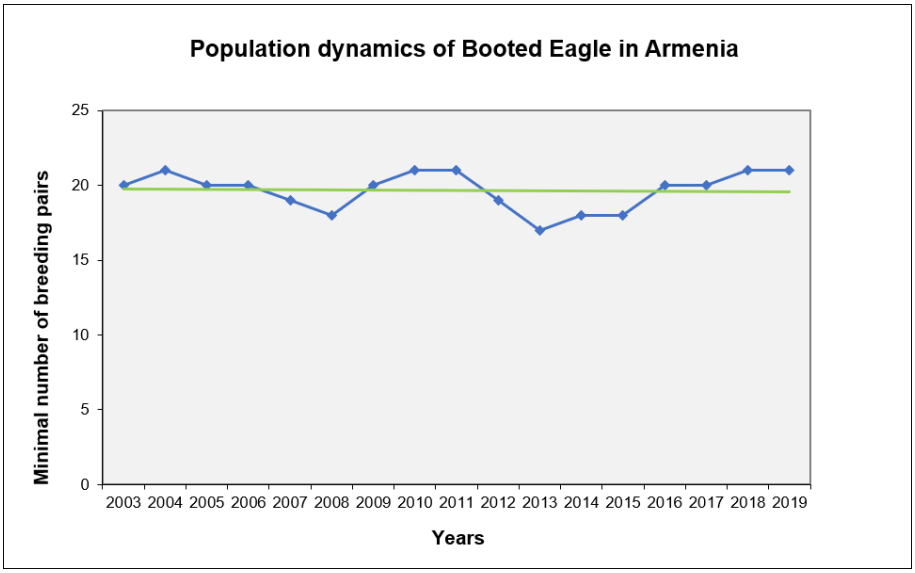

Fig. 6 Population dynamics of booted eagle based on monitoring of 21 breeding pairs.

Booted Eagle along with other pigeon stealers, like Goshawk *Accipiter gentilis* and Peregrine Falcon *Falco peregrinus*. They mentioned that the only obstacle for them: lack of technical opportunity, is easy to overcome with new technique of smearing poison over pigeon, which will kill any hawk, falcon, or eagle, upon eating of that pigeon. And eventually, our interview with the State Inspectorate for Nature Protection and Mineral Resources shows that they have lack of financial and human resources for effective control of the poaching: illegal shooting and trapping of the species, regardless of the extension of those actions. Additionally, the State Inspectorate's staff informed us that even in case of poaching, the

local hunters would not be afraid of being caught, partly because of poor coverage of the Inspection's staff of the field territory, and partly because of relatively low punishment: the penalty for illegal shooting or trapping of this red-listed species makes less than equivalent of 140 Euros [12].

4. Discussion

4.1 Causes of Observed Population Trend

It appears that despite on some level of negative perception towards the species in the villages, when people consider it as chicken and domestic pigeon stealer, the poaching cases do not significantly affect the species population. Of course, here we should take into account that with spreading of such attitude the situation can significantly change, as it might result in elimination of the species. The same, although with less extent, is related to the attitude towards the species as an object for falconry. That is why among the conservation measures, it is very important to include a nation-wide education program aimed at demonstration of the usefulness of the species for agriculture and raising of intrinsic value of the species. Also, a program that would assist farmers and pigeon breeders to better protect their poultry might help change the negative attitude towards the species. Among such hawk-friendly methods we would like to mention the hawk balls and other light-reflecting techniques, used in other countries [13].

4.2 Present Conservation Measures

The Booted Eagle is listed in *Red Book of the Animals of Armenia* as Vulnerable-VU D1 [7] and included in Appendix II of the *CITES* and in Appendix II of the *Bern Convention*. At current, at least eight pairs are found to be breeding in Dilijan National Park, Khosrov Forest Reserve, Arevik National Park, Lake Arpi National Park, and Shikahogh Reserve. Most of the other breeding sites are included in the Emerald Network, protected under *Bern Convention* [8].

4.3 Proposed Conservation Measures

At first, the conservation status of the species should stay the same in accordance to criteria D1: less than 1,000 mature individuals [14]. Taking into account the current and potential threats, the proposed conservation measures for the species should include: (1) start of a nation-wide educational program aimed at changing the attitude and perception towards raptors in the country in general and towards Booted Eagle in particular; (2) increase of punishments for illegal hunting and trapping of the species; (3) setting up a state exam for the hunters, which will check their knowledge on red listed species and their understanding of punishments for illegal killing of such species; (4) strengthening of Inspectorate for Nature Protection and Mineral Resources and development of its cooperation with the Hunters' Unions and Conservation NGOs in the country; (5) setting up a program that will assist farmers to improve their facilities and better protect the domestic animals—chickens and pigeons; (6) beginning of a targeted education program for pigeon breeders, aimed at teaching them alternative techniques for protection of pigeons from hawks. These conservation measures should be supported by continuous monitoring of the species with two purposes: (i) to track its further population trend, and (ii) to indicate the efficiency of undertaken conservation measures.

5. Conclusion

In Armenia the Booted Eagles breed in northern, north-eastern, central, southern, and south-eastern regions, inhabiting various deciduous and mixed woodlands at elevation range 1,200-2,300 m above sea level. The area of occupancy makes 5,110 km^2. According to the last estimation, there are 48-72 breeding pairs of Booted Eagles in the country. The population trend during 2003-2019 demonstrates stability ($p > 0.05$, $n = 21$). The average breeding success makes 1.33 ± 0.28 fledglings per occupied nest, because most of the pairs produce two hatchlings

(83%, n = 24), but the older and stronger nestling is killing the younger and weaker one in 55% of the cases (n = 20). The poaching can be a serious threat for the species due to low level of education of local hunters. The present conservation measures including the Vulnerable status of the species in current *Red Book of Animals of Armenia* are not enough. There is a need for change of the conservation measures, which should include: (1) nation-wide educational program on raptors; (2) increase of punishments for illegal hunting and trapping of the species; (3) setting up a state exam for the hunters to check their knowledge; (4) strengthening of Inspectorate for Nature Protection and Mineral Resources; (5) assisting farmers and pigeon breeders to improve facilities for protection of domestic birds. The continuous monitoring of the species remains essential to track its further population trend, and to indicate the efficiency of undertaken conservation measures.

Acknowledgements

The inventory and monitoring of Booted Eagles in Armenia as well as the study of its biological peculiarities is supported by members of Armenian Birdwatching Association, Ministry of Environment of RA, Inspectorate for Nature Protection and Mineral Resources, Khosrov Forest State Reserve, Dilijan National Park, Arevik National Park, and Zangezur Biosphere Reserve.

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