Assessing the current status of the Common Pochard *Aythya ferina* in Armenia

KAREN AGHABABYAN[1,*], ANUSH KHACHATRYAN[1], SEVAK BALOYAN[2], ASYA GHAZARYAN[1] & VIKTORYA GEVORGYAN[1]

[1]BirdLinks Armenia, 87b Dimitrov, Apartment 14, 0020 Yerevan, Armenia.
[2]Department for Licenses, Permits and Compliances, Ministry of Environment (CMS Focal Point for Armenia), Government Building 3, Republic Square, 0010 Yerevan, Armenia.
*Correspondence author. E-mail: karen.aghababyan@gmail.com

Abstract

The national conservation status of the globally threatened Common Pochard *Aythya ferina* has not previously been assessed in Armenia. Monitoring of the species in 2003–2019 shows that the Pochard breeds in the wetlands of the Ararat Plain, on the Shirak and Lori Plateaus, and at Lake Sevan, *c.* 800–2,040 m above sea level. It occurs in a core area of *c.* 64 km^2, but defining a minimum area polygon that includes all known breeding sites extends to over *c.* 14,887 km^2. In 2019, the total number of breeding Pochard pairs in Armenia was estimated at 1,917 (95% CI = 1,186–2,647) with a mean breeding density of 30.4 (± 5.91 s.e.) pairs/km^2 (95% CI = 18.8–42.0 pairs). TRIM analysis of available count data found a moderate decline in the breeding population during 2003–2019, with Pochard numbers diminishing by 33% over the 17-year period, and by 16% in the last ten years. Numbers recorded in winter ranged from 34 birds in 2008 to 3,421 in 2015, with the variation apparently attributable to whether water bodies were frozen. A review of the potential threats to the species in Armenia showed that the primary threats are from habitat loss and/or degradation following changes in fish farm management, and also hunting pressure resulting from poor recognition of game species by hunters and a lack of control of hunting regulations. Pochard in Armenia should be considered as Vulnerable under International Union for the Conservation of Nature (IUCN) criteria, and two main measures are recommended to improve the conservation status of the species: better control of hunting and poaching nationally, and protection and improved management of key habitats used by the Pochard. Continued monitoring of the species is also essential, for assessing future population changes and to evaluate the efficacy of conservation interventions.

Key words: abundance, conservation status, distribution, population trends, threats.

The Common Pochard *Aythya ferina* (hereafter Pochard) is a monotypic species, which breeds from western Europe through central Asia east to central Siberia and northern China, and winters across Europe, north and east Africa, the Mediterranean, Black and Caspian Seas, India and southern China, Japan and Korea (Cramp & Simmons 1977; Carboneras *et al.* 2020). In 2015, its global conservation status was up-listed in the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species, from Least Concern to Vulnerable (under IUCN criteria: A2ab + 3b + 4ab), following a 30% reduction in the population observed over three generations and with the decline projected to continue (BirdLife International 2019, 2021). The Pochard is also considered Vulnerable at the European scale, with additional criteria A2abcd + 3bcd + 4abcd reflecting assessment that range contraction and/or habitat loss, together with exploitation levels in the region, may be causing the decline (BirdLife International 2015a). The species is also included in Resolution 6 of the "Bern Convention" (the Convention on the Conservation of European Wildlife and Natural Habitats 2011) and Annex II of the African Eurasian Agreement for Migratory Waterbirds (AEWA 2018), which means that the signatory countries have to secure adequate protection of the species' habitats and demonstrate sustainable management of the species and the habitats it is dependent upon. Despite this, the species was not assessed for the latest edition of the Red Data Book of Animals of Armenia (Aghasyan & Kalashyan 2010), and currently has the national status of "Not Evaluated".

In Armenia, the Pochard breeds on a variety of types of water bodies, *e.g.* natural lakes and fish ponds farmed for Common Carp *Cyprinus carpio*, as well as occurring as a passage and wintering species (Adamian & Klem 1999; Ananian *et al.* 2007). Fish farming in Amenia commenced in 1972 and it has since played an important role in the ecology and life-cycle of waterbirds in the country, by providing semi-natural habitats with extended reedbeds and a rich fauna of water invertebrates, where the birds can feed and breed. The Pochard's status in neighbouring countries is also quite poorly known. It is reported as being present in Georgia, and 500–1,000 breeding pairs have been estimated for Turkey where data are considered to be of medium quality (BirdLife International 2015b). The only data from Azerbaijan is from the late 1990s, however, when up to 75,000 were recorded at the Gyzylagach State Reserve in winter (Sultanov 2008), whilst data from Iran indicates *c.* 30,000–40,000 wintering in that country during 1993–2003 (Carboneras *et al.* 2020).

Taking into account its global conservation status, and also difficulties with hunting regulation in the country, the Pochard has been excluded from the list of game birds for Armenia since 2018 (Ministry of Nature Protection 2018). The extent to which the hunters are aware of this protection measure, however, remains unclear. Given that the relative lack of synthesised knowledge about Pochard in Armenia, where the species was legally huntable until recently, this paper aims to assess its current conservation status in Armenia, by examining changes in its distribution and abundance,

and evaluating existing and potential threats to the species.

Methods

Pochard data collection

All early observations of Pochard in Armenia recorded in the literature were collated and summarised by Adamian & Klem (1999). More recently, systematic collection of data on Pochard numbers and distribution was initiated as part of a National Bird Monitoring Program in 2003, with application of the standard European Monitoring Grid (10 × 10 km) to Armenia (Council of Europe 2018) resulting in 374 count squares being outlined for the country. The count squares were allocated to one of three groups: (1) "annual counts" where, once counting commenced, the squares were surveyed and the birds counted each year thereafter, (2) "systematic counts" where, once counting commenced, the squares were surveyed every 2–3 years thereafter, and (3) "opportunistic counts", where counts were carried out when the opportunity arose. During the period of 2003–2019 a total of 325 squares were visited at least once, including 147 squares with systematic data collection (Fig. 1). The systematic count squares were selected so that they represented different parts of the country and all types of habitats in Armenia. Numbers of breeding Pochard were recorded in 17 squares with the suitable habitat, and data on winter abundance were gathered from 29 squares in three major water systems: Lake Sevan, the Armash Wetlands, and Wetlands of Yeghegnut–Sevjur River system (Fig. 2).

The Pochard is a readily detectable species, which spends most of the time in open water close to aquatic vegetation. Data gathered from both survey methods (*i.e.* the standard counts and opportunistic observations) therefore were used to create species distribution maps for Armenia, but only standard count data were used for estimating population densities and trends. More information on the methods used and treatment of the data are described below.

Opportunistic observations. Opportunistic observations were provided by birdwatchers. These were accepted as long as they conformed to minimum data requirements, *i.e.* accurate species identification, observation date, geographical coordinates, name of the nearest locality (*e.g.* human settlement, mountain or historical site), 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. Since photographs were often provided with the data, there was usually no need to validate species identification. In other cases, in the absence of photographs, species identification was confirmed through personal communication with the observers. The observations often included additional information, *e.g.* time of day, observation duration, and the number of people in the group. Since it was not always possible to record the precise geographical coordinates on the spot, the information was sometimes provided at the 10 × 10 km^2 level.

Standardised counts. Standardised counts (conducted following a predefined protocol), were made by ornithologists and/or skilled birdwatchers. Point counts were used, where

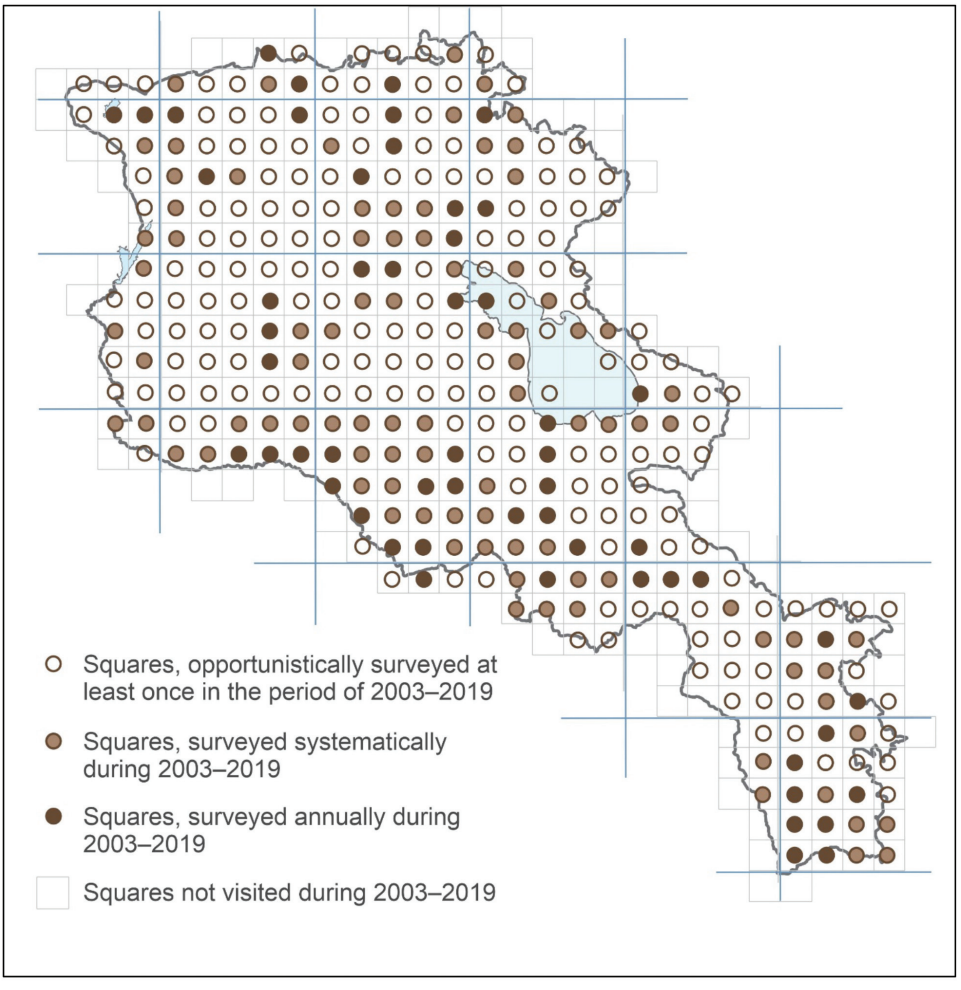

Figure 1. Grid squares (10 × 10 km) surveyed for Common Pochard in Armenia either annually after first count, or systematically every 2–3 years after first count, or opportunistically (at least in one year) over the period 2003–2019.

observers systematically counted all the birds within a sector of certain radius (300–500 m) and angle of view (usually close to 180°) during a fixed 30 min period. The species is distinctive and not secretive, so we assumed high detectability of birds within the survey sectors. As far as possible, surveys were made from sunrise until 11:00 h and then from 16:00–17:00 h until dusk, in favourable weather conditions (*e.g.* in absence of rain and with light winds below Beaufort Force 3), between 1 May and 10 June because this period was considered optimal for detecting breeding Pochards. Assessment of wintering abundance was considered best undertaken

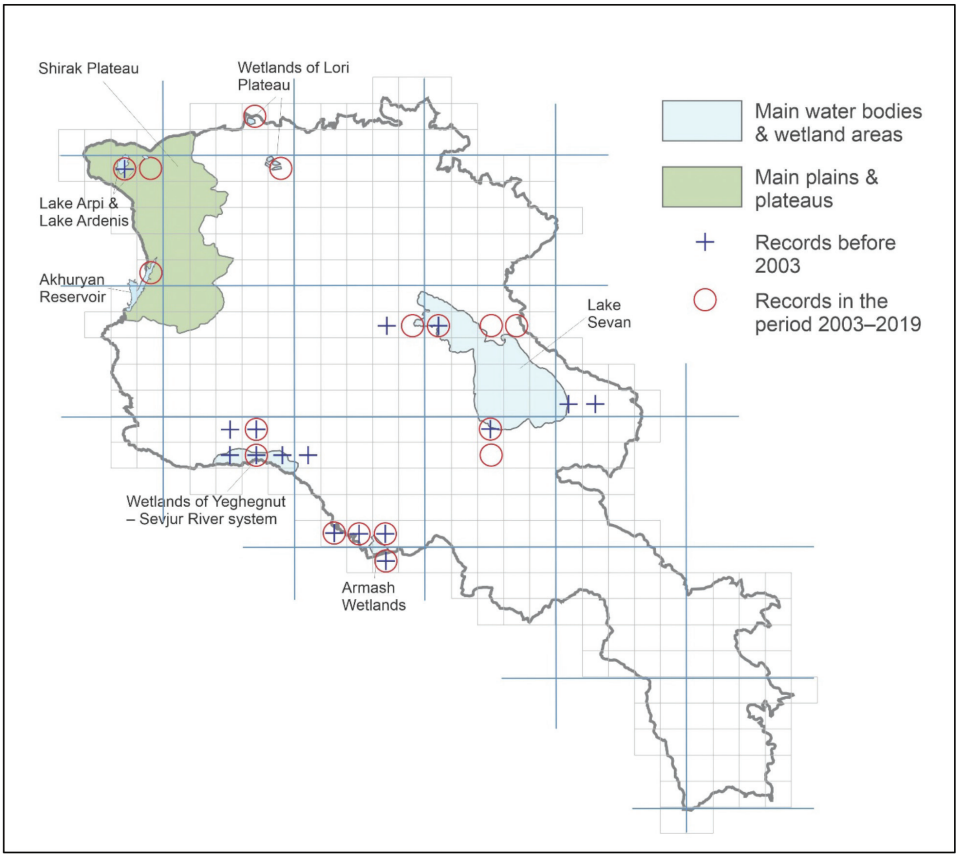

Figure 2. Breeding distribution for Common Pochard in Armenia (pairs recorded within 10 × 10 km grid squares) before and after 2003.

between 1 December and 31 January, with most counting effort in mid-January to coincide with data collection for the International Waterbird Census (Wetlands International 2010). The standardised counts required more detailed records than incidental observations, and aimed to include the following data: the number of birds present and their sex, observation date, geographical coordinates of the observation point, radius and angle of the count, type of habitat, start and end times of the count, individual-specific breeding codes, observer name and contact details. The number of points within any one 10 × 10 km square varied, depending on the number and topography of separate lakes and ponds. At the larger lakes, we conducted 2–3 point counts from different observation points simultaneously, to cover the entire water surface area. We tried to retain the same points for the standardised counts, and to survey from them each year whenever possible. During 2013–2017, the number of

volunteer counters increased in response to fieldwork required for the European Breeding Bird Atlas 2 (Keller *et al.* 2020), and some new standardised counts were created as a result of the atlas initiative. All data were collated at the end of each counting season, entered into a database and checked. To avoid duplication of counts, we prepared a counting plan and circulated it to the counters each year, in January–March for the breeding surveys and in October for the winter counts. After each data entry, one team member checked the information added to the database with the original record, and corrected any errors that occurred.

Hunting data collection

Information on the possible hunting pressure on Pochard was gathered by conducting questionnaire surveys of the heads and members of seven Hunting Unions, keeping the hunters' responses on the forms confidential to reduce the risk of false reporting. Since the questions could be rather sensitive, we asked the Hunting Unions to collect the filled-out questionnaires in closed envelops, which contained no personal information, to maintain confidentiality. Once all the envelopes had been collected, they were then passed to our team. We tried to keep the numbers surveyed from each Hunting Union roughly equal (65–75 members per union; median = 73). The survey was conducted in spring 2019, after the end of the 2018–2019 hunting season, which usually starts on 20–25 August and lasts until end of February of the next year. A total of 820 questionnaires were issued, which generated 486 responses, with a further 14 completed forms obtained following personal requests, resulting in 500 hunters contributing to the survey. The following questions were included in the questionnaire: (1) do you hunt? (2) do you know Pochard (photo of the bird supplied)? (3) do you ever hunt Pochard? (4) how often do you hunt Pochard (almost every year; not frequently; rarely)? (5) how many Pochard do you harvest *per annum*? (6) to your knowledge, is the Pochard a protected bird or not? and (7) to your knowledge, is there a punishment for illegal shooting of Pochard?

Two more interviews were conducted, with the staff of the State Inspectorate for Nature Protection and Mineral Resources and with the owners of Armash fish farm. The interviews with the Inspectorate were conducted with inspectors from the four provinces of Ararat, Armavir, Shirak and Lori, and were less structured. The main questions here related to the ability of the inspectors to detect poaching of this globally protected species, after 2017, when the Pochard was excluded from the list of huntable birds. The interview with the owners of Armash fish farm aimed to obtain a rough idea of the total number of hunters who visited the fish farm for waterbird hunting.

To analyse hunting statistics, we obtained data on the timing of the hunting season, game species, the daily bag limits for each species, availability of game bird monitoring data, and the national annual bag recorded for waterfowl (ducks, coots and moorhens). These data were gathered through decrees from the Ministry of Nature Protection

of the Republic of Armenia (2014, 2015b, 2016, 2017, 2018; later renamed as the Ministry of Environment of the Republic of Armenia, 2019). The Head of the Bioresources Management Agency was interviewed to obtain the national annual species harvest size.

Data analysis

Individual-specific breeding codes (following Voříšek *et al.* 2008) were used to confirm breeding, and the breeding distribution of Pochard in Armenia was mapped on the 10 × 10 km^2 grid. A given square was considered to be occupied if pairs were recorded, through incidental observation or standardised count, in any year of the 17-year (2003–2019) study. To compare the birds' pre-2003 distribution with that during 2003–2017, we also digitised 159 records for the period 1984–1997 which were summarised in Adamian and Klem (1999). The habitats used by the Pochard were classified in accordance with the most recent publication on Armenian habitats (Fayvush & Aleksanyan 2016), which adapted Armenian habitat classification to the European Nature Information System (EUNIS). Habitats available for the species across the entire country were calculated using the software package ArcGIS 10.0 (Environmental Systems Research Institute, Inc.), using our own database of the habitat shape files.

Breeding Pochard density was estimated for each observation point by dividing the number of recorded pairs by the count area. The count area was computed by multiplying the central angle of the sector by the radius squared, and dividing by 2. Density values were then averaged across observation points and its standard error (s.e.) was calculated. The total size of the breeding population of Pochard in Armenia in 2019 was calculated by multiplying the 2019 upper and lower ranges of the density (mean ± s.e.) by the area of habitat within the occupied range. The 95% confidence limits were calculated as the total population estimates ± 1.96 s.e. The number of wintering birds was calculated annually, based on the total number of individual Pochard counted. Data for the period 2003–2007 were taken from Ananian *et al.* (2007).

To calculate trends for the breeding population, we used data from observation points which provided a multi-year data series and processed the data (density values per point and year) using rtrim package (Bogaart *et al.* 2018), which is a reimplementation of TRIM ("Trends and Indices for Monitoring Data") 3.54 software (Van Strien *et al.* 2004; Pannekoek & van Strien 2005). We applied the "time effect" basic model, which corrects for over-dispersion and serial correlation, and estimates trends based on the imputed slope. In total, there were 289 data values analysed from 17 points monitored annually. We calculated a population index using log-linear Poisson regression, and applying a time effect model; the indices were calculated relative to 2003, which was given a value of 100. TRIM also provides an estimate of overall trend in the form of the mean annual rate of change (r) and its associated standard error (s.e.) across the full span of years (Pannekoek & van Strien 2005). To assess the nature and direction of the trend, van Strien *et al.* (2001)

recommended considering both its magnitude and statistical significance according to five categories: (i) substantial decline/increase (confidence interval lies below –20% or above 20% respectively in a 20-year period), (ii) non-substantial decline/increase (confidence interval lies above –20% or below 20% respectively and excludes zero), (iii) decline/increase (confidence interval includes –20% or 20% respectively and excludes zero), (iv) stable (confidence interval lies above –20%, below 20% and includes zero), and (v) poorly known (confidence interval includes both zero and one or both of –20% and 20%).

The trend for wintering birds was analysed using a Generalized Linear Model (GLM), selecting the Poisson log-linear model, taking the number of wintering birds as a dependent variable, the year as an independent variable, and whether or not the lakes were frozen that winter a covariate. We first checked whether there was temporal autocorrelation in the residuals, which can influence interpretation of the results. This is an issue on analysing data for long-lived birds because of the non-independence of population estimates in successive years (described for swan species by Wood *et al.* 2019).

The area of species occupancy (AOO) and the extent of the species occurrence (EOO) were computed using IUCN guidelines (IUCN Standards and Petitions Committee 2019). To compute the AOO we divided the existing 10 × 10 km^2 cells into 2 × 2 km^2 cells and overlapped the new grid with the range occupied by the species, so that occupied cells were recorded at a 2 × 2 km^2 grid level. The number of occupied cells was then multiplied by the area of an individual cell, taking 4 km^2 (2 × 2 km) cells as the reference scale. To compute the EOO, 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 for the species' AOO, excluding discontinuities and disjunctions within the overall distribution inside the borders of Armenia.

Results

Breeding distribution and abundance in Armenia

During the surveys of 2003–2019, the Pochard was recorded in the wetlands of the Ararat Plain, the Shirak and Lori Plateaus, and at Lake Sevan (Figs 2 and 3). Breeding Pochard were recorded at 800–2,040 m above sea level, mainly in rather shallow fish farm ponds, small lakes or shallow areas of larger lakes with well-developed macrophytes, such as reeds *Phragmites* sp. and cattails *Typha* sp.) (Fig. 3). The total core area occupied by breeding Pochard in Armenia was estimated at 64 km^2, within a total extent of occurrence estimated at 14,887 km^2. The breeding population appears to be distributed between at least six separate sub-areas (Fig. 2). The mean density of the species (± s.e.) in 2019 was 30.4 ± 5.9 pairs/km^2 (95% confidence limits: 18.8–42.0 pairs), and there was an estimated total of 1,917 pairs (95% confidence limits: 1,186–2,647 pairs) of Pochard breeding in Armenia.

From 2003–2019, the breeding population indices calculated by TRIM (Fig. 4) demonstrates a moderate decline (Goodness of fit test: $\chi^2_{294} = 554.47$, $P < 0.0001$; Wald

Figure 3. Typical Common Pochard habitat in the Armash Wetlands, Armenia. Photograph by K. Aghababyan.

test for significance of deviations from a linear trend: W_{15} = 9.34, P = 0.8592, n.s.; Imputed Overall Slope (± s.e.): *Additive* = –0.0357 ± 0.0071, *Multiplicative* = 0.9650 ± 0.0069, $P < 0.01$). Numbers declined by 33% over 17 years, with a 16% decline in the last ten years and little variation in the trend (Fig. 4).

Non-breeding distribution and population in Armenia

During the non-breeding season, the species was predominantly recorded at Lake Sevan and the wetlands of the Ararat Plain, comprising pure or mixed flocks with Tufted Duck *Aythya fuligula* and Red-crested Pochard *Netta rufina*. Lake Sevan, is the second biggest high-altitude lake in the world, at 1,900 m above sea level, but its large water mass ensures that wave action keeps it ice-free the entire winter. The wetlands of the Ararat Plain also provide open water for the species to stay over winter. The maximum number of Pochard recorded during non-breeding seasons of different years varied between 34 birds in 2008 and 3,421 in 2015. The numbers recorded each winter were found to increase over time on including year as an independent variable and ice cover as a covariate (Fig. 5), with a Wald-test for the significance of effects of the covariate on the slope

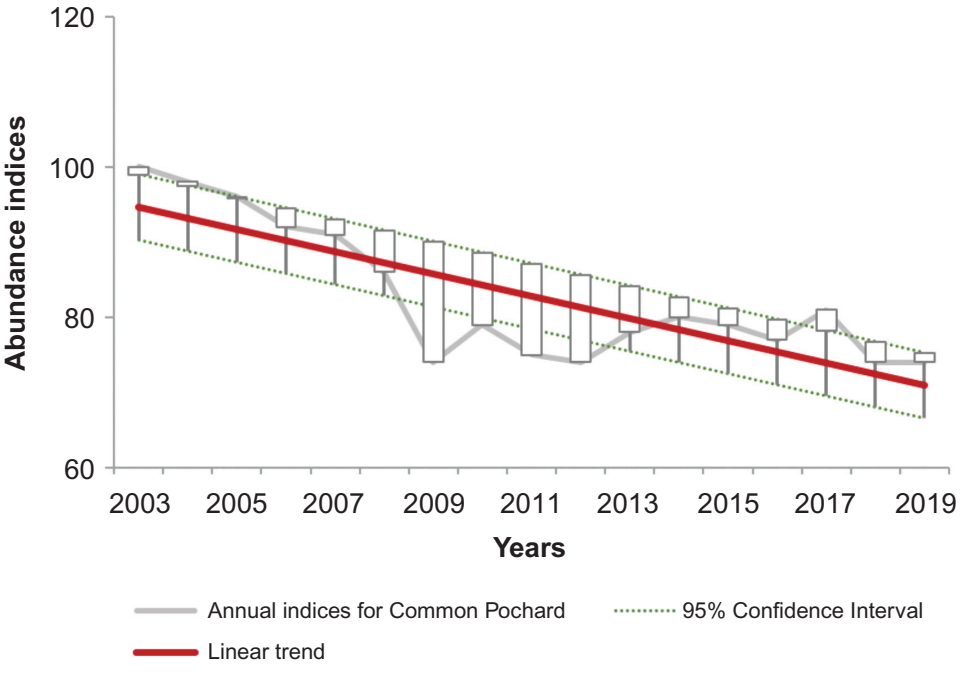

Figure 4. Annual TRIM index (relative to 2003, which is standardised to 100) of Common Pochard abundance in Armenia during the 2003–2019 breeding seasons (Goodness of fit test: $\chi^2_{294} = 554.47$, $P < 0.0001$; Wald test for significance of deviations from a linear trend: $W_{15} = 9.34$, $P = 0.8592$, n.s.; Imputed Overall Slope (± s.e.): *Additive* = –0.0357 ± 0.0071, *Multiplicative* = 0.9650 ± 0.0069, $P < 0.01$). Red line indicates the best-fitting trend; a linear trend ($F_{1,15} = 30{,}844$, $R^2 = 0.672$, $P < 0.001$) with a constant rate of change. Boxes indicate the difference between data points and the upper 95% confidence interval (CI). Solid bars indicate the difference with the lower 95% CI.

parameters showing that the trend was statistically significant (GLM: $W_1 = 1548.31$, $P < 0.05$). Tests for residual autocorrelation between different years (or lags) in the count data found some indication of statistically significant autocorrelation in the data for one year (at time lag 2, $P < 0.5$), but it was marginal, so we were able to conclude that there was no significant autocorrelation across multiple time lags, and therefore it is unlikely that autocorrelation would affect the results of the GLM analysis (Fig. 6).

Hunting

According to the seven Hunters' Unions of Armenia, there are > 50,000 hunters in the country. However, the number of active hunters was estimated by the Hunters' Unions to lie between 10,000–20,000 people. Out of the 500 hunters surveyed, all reported that they do hunt almost every season, but only 182 (36%) of them recognised the Pochard. Out of those 182 hunters, 92 (18% of total hunters surveyed) responded that they had harvested Pochard.

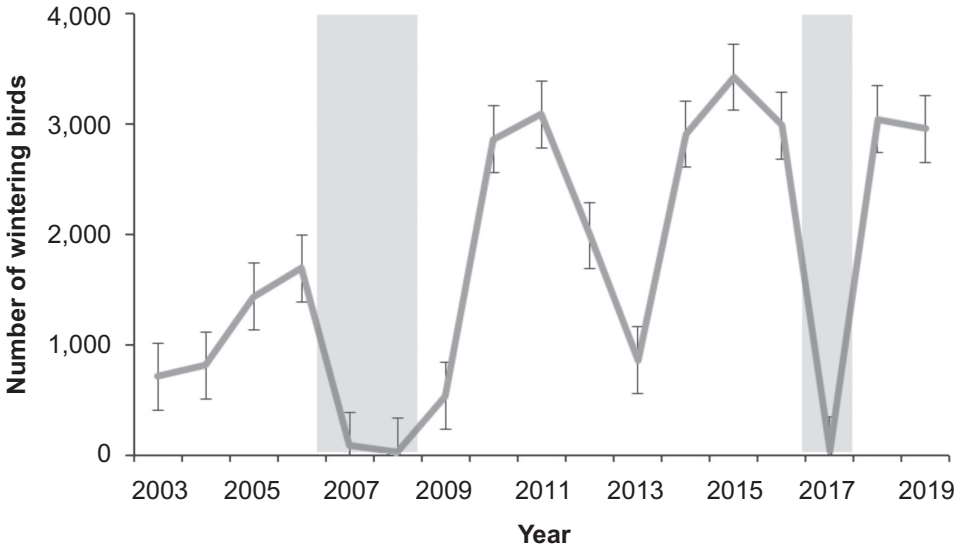

Figure 5. Estimated numbers of Common Pochard wintering in Armenia during 2003–2019. Data for 2003–2007 are from Ananian *et al.* (2007). The pale grey areas indicate the years, when the Lake was partly frozen (in 2007) or was covered with ice completely (in 2008 and 2017).

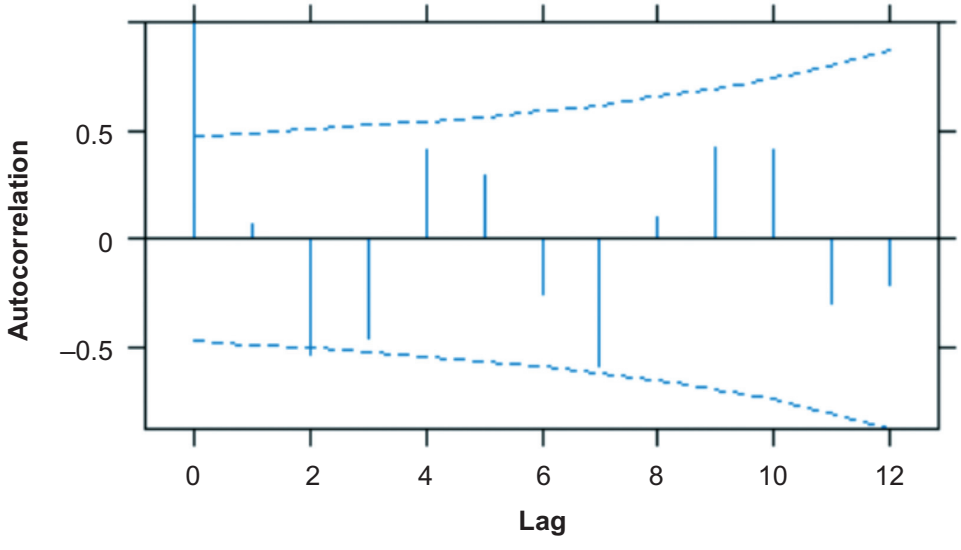

Figure 6. ACF plot with residual autocorrelation between different years (or time lags). Almost all of the solid lines are within the dashed lines, which indicate $P > 0.05$. There is only some indication of significant autocorrelation at time lag 2, but it is marginal; therefore, it is unlikely that autocorrelation has affected the results of the analysis.

Out of those 92 hunters, 49 (10%) reported that they hunt the species almost every year, 25 (5%) reported that they hunt it infrequently, and 18 (4%) reported that they hunt it rarely. The 49 hunters who harvest the species almost every year reported that they shot 1–5 birds per season; the 25 hunters (who harvest the species infrequently) reported that they take 1–2 specimens annually; and the last group of 18 hunters (who harvest the species rarely) talked about 1 bird per season. Of 182 hunters who recognised Pochard as being among the birds that they hunted, 43 (24%) did not know whether the species is protected or not, while the remaining 139 (76%) stated that the species is not protected. Of those 43 hunters, 38 hunters (88%) have never harvested Pochards and 5 (12%) belonged to the category that harvested the Pochard infrequently. None of the hunters knew about the existence of penalties for shooting Pochard illegally, following the exclusion of the species from the list of game birds in 2018.

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 covered weapon safety but did not assess their knowledge of quarry species identification, which public lands are open to hunting, which species are protected, which hunting methods are allowed and which are prohibited, how to obtain information about daily bag limits, what is considered to be poaching, and the penalties if prosecuted and found guilty of poaching.

Annual information on the waterbirds (Rallidae and Anatidae) that were legal quarry and the annual duck harvest data for 2014–2019 were also analysed and summarised in Table 1. The hunting management unit (Bioresources Management Agency before 2020) made decisions on annual legal quarry based not on individual species, but on groups of waterbirds, which in 2014 included Mallard *Anas platyrhynchos*, Pochard, Teal *Anas crecca* and Garganey *Spatula querquedula* among the ducks, and Common Coot *Fulica atra* and Common Moorhen *Gallinula chloropus* among the rails. The decision taken on the total number of ducks and rails that could be shot in a season was only occasionally based on population data, based on estimates (as in 2014), or on counts (as in 2017). However, the ultimate basis upon which the decision is taken remains unclear. In 2017, when count data were available, it was decided to allocate 50% of the number of birds counted for hunting; for the other years, the Bioresources Management Agency based its decisions on the expert opinion of the Scientific Centre of Zoology and Hydrobiology of the National Academy of Sciences (A. Tarzyan, Head of Bioresources Management Agency, pers. comm.).

The interview with the State Inspectorate body established that in the winter of 2018/19, when shooting of Pochard was prohibited, they recorded six cases of poaching of this species, although the Inspectorate pointed out that the real number of cases were likely higher than the reported number of cases. According to inspectors' opinion, this can be a result of

Table 1. Statistics on duck and rail hunting in Armenia for the period 2014–2019.

Factor	Year					
	2014	**2015**	**2016**	**2017**	**2018**	**2019**
Start of season	15 Sep	15 Sep	15 Sep	15 Sep	15 Sep	15 Sep
End of season	15 Feb	29 Feb	10 Feb	28 Feb	28 Feb	28 Feb
Season duration (days)	153	167	148	166	166	166
Species or groups allocated for hunting	Ducks (Mallard, Pochard, Teal, Garganey) & Rails (Coot, Moorhen)	Ducks (Mallard, Pochard, Teal, Garganey) & Rails (Coot, Moorhen)	Ducks (Mallard, Pochard, Teal, Garganey) & Rails (Coot, Moorhen)	Ducks (Mallard, Pochard, Teal, Garganey) & Rails (Coot, Moorhen)	Ducks (Mallard, Teal, Garganey) & Rails (Coot, Moorhen)	Ducks (Mallard, Teal, Garganey) & Rails (Coot, Moorhen)
Total Number of ducks and Coots in the public hunting lands	10,000	N/A	N/A	32,720	N/A	N/A
Daily bag for ducks (no more than)	2	2	2	2	2	2
Count of quarry species implemented	No	No	No	Yes	No	No
Total number of harvested ducks and Coots	9,980	9,990	4,110	15,565	20,174	59,919

very low number of inspections (given levels of understaffing within the Inspectorate), 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, which could potentially help to keep poaching at a low level.

The fish farm owners reported that *c.* 1,000–2,000 hunters visit the Armash Wetlands and surrounding area each year, predominantly at weekends, and that they target various ducks, coots and wader species. Unfortunately, it was not possible to obtain more specific information from the fish farm owners.

Discussion

Changes in Pochard distribution and abundance in Armenia

Adamian and Klem (1999) summarised the historical breeding distribution of the Pochard in Armenia, showing that the species had a wider range in the northern part of the Ararat Plain, in the southeast corner of the Lake Sevan and in the reservoirs of Hrazdan River system at that time. Contraction of the species' range in the northern part of the Ararat Plain is most probably the result of habitat loss, following the conversion of formerly semi-natural extensive carp-farming ponds of previous times into intensive trout farms, which are now rearing fish in concrete tanks (World Bank Group 2015). The disappearance of the species in the south-eastern corner of Lake Sevan was also related to habitat loss, when the Guilli Marshes were drained by the Soviet Armenian authorities for the extraction of peat (Adamian & Klem 1999). The water reservoirs along the Hrazdan River were cleared of fringing vegetation, which resulted in habitat degradation and loss of suitable breeding conditions for Pochard. The species was however found in some new squares on the Lori Plateau, on the Akhuryan Reservoir, and in some parts of Lake Sevan. The sites on the Lori Plateau and Akhryan Reservoir were most probably just overlooked during the previous studies, as these areas were visited only occasionally. The expansion of the species' range at Lake Sevan coincides with increasing water levels at the lake, which has created new wetland areas along the shore. Since the lake was always intensively visited by the birders and scientists, it seems highly unlikely that this species was overlooked here, but rather that the formerly absent species has returned as a result of the creation of suitable habitats.

The number of breeding pairs currently estimated in Armenia (1,186–2,647) differs significantly from the figures presented in the assessment of the species in the European Red List of Birds (BirdLife International 2015b), which covered the period 2002–2012 and described just 100–350 breeding pairs in the country. Given the recent local declines in breeding abundance of the species in Armenia shown in Fig. 4 (based on regular coverage at restricted sites), it seems likely that the 2015 estimate was an underestimate, based on much poorer coverage than that which we achieved in this study.

The increase in wintering numbers in the country is most probably related to the general increase in water surface

temperature at Lake Sevan (Ministry of Nature Protection 2015a) which receives most of the Pochard wintering in Armenia. The increased water temperature could enhance activity of aquatic invertebrates and small fish, which constitute the food supply for this duck species (Carboneras *et al.* 2020). The extreme fluctuations in wintering numbers can be explained by the freezing of Lake Sevan in 2007, 2008 and 2017.

Conservation status of Pochard in Armenia

Pochard was not included in the evaluation of species for the latest edition of the Red Data Book of Animals of Armenia (Aghasyan & Kalashyan 2010). This is despite the fact that the species was declining in abundance globally (BirdLife International 2019), even allowing for the fact that numbers may be stable locally (Wetlands International 2012). BirdLife International (2015b) estimated the rate of decrease among Pochard numbers in Europe (both breeding and non-breeding) at 30–49% in 22.8 years (three generations). Extrapolation of the change in the Armenian breeding population to 22.8 years also constitutes a 47% decline. The increase of the wintering numbers (except the years when Lake Sevan was frozen) is possibly due to the fact that many of these birds originate from breeding areas in continental eastern Europe, which remains the breeding stronghold for the species in the region (Fox 2020). However, the increase in wintering numbers seems not to have contributed to the enhancement of breeding numbers in Armenia, probably because generally the Pochard show high natal site fidelity, as described by studies in Latvia (Blums *et al.* 2003), necessitating time required for the birds to discover and recolonise unoccupied areas. Meanwhile, the declining ratio of females to males, reported in Europe and North Africa (Brides *et al.* 2017), is also likely to be a factor that inhibits any increase in annual breeding numbers. The western Siberian breeding population, which winters in southwest Asia, is also declining at the present time (Nagy *et al.* 2014; Mischenko *et al.* 2020). The current decline of Pochard in Armenia exceeds the threshold of 30% needed for it to qualify as Vulnerable under Red List criterion A2b. The species also fits the category Vulnerable under criteria B1, having an Extent of Occurrence of $< 20{,}000$ km^2. Evaluation of the species under criteria B2 shows that the Pochard has an Area of Occupancy of < 500 km^2, which qualifies it as Endangered, but the accompanying points 'a' (*i.e.* when the species has severely fragmented population), again qualifies it as Vulnerable, as the number of subpopulations is greater than five. In conclusion, from the evidence presented above, the species should be considered as Vulnerable in Armenia under criteria A2b + B1 + B2a (IUCN Standards and Petitions Committee 2019).

Threats

It appears that habitat loss and/or degradation caused the disappearance of Pochard from a number of sites on the Ararat Plain, around Lake Sevan, and within the Hrazdan River System. The existing wetlands of the Ararat Plain are mostly carp

farms, which operate a form of extensive aquaculture, raising mixed stocks of Common Carp *Cyprinus carpio*, Bighead Carp *Hypophthalmichthys nobilis*, Grass Carp *Ctenopharyngodon idella* and Wels Catfish *Silurus glandis*. The fish farms are predominantly fed by the canal, which brings water from Araks River and the farms do not artificially feed the fish. The existing mosaic of natural macrophytes is therefore beneficial for the farms, as they find a balance between the low density of the fish stocks and a lack of additional operational expenses from buying in fish fodder. However, some smaller farms have started a transformation into intensive production, which involves cleaning the shorelines of vegetation, feeding the fish artificial food and increasing the fish density. If these practices continue to expand, they would threaten over 29 km^2 (46%) of the Pochard's existing core habitat. Besides, such intensification can increase the food competition between Common Carp and Pochard, as reported from the Mediterranean region (Fox *et al.* 2016). At the same time, the abandonment of the carp farms can also be problematic for the species, as shown in Lithuania and Belarus, where the abandonment of fish farms has led to major losses in the biodiversity of wetland areas and local reductions in breeding Pochard abundance (Fox *et al.* 2016; Broyer & Bourguemestre 2020).

Hunting pressure on the Pochard can pose another threat to the species in Armenia. This can result from the use of inappropriate methods in calculating of annual quotas. For example, Table 1 suggests that in 2014 there would only be 20 birds remaining, based on the estimated number of ducks and coots on public hunting lands (10,000 birds), following the harvest of some 9,980 birds. Another example dates from 2019, when it was estimated that almost 60,000 birds were harvested, more than twice the largest number of harvested birds in the previous years. Also, the lack of training for hunters in field identification of duck species, and the lack of any exam to demonstrate their abilities (which could potentially check their identification abilities and initiate further training where needed), result in poor identification skills in recognising different game species among many of the hunters. As a result, we fear that the Pochard may still be shot in substantial numbers unintentionally, even when hunters know about the protected status of the species. Assuming that only 10% of hunters shoot 2.5 birds (an average of the 1–5 range) annually, and 5% of hunters shoot 1.5 birds (average of the 1–2 range) every other year, and 4% of hunters shoot one bird every fifth year, this would extrapolate to an estimated 2,955 birds killed by 10,000 active hunters. This number approximates relatively closely to the total numbers counted in winter, which suggests that most of the birds are being shot during migration on the wetlands of the Ararat Plain. Obviously, to determine the true significance of this threat to the Pochard there is a need for more data, specifically on the situation regarding hunting in general and the size, timing and distribution of the harvest of Pochards in particular. Such information could be derived, and be beneficial for the species, with better cooperation between the Ministry

of Environment, State Environmental Inspection, the Hunters' Unions, and the non-governmental conservation organisations promoting sustainable hunting in Armenia.

Recommendations

To halt the decline of Armenian population of the Pochard, we recommend: a) better management and data recording of hunting, b) greater collaboration to promote sustainable hunting and reduce accidental and deliberate poaching of protected waterbirds, such as the Pochard, and c) greater protection of existing, and restoration of former, breeding habitats. Specifically, we suggest the development of alternative mechanisms for allocating the funds generated from the sale of hunting permits, targeting the revenue towards monitoring the populations of the game species and towards better control of both hunting and poaching on the ground. We also recommend developing a new State examination as a requirement for obtaining a hunting licence aimed at ensuring a better-educated and more responsible body of hunters. The official designation of the Armash Wetlands and Yeghegnut Wetlands as Emerald Sites, protected under the Bern Convention (Fayvush *et al.* 2016), and their inclusion into sites of international importance under the African-Eurasian Migratory Waterbird Agreement (AEWA), would improve their protection and the opportunities for sympathetic management. We would also like to see the development and introduction of sympathetic management at carp farms, which could generate additional income from birdwatching, as it will motivate the farms to protect the habitats for the waterbirds as well as being a source of income from the fish. Finally, the development of a compensatory scheme for other carp farms, which allow waterbirds to breed, would enable the farmers to generate some income from the government in return for protecting waterbirds at their fish ponds. These proposed conservation measures should be accompanied by further study of other possible threats, such as water pollution by agricultural runoff, competition with non-native fish species and changes in vegetation, as well as improved monitoring of the species, to track future population changes and to secure proper assessment of the efficiency of the conservation interventions.

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