

About the state of Corn Crake *Crex crex* Bechstein 1803 in Armenia

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Abstract. The Corn Crake *Crex crex* is one of the most secretive birds in Armenia, which was assessed as Vulnerable in the last edition of National Red Book. We carried out national surveys in 2003–2019 and estimate the current occupied range of the Corn Crake in Armenia as 1,859 km² and its Extent of Occurrence as 16,621 km². In 2019 we estimate the species' population size at 2,529 calling males (95% CI: 1,770–3,290). Its population trend shows a moderate significant decline; –19% in 17 years, with insignificant fluctuations. Surveys of the seven Hunters' Unions of Armenia found that there are 10,000 to 20,000 active hunters, which sometimes shoot Corn Crake due to lack of knowledge of the Red-listed status of the species. Existing mowing practices result in habitat degradation, which also contribute to the decline of the Corn Crake. Currently the species deserves a conservation status of Vulnerable under criteria B1ab+B2ab+C1. To protect the species, it is recommended: (1) develop better financial mechanisms to fund the monitoring of the populations of the game species and control of hunting and poaching; (2) develop a new State exam for obtaining a hunting license aimed at having better educated and more responsible hunters; (3) establish small seasonal protected areas for the Corn Crakes; (4) develop and introduce alternative mowing schemes which support higher survival of Corn Crakes' chicks; (5) develop alternative fodder for livestock in winter to decrease their need in hay. The proposed measures should be accompanied by monitoring of the species.

Introduction

Corn Crake (*Crex crex*) is a monotypic species, widely distributed in Eurasia (Taylor & Kirwan 2020). Its global conservation status was downgraded during the last decade from Near Threatened with decreasing population trend (BirdLife International 2008) to Least Concern with a stable population trend (BirdLife International 2016). This classification has taken place on the basis of improved knowledge of the species's global extinction risk, as opposed to a genuine recovery to favourable conservation status across its range. At the European scale the species is also considered as Least Concern (BirdLife International 2015), while in Armenia it was included in the Red Book of Animals of Armenia as Vulnerable VU B1ab (iii)+2ab (iii) with unknown population size and trend and an assumption of such threats as disturbance by agricultural operations during the breeding season, disturbance by shepherd dogs, which accompany livestock in the period of nomadic grazing in the mountains, disturbance by wild herb collectors, and poaching (Aghasyan

& Kalashyan 2010). Corn Crakes show some habitat specialization within Armenia, inhabiting a rather narrow range of meadows and marshes from 1,200 to about 2,500 metres above sea level (Adamian & Klem 1999). The landscapes inhabited by the species may indeed potentially be influenced by various anthropogenic factors, and the birds may be victims of direct persecution. Ten years after the last assessment, it is a time to review the conservation status of the Corn Crake examining changes in its distribution and population, and evaluating existing and potential threats for the species.

Material and methods

Corn Crake data collection

Early observations of Corn Crake in Armenia recorded in the literature were collated and summarized in Adamian & Klem (1999). Systematic data collection on the Corn Crake started in 2003 within a National Bird Monitoring Program. The standard European Monitoring Grid with a

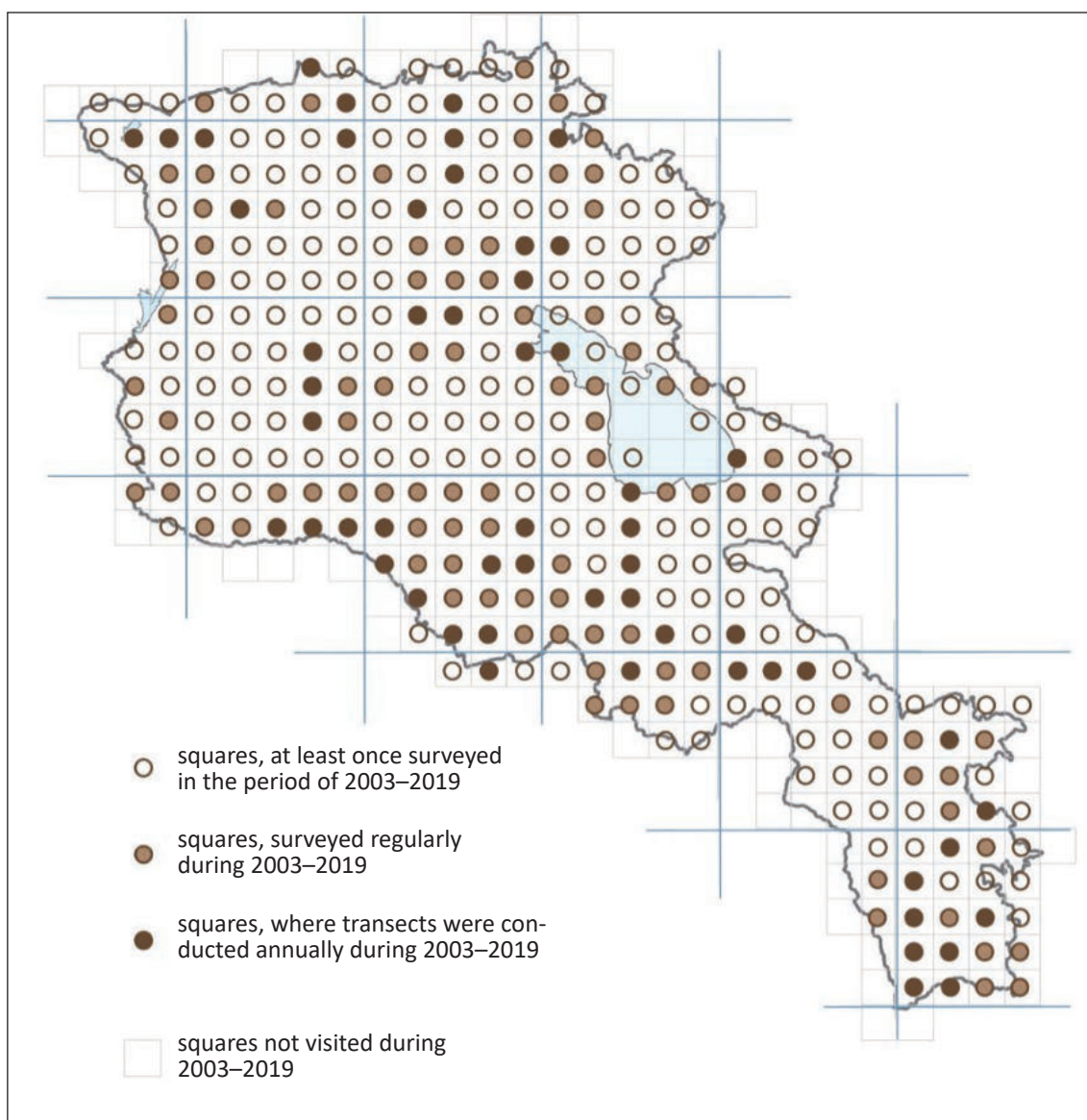


Figure 1. Squares (on a 10×10-km grid) surveyed for Corn Crakes in Armenia either systematically (annually after first count), or opportunistically (at least in one year) over the period 2003–2019.

10×10-km mesh was applied to Armenia (Council of Europe 2018), dividing the territory of the republic into 374 squares. The monitored squares were of two kinds: “systematic” ones that, once counting started on them, were systematically counted every subsequent year, and “opportunist” ones, where counts were carried out when the opportunity arose. In total, in the period of 2003–2019 the 325 squares were visited at least once during that period, including 147 squares, with systematic data collection (see the map on Fig. 1). In total, out of 325 surveyed squares the data on Corn Crane was collected in 118 squares. The Corn Crane is quite a secretive species, which spends most of the time in rather high herbal vegetation, and is hardly seen walking or flying. How-

ever, males call loudly and regularly during the breeding season, having an unmistakable voice and making it possible to detect their presence and to count them. In the surveyed squares, data on Corn Crane was obtained from two different sources: (1) opportunistic observations and (2) standardized counts (data collected according to standard methodology). Both types of data may be used to create species distribution maps, and data collected by the second method was used for estimating population densities and trends.

1. Opportunistic observations were provided by birdwatchers and accepted as long as they conformed to minimum data requirements: accurate species identification, observation date, geographical coordinates, name of nearest locality (human

settlement, mountain, historical site, etc.), breeding code (based on the bird's behaviour, indicating how likely it is that the bird is breeding in the surveyed area — (Voříšek *et al.* 2008)), observer name and contact details. The observations often have additional information, e.g., time, observation duration, number of people in the group, etc. Since it was not always possible to record the precise geographical coordinates on the spot, the information was sometimes provided at the level of the 10×10-km square.

2. Standardized counts (counts done following a predefined standard protocol) can be conducted by both professional ornithologists and amateur skilled birdwatchers. Counts were carried out during a fixed period of 1 or 2 hours, when an observer slowly walked along a transect route counting all the calling males within 200 m either side of the transect (hence in a strip 400 m wide). The specific call of the Corn Crake is clearly audible even from a farther distance, that is why we assume high detectability of the birds within the 200 m distance from each side of the transect. As far as possible, surveys were done a couple of hours before the sunrise or in evening soon after sunset, in favorable weather conditions, such as absence of rain and weak wind (below Beaufort Force 3). The earlier studies (Hudson *et al.* 1990) suggest that the calling activities of Corn Crakes can be significantly reduced before 23:00 and after 2:00 am, and therefore its number could be underestimated, however we assume that use of the same method over the period of time provides us with the reliable data for computation of the species population trend. The best period for Corn Crake counts was considered to be between 15 May and 10 June, nevertheless, data collected later in mid-June to July were used as well. The standardized counts required more detailed data collection than incidental observations: number of calling males heard, observation date, geographical coordinates of the beginning and end of the route, type of habitat, start and end times of the count, individual-specific breeding codes, observer name and contact details. The number of routes in one 10×10-km square varied from one to two, depending on how many habitat types were present in a square. Each route was dedicated to one type of habitat only. We tried to keep the same routes for the standardized counts and to survey them every year, whenever possible. However, in the period 2013–2017, when the number of volunteer counters increased

thanks to the fieldwork required for the European Breeding Bird Atlas 2 (Keller *et al.* 2020), and some new standardized counts were created from atlas routes. All data were collated at the end of each counting season, entered into a database and checked.

Hunting data collection

To gather information on possible hunting pressure on the Corn Crake, we conducted surveys of the heads of seven Hunting Unions and their hunter members (keeping the hunters' survey confidential to reduce the risk of false reporting). We tried to keep the numbers per Hunting Union roughly equal (minimum difference was two and the maximum difference was 10 hunters). The survey was conducted in spring 2019, after the end of the 2018–2019 hunting season, which usually starts on 20th to 25th of August and lasts until end of March of the next year. For the survey we have sent out over 800 questionnaires. A total of 486 responses were received, and a further 14 responses obtained following personal requests, giving a total of 500. The following questions were included in the questionnaire: (1) do you hunt? (2) do you know Corn Crake (photo of the bird supplied)? (3) do you ever hunt Corn Crake? (4) how often do you hunt Corn Crake (almost every year; not frequently; rarely)? (5) how many Corn Crake do you hunt per annum? (6) do you know whether Corn Crake is in Red Book of Armenia or not? (7) do you know anything about punishment for illegal shooting of Corn Crake? We also interviewed staff at the State Inspectorate for Nature Protection and Mineral Resources. These interviews were conducted with four inspectors from Shirak, Lori, Kotayk, and Vayots Dzor Provinces and were less structured. The main questions that were relevant here were related to the ability of the inspectors to detect poaching on this red-listed species.

Data analysis

The distributional range of Corn Crake was determined at the 10km x 10-km square level. A given square was considered occupied if the calling males were recorded in any of the 17 years 2003–2019 through incidental observation or standardized count. To compare the change in distribution from before 2003 with that during 2003–2017, we also digitized all the previous records summarized in Adamian and Klem (1999). The available

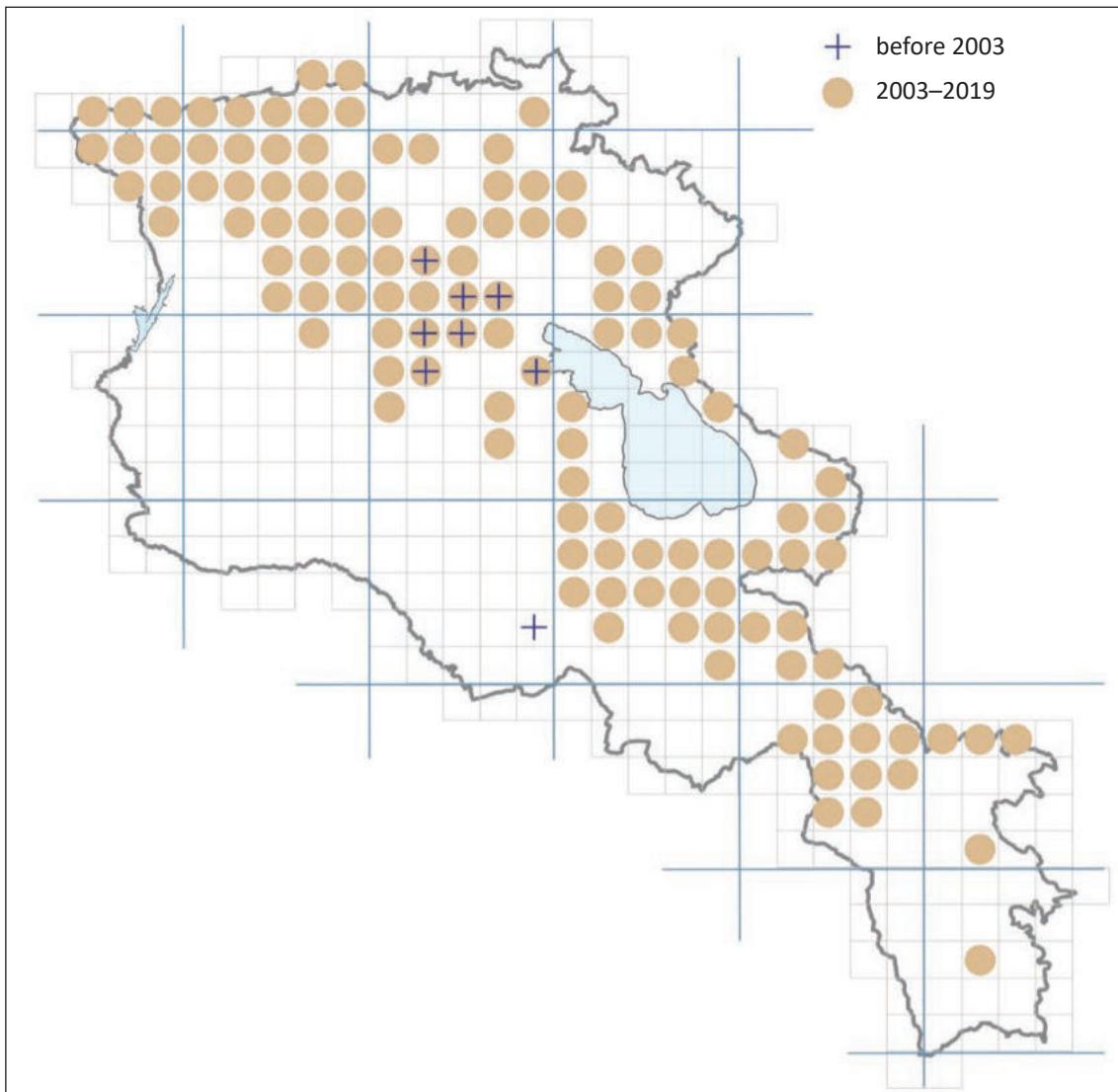


Figure 2. Distribution of the Corn Crake in Armenia based on a 10×10-km square grid, before and after 2003.

habitats of the species were calculated using the software package ArcGIS 10.0 (Environmental Systems Research Institute, Inc.) using the own database of the habitat shape files. The Extent of Occurrence was computed using IUCN guidelines (IUCN Standards and Petitions Committee 2019). For the purpose the rule of minimum convex polygons (the smallest polygon in which no internal angle exceeds 180° and which contains all the sites of occurrence) was applied within the overall distribution inside the borders of Armenia. The density of the Corn Crake was taken in common for this species format of calling males (Taylor & Kirwan 2020, EEA 2020). The density of Corn Crakes was estimated for each transect route by dividing the recorded number by the area around a transect, obtained as the length of the route multiplied by the strip width of 400 m. The density values were then averaged across

transects and its standard error (SE) was calculated. The total size of the population of Corn Crakes in Armenia in 2019 was estimated as the sum of the number obtained by multiplying the 2019 upper and lower ranges of the density (average \pm SE) by the area of habitat within the occupied range. The density of the species and therefore the total population size of the species is taken as minimum, since the earlier studies (Hudson *et al.* 1990) demonstrated that the surveys conducted before 23:00 and after 4:00 am can provide figures, which are up to five times lower than the real densities of the species.

To calculate population trends, we used transects with multi-year data series and processed the data (density values per transect and year) using TRIM 3.54 software (van Strien *et al.* 2004). In total, there were 289 data values analyzed from 17 transects monitored annually. We calculated a



Figure 3. Typical habitat of the Corn Crake in the Vardenis mountains of Armenia. Photo by K. Aghababyan.

population index using log-linear Poisson regression, and applying a time effect model; the indices are calculated relative to 2003, which is given a value of 100. TRIM also provides an estimate of overall trend in the form of the average annual rate of change r and its standard error $SE(r)$ across the full span of years (Pannekoek & van Strien 2005). The importance of the trend was assessed based on its magnitude and statistical significance in accordance to van Strien et al. (2001).

Results

Distribution, population size and trend in Armenia

During the surveys of 2003–2019 the Corn Crake was recorded in relatively large areas of Northern and Central regions of the country (Fig. 2). The species was recorded at elevations mainly ranging from 1,400 to 2,600 m above sea level, although some calling males were recorded as low as 1,020 m above sea level. The main habitats occupied by Corn Crake included meadows located on plateaus, in river valleys, and on slopes above

the timberline (Fig. 3). Its presence was typically associated with tall (60–100 cm) herbal vegetation and often with some wet marsh-like areas. The total area occupied by Corn Crake in Armenia is estimated at 1,859 km². The Extent of Occurrence is estimated at 16,621 km². The population appears to be fragmented into at least 15 sub-populations.

The average density of the species ($\pm SE$) in 2019 makes 1.36 (± 0.21) calling males per square km (95% confidence limits 0.95 to 1.77 birds). For 2019 the size of the breeding population of Corn Crakes in Armenia was estimated at 2,529 calling males (95% confidence limits 1,770 to 3,290 birds).

From 2003 to 2019, the population index calculated by TRIM (Fig. 4) showed a moderate decline ($p < 0.05$). The overall decline of the population during 17 years was -19% , while the annual decrease was $-1.3\% \pm 0.020\% SE$ (Fig. 4).

Hunting

According to the seven Hunters' Unions of Armenia, there are over 50,000 hunters in the coun-

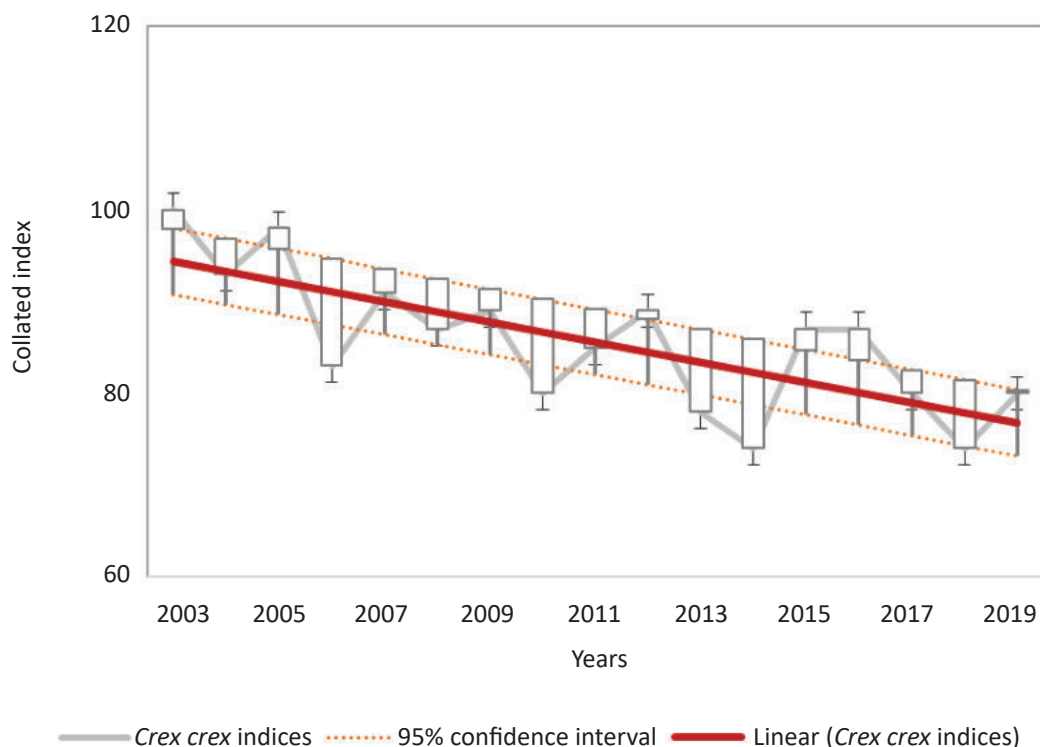


Figure 4. Annual abundance index (relative to 2003, which is standardized to 100) of Corn Crake abundance in Armenia during 2003–2019. The red line is the best-fitting curve with a constant rate of change. Up-down boxes indicate the difference between data points and the upper 95% confidence interval (CI), while up-down solid bars indicate the difference with lower 95% CI.

try. However, the number of active hunters was estimated by the Hunters Unions to lie between 10,000 and 20,000 people. Out of the 500 hunters surveyed, all reported that they do hunt almost every season, but only 87 (17%) of them knew the Corn Crake. Out of those 87 hunters, 23 (26% or 5% of total hunters surveyed) responded that they have hunted Corn Crake. All 23 hunters mentioned that they hunt Corn Crake rarely (at most once per three years) and every time they have got 1–2 birds. Only two hunters (2% of 87 hunters who knew the bird and 0.4% of total hunters surveyed) responded that they know about inclusion of the Corn Crake in the Red Book and about existence of punishment for illegal shooting of the species.

Interviews with the heads of seven Hunters’ Unions established that the hunters obtain hunting permits based on two recommendations from existing hunters and a face-to-face interview. The questions asked at the interview cover weapon safety but do not assess knowledge on game birds’ species identification, which public lands are open to hunting, which species are Red-listed, which hunting methods are allowed and which ones prohibited, daily bag limits, cases of poaching and the punishments.

The interview with the State Inspectorate body established that during the last four years there were no cases of poaching of Corn Crake recorded. However, the Inspectorate pointed out that the absence of such records can be a result of very low number of inspections, due to understaffing within the Inspectorate body and a lack of financial resources allocated for the inspection process. The Inspectorate also noted an absence of cooperation between the Inspectorate and the Hunters’ Unions, in contrast to the situation that prevailed in Soviet times (before independence in 1991), when such cooperation was very efficient and hunters volunteered for the inspection process, keeping poaching at a low level.

Discussion

Corn Crake population status

Adamian and Klem (1999) summarize the historical distribution of the Corn Crake in Armenia, and state that the species is rare and occurs in Tsakhkunyats and Pambak mountain ridges. The publication also mentions a single record from 16 May 1963 and 5 May 1964 in Jrvezh, but the specimen can hardly be considered a breeding

one as the area is occupied by semi-desert and arid mountain steppe. Lyaister and Sosnin (1942) add several points to those records, which slightly expand distribution of Corn Crake at Pambak mountains and vicinity of Lake Sevan. Dahl (1944) adds a point in Urts Mountain Ridge where the bird was observed on 15 May 1939. By comparison with the results of our surveys, it therefore appears that the Corn Crake's distribution in Armenia is much wider and the species was most probably overlooked in the counts due to its very secretive and nocturnal behavior. We did not find the species at Urts mountains again, and assume that the Corn Crakes could probably breed here in past, but disappeared due to change of the habitat under aridization, which is caused by decrease of precipitations and increase of average summer temperature documented for entire Armenia (Ministry of Nature Protection 2015).

The number of calling males, currently estimated for Armenia (1,770 to 3,290) significantly differs from the figures presented in the IUCN assessment of the species, which supposes presence of 500–800 calling males in the country (BirdLife International 2015). Taking into account that our survey of the species was conducted in the hours when the calling activities of the Corn Crakes decline (Hudson *et al.* 1990), the real number of the calling males could be substantially higher. Therefore, we take the current estimate as conditional and preliminary, aiming to test the night counts of the Corn Crakes for the subsequent studies. With the same reservation in mind, the number of mature individuals can be roughly estimated from the assumption that one male of Corn Crake usually bonds with two – three females (Taylor & Kirwan 2020), and thus can be computed by multiplying number of calling males by 2.5, resulting to 4,400 to 8,200 mature individuals.

The conservation status of the Corn Crake was evaluated as Vulnerable B1ab(iii)+2ab(iii) for the latest edition of the Red Book of Animals of Armenia (Aghasyan & Kalashyan 2010). Under IUCN Red List guidelines, the time period over which to assess population change is three generation lengths, which in the case of the Corn Crake is 11.1 years (from the BirdLife global assessments at <http://datazone.birdlife.org>). Calculation of the extent of the decline during a period of 11 years indicates a reduction of 16%, which is well below the threshold of 30% needed to qualify under Red List criterion A. The species nevertheless fits the category Vulnerable under criteria B1, having

the Extent of Occurrence below 20,000 km², criteria B2, having the Area of Occupancy below 2,000 km², and accompanying points 'a' — as it has severely fragmented population and 'b' — because it shows continuous decline of mature individuals. Also, conditionally, the species fits criteria C1, having less than 10,000 mature individuals and decline of more than 10% over three generations. The rescue effect, which could be an important point for the small countries like Armenia is theoretically possible in northern and north-western regions of the country, which are bordering with Georgia and Caucasus part of the Turkey. Currently, the detailed information about the population status is available for Turkey, which supposes breeding of 80–200 calling males (BirdLife International 2015) and can hardly support Armenian population. The information for Georgia is less precise and suggests 10,000–50,000 calling males with a poor data quality, while providing no information on the species' trend (BirdLife International 2015). In the same time, both countries are facing the similar issues of overgrazing and uncontrolled mowing (Javakhisgvili *et al.* 2020), which could probably affect the population of the Corn Crake in their countries, and therefore can negatively influence their potential in rescue of Armenian population of the species. Therefore, the species should still be considered as Vulnerable, but the criteria have to be revised into B1ab+B2ab+C1 (IUCN Standards and Petitions Committee 2019) in Armenia.

Threats

The poaching on the Corn Crake takes place, and rough calculation of number of shot birds per annum results from 420 to 840 specimens, assuming existence of 10,000 to 20,000 active hunters respectively. The main causes of poaching are lack of hunters' education and awareness and lack of inspection's control. This is mostly the result of a lack of targeted financial resources and a lack of cooperation between the Ministry of Environment, State Environmental Inspection and the Hunters' Unions.

Another threat comes from the practice of hay-making, similar to the situation in many European countries such as Britain and Ireland (Green & Stowe 1993), and Sweden (Berg & Gustafson 2007). The local villages mostly use slopes for livestock grazing and flatter areas for cutting the hay that is stored to feed the livestock over winter. Those flatter and moister areas with high grass are the core microhabitats for the Corn

Crake and are being harvested in late June to early July, which is likely to destroy nests and kill chicks and to leave this secretive ground nester with insufficient cover. The growing use of hand mowers allows cutting the grass in the areas, which were inaccessible for the machinery mowing before, which even more reduces the safe habitats for the Corn Crakes. A high mortality of the Corn Crake chicks is reported in Britain due to use of machinery mowing that proceeded from the outside of the field inwards and the mortality decreased with the change of the scheme, which was mowing from inside outwards (Green 2020). Most important of all is to delay hay-mowing until most birds have large young from their second brood that takes place in August (Green 2020).

Recommendations

To halt the decline of Armenian population of Corn Crake, we recommend two groups of measures, related to (a) improving the control of hunting and poaching and (b) improving the management of meadows and reconsidering the mowing practices. In particular, we suggest the following: (1) develop alternative mechanisms for allocating the funds which are generated from the sale of hunting permits, targeting the revenue towards monitoring the populations of the game species and towards better control of hunting and poaching on the ground; (2) develop a new State exam for obtaining a hunting license aimed at having better educated and more responsible hunt-

ers; (3) establish small seasonal protected areas prohibited for mowing and livestock grazing; (4) develop and introduce alternative mowing schemes which support higher survival of Corn Crakes' chicks; (5) develop alternative fodder for livestock in winter to decrease their need in hay. The proposed conservation measures should be accompanied with the monitoring of the species, to secure proper assessment of the efficiency of the suggested methods.

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References

- Adamian, M. & Klem, D. 1999. Handbook of the Birds of Armenia. American University of Armenia, California.
- Aghasyan, A. & Kalashyan, M. (eds.) 2010. The Red Book of Animals of the Republic of Armenia. Yerevan, Ministry of Nature Protection.
- Aghababyan, K.E., Ter-Voskanyan, H., Tumanyan, S., & Khachatryan, A. 2015. First National Atlas of the Birds of Armenia. Bird Census News, 28 (2): 52–58.
- Berg, Å. & Gustafson, T. 2007. Meadow management and occurrence of corncrake *Crex crex*. Agriculture Ecosystems & Environment, 120 (2–4): 139–144.
- BirdLife International. 2008. *Crex crex*. The IUCN Red List of Threatened Species 2008. e.T22692543A26660497. Downloaded on 04 January 2021.
- BirdLife International. 2015. *Crex crex*. The IUCN Red List of Threatened Species 2015. e.T22692543A60016665. Downloaded on 04 January 2021. (scope: Europe).
- BirdLife International. 2016. *Crex crex*. The IUCN Red List of Threatened Species 2016. e.T22692543A86147127. <https://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22692543A86147127.en>. Downloaded on 04 January 2021.
- Cramp, S. & Perrins, C. M. 1980. Handbook of the birds of Europe, the Middle East and Africa. The birds of the western Palearctic, Vol II: Hawks to Bustards. Oxford University Press, Oxford.
- Council of Europe 2018. Transfer of National Data to Pan-European 10×10 km grid for Non-EU contracting parties to Bern Convention (Guidance Document). European Topic Centre on Biological Diversity. Strasbourg, 27 September 2018. T-PVS/PA (2018) 14. 42 pp.

- Dahl, S.K. 1944. Vertebrates of Sarayboolagh Mountains. Zool. Digest, 3: 5–46. [In Russian].
- EEA, 2020. Article 12 EU population status assessments — Methodology. European Environmental Agency, European Topic Centre on Biological Diversity. Technical paper. 10 pp.
- Fayvush, G., Arakelyan, M., Aghababyan, K., Aleksanyan, A., Aslanyan, A., Ghazaryan, A., Oganesyanyan, M., Kallashyan, M. & Nahapetyan, S. 2016: In Baloyan, S. (ed.) The “Emerald” Network in the Republic of Armenia. Yerevan. Ministry of Nature Protection.
- Green, R., & Stowe, T. 1993. The Decline of the Corncrake *Crex crex* in Britain and Ireland in Relation to Habitat Change. Journal of Applied Ecology, 30 (4): 689–695.
- Green, R. 2020. Corn Crake conservation. British Birds, 113: 671–685.
- Hudson, A., Stowe, T. & Aspin, S. 1990. Status and distribution of Corncrakes in Britain in 1988. British Birds, 83 (5): 173–187.
- IUCN Standards and Petitions Committee. 2019. Guidelines for Using the IUCN Red List Categories and Criteria. Version 14. Prepared by the Standards and Petitions Committee. 113 pp.
- Javakhishvili, Z., Aghababyan, K., Sultanov, E., Tohidifare, M., Mnatsekanov, R., Isfendiyaroglu, S. 2020. Status of Birds in the Caucasus. In: Zazanashvili, N., Garforth, M., and Bitsadze, M. Ecoregional Conservation Plan for the Caucasus, 2020 Edition. Supplementary Report. WWF, KfW, Tbilisi. 72–82.
- Keller, V., Herrando, S., Vorišek, P., Franch, M., Kipson, M., Milanese, P., Martí, D., Anton, M., Klvanová, A., Kalyakin, M.V., Bauer, H.-G. & Foppen, R.P.B. 2020. European Breeding Bird Atlas 2: Distribution, Abundance and Change. European Birds Census Council & Lynx Edicions, Barcelona.
- Lyaister, A.F. & Sosnin, G.V. 1942. Materials on Ornithofauna of Armenian SSR. Ornith Armeniaca. Yerevan, 418 pp. [In Russian].
- Ministry of Nature Protection. 2015. Armenia’s Third National Communication on Climate Change. Yerevan, “Lusabats” Publishing House, 165 p.
- Taylor, B. & Kirwan, G.M. 2020. Corn Crake (*Crex crex*), version 1.0. In Birds of the World (del Hoyo, J., Elliott, A., Sargatal, J., Christie, D.A. & de Juana, E., eds). Cornell Lab of Ornithology, Ithaca, NY, USA.
- Pannekoek, J. & van Strien, A.J. 2005. TRIM 3 Manual (TRENDS & INDICES FOR MONITORING DATA). Statistics Netherlands. Retrieved from <https://www.ebcc.info/art-13/> on 16th of Dec 2019.
- van Strien, A.J., Pannekoek, J. & Gibbons, D.W. 2001. Indexing European bird population trends using results of national monitoring schemes: a trial of a new method. Bird Study, 48: 200–213.
- van Strien, A.J., Pannekoek, J., Hagelmeijer, E.J.M. & Verstrael, T.J. 2004. A loglinear Poisson regression method to analyse bird monitoring data. In: Anselin, A. (ed.). Bird Numbers 1995, Proceedings of the International Conference and 13th Meeting of the European Bird Census Council, Pärnu, Estonia. Bird Census News, 13: 33–39.
- Voříšek, P., Klvaňová, A., Wotton, S., & Gregory, R.D. 2008. A best practice guide for wild bird monitoring schemes. First edition. RSPB/CSO.

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