Conservation status of Marbled Teal *Marmaronetta angustirostris* in Armenia and Türkiye

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Summary

Marbled Teal *Marmaronetta angustirostris* is a globally threatened species that has been undergoing population declines across much of its range in recent years. This is particularly true in the Middle East and the Caucasus, where the species once commonly bred across much of the region. However, there is a dearth of recent literature and population-level assessments of the species in the countries in this region. For example, the last update of conservation status for Marbled Teal in Armenia was undertaken in 2009 and in Türkiye in 2008. Therefore, this study addresses the urgent need for an updated evaluation of the species' status in both Armenia and Türkiye. For Armenia, the current population estimate is 8–11 breeding pairs, with a steep decline of 87% between 2003 and 2019. In Türkiye, the species appears to be functionally extirpated from the country due to an absence of breeding in almost a decade and multiple years without any records, with only a handful of wandering individuals detected in recent years. This study highlights the threats facing the species, particularly changes to wetland habitat and quality as well as hunting pressures and illegal poaching. Based on our findings, we propose that the conservation status of Marbled Teal in both countries be updated from "Endangered" to "Critically Endangered". Finally, we note the conservation requirements for the species in the region and provide a set of recommendations for its protection, including a species recovery plan. Without urgent conservation measures such as the creation of new protected areas and establishment of new populations from released birds, the long-term viability of Marbled Teal populations in the region is in jeopardy.

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Introduction

The Caucasus is a global biodiversity hotspot, especially for birds, and functions as both an important migratory flyway for migratory birds (Kittelberger et al. 2021, 2022, 2023) and a source of important breeding habitats for a variety of species. In the region, Armenia is a relatively small (29,743 km^2), landlocked mountainous country, where elevation varies from 375 m to 4,090 m a.s.l. The country hosts a variety of wetlands, including the large, high elevation Lake Sevan, situated at 1,900 m a.s.l, the brackish marshes of the Ararat Plain, and the grassy marshes of the mountain plateaus (Aghababyan et al. 2015). Neighbouring Türkiye (783,562 km^2) is the only country covered almost entirely by three of the world's 36 biodiversity hotspots: Caucasus, Irano-Anatolian, and Mediterranean (Kittelberger et al. 2023; Şekercioğlu et al. 2011a).

Türkiye has 131 delineated "wetlands of international significance" covering 2.2 million ha (GDNCNP 2025). At least 500 other large wetlands exist across Türkiye, but a rigorous national wetland inventory has yet to be undertaken. Unfortunately, like many other countries around the world, Türkiye has seen high levels of anthropogenic pressures on wetlands in the country, leading to their degradation, desiccation, and in some cases, complete destruction (Kittelberger et al. 2023). In fact, Türkiye has lost at least 1.3 million ha of its historic wetlands over the past 60 years, mostly due to draining by the government for malaria control and to create agricultural lands (Nivet and Frazier 2004). Altered surface and subsurface flows, eutrophication, and exceedingly high sedimentation rates have been the greatest regional threats to wetlands, especially in the last 50 years (Reed et al. 2008). Locally, overexploitation of peripheral vegetation by livestock or local people often further degrades the quality of wetlands and negatively affects their inhabitant communities (Şekercioğlu et al. 2011b). The reductions and disappearance of many critical wetlands are being exacerbated by climate change (Dervisoglu 2022), which is also expected to lead to substantial range reductions and distributional shifts of many bird species in the region (Abolafya et al. 2013; Kittelberger et al. 2023).

The wetlands in the Caucasus provide critical habitat for a variety of native and even rare or threatened wildlife (Kitel et al. 2024; Kittelberger et al. 2023), including waterfowl like Marbled Teal *Marmaronetta angustirostris.* This species is classified globally as "Near Threatened" on the International Union for Conservation of Nature (IUCN) Red List, with a decreasing population trend and a global population of c.10,000–42,000 mature individuals (BirdLife International 2022, 2024). Marbled Teal is also classified as "Vulnerable" on the European Red List, with a European population ranging from 760 to 2,200 mature individuals and an unknown population trend (BirdLife International 2021). Marbled Teal has been a known species of concern in the Palearctic for decades, declining across much of its range due to habitat loss (BirdLife International 2024; Chaudhry et al. 2019; Green 1993, 1998; Tucker et al. 1994). While loss and degradation of wetlands are important threats to the species, hunting pressure (both legal and illegal) may be an even more significant factor affecting the species' population (BirdLife International 2024; Pérez-García et al. 2024). This may be especially true in the Middle East and Caucasus region, where rampant hunting and poaching of birds results in prominent human-induced mortality (Kittelberger et al. 2021; Serratosa et al. 2024), especially in countries like Türkiye and Armenia that have a large number of hunters (WWF Türkiye 2022; Zobar 2023).

Marbled Teal breeds in the western and eastern Mediterranean, Middle East, central and southern Asia, and extreme north-western China (Cramp and Perrins 1977; BirdLife International 2024; Carboneras and Kirwan 2020). Within the Caucasus, Marbled Teal is recorded as a breeding species in Armenia, distributed in the Ararat Plain (Adamian and Klem 1999). According to records from 1993–1999, the abundance of Marbled Teal in Armenia was assessed as uncommon (Adamian and Klem 1999), while the species' conservation status for the Red Book of Animals of Armenia (Aghasyan and Kalashyan 2010) was evaluated as "Endangered" under criteria D. The species is legally protected in Armenia, although most of its distribution lies outside the National Protected Areas network (Aghasyan and Kalashyan 2010) and instead within the Public Hunting Lands (Aghababyan et al. 2023). In comparison, Marbled Teal used to occur and breed regularly in Türkiye (Green 1993, 1998), but the species has become quite rare in the country within the past couple of decades (Kittelberger et al. 2023), and its breeding population in Türkiye was recently assessed as having gone extinct (Boyla et al. 2019).

There is relatively limited published research on the status of Marbled Teal populations (Abed et al. 2014; Chaudhry et al. 2019; Ouassou et al. 2021), particularly in the Caucasus region (but see Green 1993, 1998; Green and Navarro 1997; Kittelberger et al. 2023). Taking into account the importance of the species for the assessment of Emerald Sites of Armenia (Fayvush et al. 2016), Key Biodiversity Areas of Türkiye (Eken et al. 2006), Ramsar sites (Green 1993; Jenderedjian et al. 2004), critical migration stop-over points (AEWA 2005), and Important Bird and Biodiversity Areas (IBAs) (Aghababyan et al. 2022; Kılıç and Eken 2004), its inclusion in Appendix I and II of the Convention on Migratory Species (CMS) and the EU Birds Directive Annex I, as well as the fact that it has been over 10 years since the last edition of the Armenian Red Data Book and 15 years since the last edition of the Red Book of Birds of Türkiye (Kiziroğlu 2008) were published, it is timely and prudent to update our knowledge of the status of the species in the region. Therefore, in this study, we aimed to evaluate the status of Marbled Teal in Armenia and Türkiye and to assess its population size and long-term trend in each country. We also researched the threats facing the species, specifically hunting pressures and

illegal poaching, and noted any existing and required conservation measures for the species in either country. Finally, we developed a set of recommendations for a species' protection action plan for Marbled Teal in these two countries and the region at large.

Methods

Marbled Teal data collection

Armenia

All early observations of Marbled Teal in Armenia recorded in the literature were collated and summarised by Adamian and Klem (1999). In 2003, a National Bird Monitoring Programme was launched to ensure structured surveys of the breeding birds of Armenia. To secure proper coverage of the country, the standard European Monitoring Grid (10 × 10 km) was applied (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; (3) "opportunistic counts", where counts were carried out when the opportunity arose by members of the public. During the period 2003–2019, a total of 325 squares were visited at least once, including 147 squares with systematic data collection (Figure 1). The annual and systematic count squares were selected to represent different parts of the country and all types of habitats in Armenia. Numbers of breeding Marbled Teal individuals were recorded in five squares with suitable habitat (Figure 2).

In addition to the structured surveys, opportunistic observations of Marbled Teal were conducted by birdwatchers. Thus, in the period 2003–2012, birdwatchers reported their observations via email, filling out a data table. Since 2013, data from two platforms, eBird and Armenia.Observation.Org (owned by the Observation International Foundation), have been used. These observations were accepted as long as they conformed to the minimum data requirements: accurate species identification (validated by the experts of BirdLinks Armenia or the reviewers of eBird and Observation.Org), 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 was breeding in the visited area; Voříšek et al. 2008), and/or 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, with an 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.

The annual and systematic counts were standardised and conducted following a predefined protocol. Such standardised counts were made by both ornithologists and/or skilled birdwatchers using point counts, where observers systematically counted all the birds within a sector of a certain radius (300–500 m) and an angle of view (usually close to 180°) during a fixed 30-minute period. While Marbled Teal can be secretive in its habits, especially when individuals have chicks, it is rather noticeable during the breeding period in Armenia. On the water or on the shore, its plumage is easy to detect by trained observers and, therefore, it is
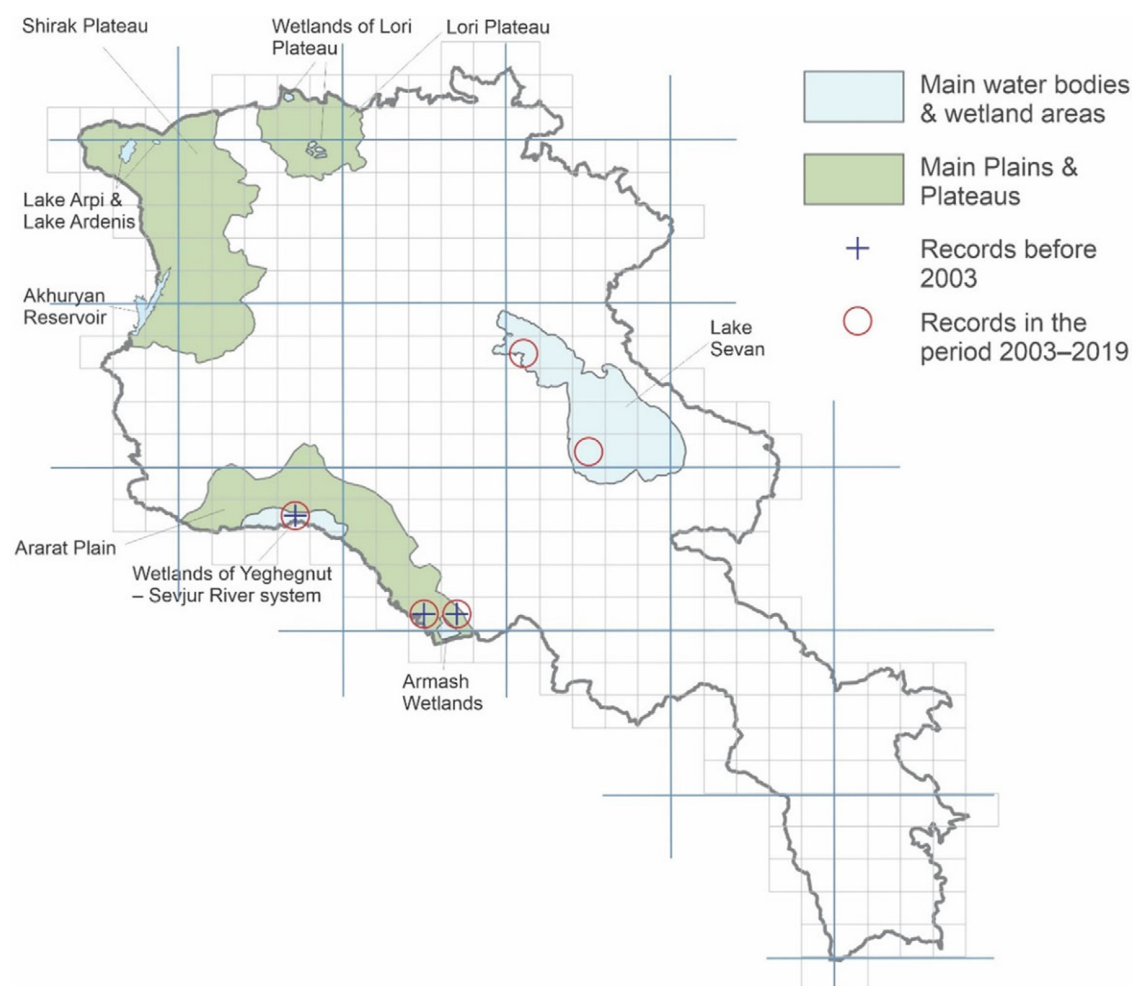
Figure 1. Distribution map of Marbled Teal in Armenia as of 2019.

straightforward to distinguish it among other waterfowl species of the region. Based on the ease of finding and identifying the species during this period, we assumed a high degree of detectability of birds within the survey sectors. As much as possible, surveys were carried out from sunrise until 11h00 and then from 16h00–17h00 until dusk, in favourable weather conditions (e.g. in the 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 teals.

The standardised counts required more detailed records than the incidental observations and aimed to include the following data: the number of birds present and their sex (if possible), 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, and 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. Between 2013 and 2017, the number of volunteer counters increased in response to the fieldwork required for the *European Breeding Bird Atlas 2* (Keller et al. 2020), and some new standardised counts were created because 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 during January–March for the breeding surveys. After each data entry, one team member checked the information added to the database with the original record and corrected any errors.

Türkiye

For Türkiye, we only used the opportunistic data collected from the eBird community science platform, which enables users to submit their bird sightings from anywhere in the world (Sullivan et al. 2009). In comparison to Armenia, which had over 6,600 checklists submitted from over 500 eBird users through 2024, Türkiye has had a consistent usage of eBird across the country by both locals and visitors alike, with over 155,000 submitted checklists from over 6,700 users through 2024 (eBird 2024). This comprehensive coverage and upload of records from the public allows for large-scale spatial and temporal analyses of populations of birds within the country (Kittelberger et al. 2023). In the absence of targeted surveys to count Marbled Teal in Türkiye, especially since the population has almost entirely disappeared from the country, we relied solely on eBird data for the Turkish analyses.

We downloaded the complete eBird world data set (ebd_prv_relDec-2022) and restricted this to observations submitted only from Türkiye using the R package auk (Strimas-Mackey et al.

Figure 2. Typical wetland habitat of Marbled Teal in Armenia.

2018). We then filtered the data set to records of Marbled Teal submitted between 2001 and 2022 and only from complete checklists (Kittelberger et al. 2023), which is standard practice when analysing eBird data (e.g. Neate-Clegg et al. 2020; Walker and Taylor 2020). We also examined Türkiye's eBird data for any records of the species up until April 2025. See Kittelberger et al. (2023) for additional details on the methods used to examine and work with the eBird data.

Hunting pressure data collection

Currently, there are over 50,000 members of hunting unions in Armenia, of which there are about 10,000–20,000 active hunters. Information on the possible hunting pressure on Marbled Teal in Armenia was gathered by conducting semi-structured interviews with the hunters of Yerevan, Ararat, and Armavir provinces, as well as with the heads of nine hunting unions, the staff of the State Inspectorate for Nature Protection and Mineral Resources, and the owners of Armash fish-farm. We conducted 183 interviews with hunters, randomly selected to represent the community from each province (65 from Yerevan, 60 from Ararat, and 58 from Armavir). The main questions during the interviews with the hunters and heads of hunting unions were related to the hunters' ability to recognise Marbled Teal and other game ducks to species and differentiate them from one another, as well as their knowledge of the protection status of Marbled Teal. Specifically, in the first section of the interviews with hunters, the interviewers showed images of Marbled Teal, female Red-crested Pochard *Netta rufina*, Common Pochard *Aythya ferina*, Mallard *Anas platyrhynchos*, Northern Shoveler *Spatula clypeata*, Common Teal *Anas crecca*, and Gadwall *Mareca strepera*, as well as Ferruginous Pochard *Aythya nyroca* and Tufted Duck *Aythya fuligula* to the hunters, asking them to identify which species they were going to harvest. Then the hunters were asked to name the species that they had

indicated. In the second section of the interview, the interviewers asked hunters if they knew about the protection status of Marbled Teal, Common Pochard, and Ferruginous Pochard in the country.

The interviews with the heads of hunting unions were less structured than those with the hunters. Specifically, the heads of hunting unions were asked about the procedures for accepting an applicant to become a member of the hunting union and thus receiving a hunting licence. Additionally, the heads of the hunting unions were asked to evaluate the level of species identification and knowledge of their members. In addition, they were asked to estimate the number of hunters visiting various wetland areas in the Ararat Plain. The interviews with the Inspectorate were conducted with inspectors from the 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 Marbled Teal.

To analyse hunting statistics, we obtained data on the timing of the hunting season, game species, and the national annual species bag recorded for the waterfowl (ducks, coots, and moorhens). These data were gathered from the decrees of the Ministry of Nature Protection of the Republic of Armenia (2014, 2015, 2016, 2017, 2018; later renamed as the Ministry of Environment of the Republic of Armenia 2019). The director of the Bioresources Management Department was interviewed to obtain the national annual species harvest size. 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, as well as to obtain an idea of land-use practices at the fish-farms: e.g. how often and when were the ponds drained during the year, why some ponds were drained and planted with vegetables, if the drained ponds were planned to be restored, if there were any incentives to continue the extensive carp farming with no additional feeding of the fishes, the incentives for reed burning, and the attitude of the owners towards the exclusion of the fish-farm from the public hunting lands.

Information was collected about human activities and other possible threats, including reed burning, drainage of wetlands, harvesting shoreline vegetation, waste disposal in lakes, and grazing in wetland areas. This information was obtained from both direct observations during regular fieldwork and through the Armenian Ornithological Society, which has over 4,300 members who are continuously reporting environmental violations through social media, administered by the BirdLinks Armenia NGO. We also conducted a literature search to see what has been published on the known threats facing the species in both countries.

Data analysis

Armenia

Individual-specific breeding codes (following Voříšek et al. 2008) were used to analyse the breeding distribution of the duck and to help select sites with the highest breeding likelihood of Marbled Teal in Armenia, mapped on a 10×10 km^2 grid. Observations with low breeding codes, ranging from 0 (species observed but suspected to be still on migration or to be a summering non-breeder) to 3 (pair observed in suitable nesting habitat in the breeding season) were not considered to represent breeding occurrences. A given square was considered to be occupied if pairs were recorded, through incidental observation or a 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 42 records from 1984 to 1997 summarised in Adamian and Klem (1999). The habitats used by Marbled Teals were classified in accordance with the most recent publication on Armenian habitats (Fayvush and Aleksanyan 2016), which adapted Armenian habitat classification to the European Nature Information System (EUNIS) criteria. Habitats available for the species were calculated for the entire country using the software package ArcGIS 10.0 (ESRI 2020), using our own database of habitat shapefiles.

We assumed that we had visited all the areas which potentially could be inhabited by Marbled Teals (except for a few border areas where access is restricted), and thus we consider that we had carried out a count of the entire population of the species. To estimate the total number of Marbled Teal currently in Armenia, we used the last three years of our data from 2017 to 2019. Data gathered from both survey methods (i.e. the standard counts and opportunistic observations) were used to create species distribution maps for Armenia, but only standard count data were used for estimating population densities and trends, which provided a multi-year data series. We processed the data (density values per point and year) using the rtrim package (Bogaart et al. 2024), which is a reimplementation of Trends and Indices for Monitoring Data (TRIM) 3.54 software (Pannekoek and van Strien 2005; van Strien et al. 2004) via 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 221 data values analysed from 13 points monitored annually. We calculated a population index using log-linear Poisson regression and applied 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 (SE) across the full span of years (Pannekoek and van Strien 2005). To compute the trend, we utilised an exponential model. To assess the nature and direction of the trend, we followed van Strien et al. (2001), who recommended considering both its magnitude and statistical significance according to five categories: (1) substantial decline/increase (confidence interval lies below -20% or above 20% respectively in a 20-year period); (2) non-substantial decline/increase (confidence interval lies above -20% or below 20% respectively and excludes zero); (3) decline/increase (confidence interval includes -20% or 20% respectively and excludes zero); (4) stable (confidence interval lies above -20%, below 20% and includes zero); (5) poorly known (confidence interval includes both zero and one or both of -20% and 20%).

Area of species occupancy (AOO) and extent of species occurrence (EOO) for Marbled Teal were computed using the IUCN guidelines (IUCN 2019). To compute the AOO, we summed areas of all the habitats where the Marbled Teals were observed during the breeding season. 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 to the species' AOO, excluding discontinuities and disjunctions within the overall distribution inside the borders of each country.

Türkiye

To evaluate the long-term trend of Marbled Teals in Türkiye, we conducted both a detection (presence–absence) and abundance (raw number of birds observed) analysis of the species in the country using eBird data. Following Kittelberger et al. (2023), we first determined the total number of checklists for Marbled Teal for each year between 2001 and 2022 in which the species was reported.

Then, in order to examine the detection of Marbled Teal over time (2001–2022), we used the "pivot_wider" function from the tidyr package (Wickham et al. 2023) to determine the presence or absence of Marbled Teal in every complete checklist at every location during the study period (no detection was scored as 0, all other detections were scored as 1). We then used a generalised linear mixed-effects model (GLMEM), family = binomial, with detection set as the response variable (Bates et al. 2015). We also included year and sampling effort (the time duration of a checklist, obtainable only in complete checklists) as fixed effects, and set the location of a checklist and the ID of eBird observers as random effects in our model. For more on the statistical approach used here, see Kittelberger et al. (2023).

For our abundance analysis, we first checked if there were any observations of this species during 2023 and 2024 and then included these data in our data set (Table 1). We then examined the observation counts for each record to check if they were all numerical. We found that there were 11 observations with an "X" for the number of individuals present. When using eBird, people have the option to select an "X" for the number of individual birds present for a species, which signifies that a species is present but the user was not able to or did not obtain a count. We replaced each "X" value with the average number of birds counted from other checklists from the same year as the record in question (the replacement number ranged from 1 to 4 depending on the year). We then evaluated the trend for abundance using a logistic regression analysis of a linear model with the "tidy" function in the R package broom (Robinson et al. 2021), with the count of birds as our response variable and year as our fixed effect. Since Marbled Teal is a species of concern in the country and so few individual birds have been reported in recent years, we chose to examine the raw count of birds to examine the trend in the actual number of birds observed each year (instead of, for example, averaging across checklists).

Table 1. Sightings of Marbled Teal in Türkiye between 2001 and 2025 (March) according to eBird – years are only included in which Marbled Teal was recorded. "Count" represents the adjusted raw sum of individual teal from all checklists for a given year (see Methods for more details), while "Checklist" is the number of checklists in a given year in which Marbled Teal was reported. "Mean" is the average number of Marbled Teal reported to eBird in the country across all checklists for a given year

Year	Count	Checklist	Mean
2001	72	5	14.4
2002	12	6	2
2004	10	5	2
2005	5	5	1
2006	14	4	3.5
2007	15	4	3.75
2008	16	4	4
2009	30	5	6
2010	12	5	2.4
2011	21	7	3
2012	3	2	1.5
2013	4	2	2
2019	1	1	1
2023	7	2	3.5
2024	2	1	2

Statistical analyses and graphing of this eBird data were conducted in R (version 4.2.2, 2022-10-31; R Core Team 2023).

Results

Distribution and abundance in Armenia

Marbled Teal is a full migrant in Armenia and breeds in two major locations in the country (Figure 1), with most of its population breeding in the brackish marshes of Ararat Plain (Figure 2), and a couple of pairs breeding in grassy marshes surrounding the coastal area of Lake Sevan. Thus, it has an elevational range in the country of 800–1,900 m a.s.l.

The current population estimate for Marbled Teal in Armenia, based on the years 2003–2019, is 8–11 breeding pairs. During this study period, the breeding population indices calculated by TRIM (Figure 3) show a steep, significant decline (Imputed Overall Slope: Additive = -0.114 ± 0.009, Multiplicative = 0.892 ± 0.009, P <0.01). According to the exponential trend (Figure 3), teal numbers declined by 87% over 17 years, with a 66% decline in the last 10 years and a 91% decline over 21 years, corresponding to three generations of the species (BirdLife International 2017).

The AOO for Marbled Teal in Armenia is 18.19 km^2, while its EOO covers 3,869 km^2.

Distribution and abundance in Türkiye

Across Türkiye between 2001 and 2023, there were sporadic records of the species at various wetlands across the country, with the final stronghold of the species being around the southern Mediterranean coast, particularly the Göksu Delta (Figure 4). There were 55 observations of the species in the country through 2022, two more observations in 2023, and only one more observation since 2023 (Table 1). In the first two years of the second half of the study period (2012–2024), there were six sightings of Marbled Teal (n = 12) within the species' expected breeding period in Türkiye (April–June; Green 1993), and therefore these birds can be considered to have been actively breeding. However, after 2013, the only records of Marbled Teal in Türkiye occurred between the end of August and the end of January, likely indicating that these records pertained to individuals wandering during their post-breeding period or dispersing juveniles.

Among these records, the highest observation count for a single year was 72 in 2001, and the lowest was 1 in 2019 (Table 1). The highest number of submitted checklists in a given year was seven, in 2011 (Table 1). After a four-year absence of Marbled Teal records in the country between 2019 and 2023, the species was detected on
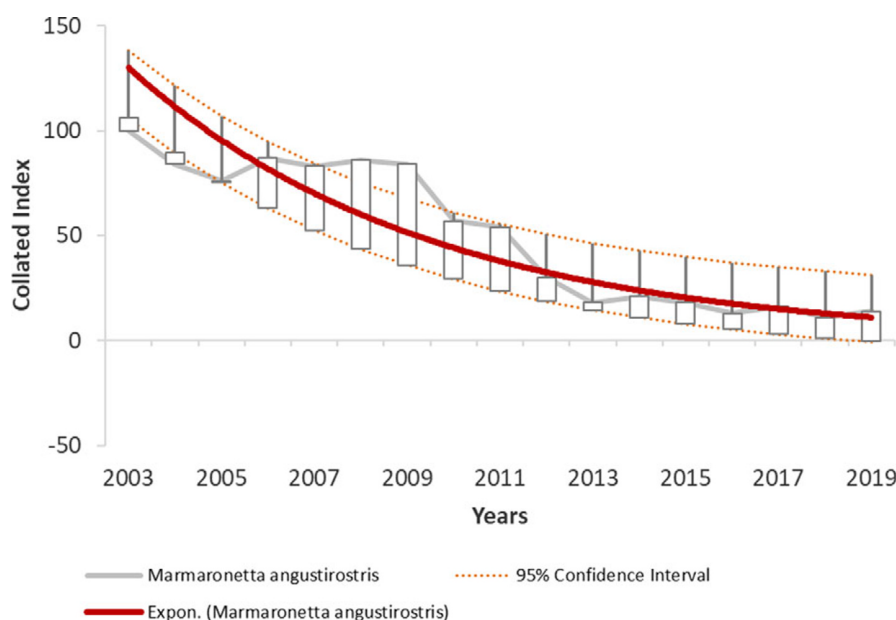

Figure 3. Exponential trend of the Marbled Teal population in Armenia during 2003–2019.

Figure 4. Distribution map of Marbled Teal observations (blue) submitted to eBird between 2001 and 2024 in Türkiye. The black circle marks Türkiye's last stronghold of the species in the Göksu Delta, where most of the records for this species since 2000 have occurred. The red dot notes the location of the two eBird checklists from 2023. The location just to the west of Syrian Aleppo is where the species was recorded in both 2019 and January 2024.

two different days in the early autumn of 2023 at Doğanpınar Sulama Göleti in Gaziantep: five individuals on 30 August (eBird checklist S148563950) and two individuals on 2 September (eBird checklist S148942317). These were noted occurring around the dammed portion of the lake, in an area where water had receded, where there were exposed mudflats, and vegetation was dense (S148563950). There was one additional observation of the species in 2024, of two individuals on 27 January (eBird checklist S164732793) from the Milleyha coastal wetland in Hatay, the same location as the 2019 sighting; eBird 2024).

For our detection analysis (which does not include the 2023 or 2024 records), we found a significant negative trend: -1.868 ± 0.450, $z = -4.148$, $P < 0.001$, Figure 5; Kittelberger et al. 2023). For our abundance analysis (including the records from 2023 and 2024), we found a negative but near-significant population trend (-1.270 ± 0.597, $z = -2.130$, $P = 0.053$; Figure 6). The species appears to be almost completely extirpated from Türkiye, with only four eBird records of Marbled Teal between 2014 and March 2025.

Hunting pressure on the species

Most of the Armenian hunters that we interviewed (93%), as well as seven out of the nine presidents of the hunting unions (77%), were not able to recognise Marbled Teal and differentiate it from somewhat closely related brown ducks, such as females and juveniles of Red-crested Pochard, Common Pochard, and Common Teal.

The distribution of Marbled Teal in the Ararat Plain overlaps with the public hunting lands, which are one of the most popular spots for hunters to visit in the country. The interviews with the owners of Armash Wetlands and the heads of hunting unions revealed that the annual number of hunters who visit Armash Wetlands varies between 1,000 and 2,000, and around 2,000–3,000 hunters visit the wetlands of the Yeghegnut–Sevjur River system. During 2009–2019, the hunting season in Armenia began around 20 August, overlapping with the period when adult and juvenile Marbled Teal have been found to occur in the Ararat Plain.

In Türkiye, hunting of Marbled Teal is illegal, but illegal hunting is widespread in the country, with an estimated 1.5 million illegal hunters in addition to approximately 300,000 legal hunters (WWF Türkiye 2022; Zobar 2023). Even more critical is the accelerating disappearance of wetlands in Türkiye, due to a combination of unsustainable water extraction and climate change (Ataol and Onmuş 2021; Kittelberger et al. 2023; Shelton 2023), especially in the drier central Anatolian and Mediterranean regions where Marbled Teal formerly had breeding populations.

Discussion

The status of the populations of Marbled Teal in Armenia and Türkiye has become especially alarming in recent years and is at the risk of collapse. In Türkiye, the breeding population is now likely
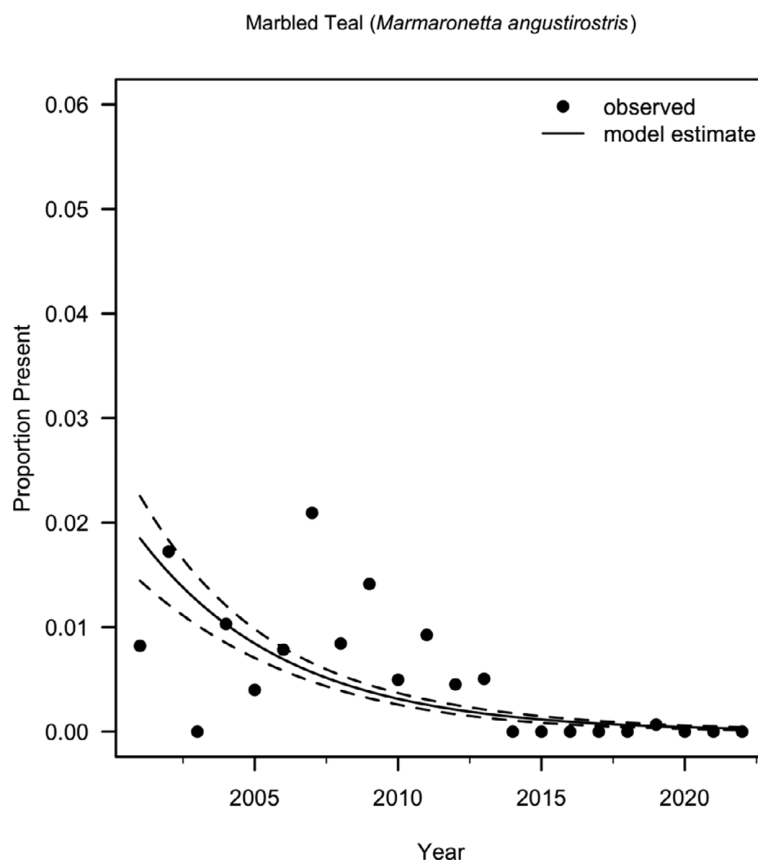
Marbled Teal (*Marmaronetta angustirostris*)

Figure 5. The proportional trend in the presence–absence of Marbled Teal from complete eBird checklists from Türkiye between 2001 and 2022. This species underwent a significant negative change in population trend across the period (-1.868 ± 0.450, z = -4.148, P <0.001). The model prediction (± 95% confidence interval) is based on a generalised linear model (GLM) estimate and does not incorporate the effects of sampling effort, observer ID or location on the trend. (Figure taken from Kittelberger et al. 2023)

functionally extinct, with the species barely recorded over the past decade and undetected for four years between 2019 and 2023 (Table 1) (eBird 2024). On the other hand, in Armenia the species can still be found annually and continues to breed, but the population is dwindling in number and is at risk of future extinction.

Marbled Teal is currently evaluated as "Endangered" in Armenia (Aghasyan and Kalashyan 2010) and is included in CMS Appendix I and II and EU Birds Directive Annex. The breeding sites of the species are partially protected in Lake Sevan National Park. All other breeding sites are included in the Emerald Network (currently, in the status of candidate Emerald Sites), protected under the Bern Convention (Fayvush et al. 2016), and in the network of critical migration stop-over points that are protected under the African–Eurasian Migratory Waterbird Agreement (AEWA). However, even with these levels of protection, Marbled Teal populations do not show that the species' population is increasing in the country long term. The population trend of the species in Armenia can be divided into three different periods. The first period, from 2003 to 2005, was when the species demonstrated a consistent decline, probably initiated during the 1990s to early 2000s, when poaching was quite common and non-regulated in the country. The next period, from 2006 to 2009, saw an increase of the species' population, which coincided with the general development of birdwatching in Armenia and, specifically, in the Armash Wetlands. The development of birdwatching with a paid entrance resulted in restricted admission for hunters, providing favourable conditions for Marbled Teals. The final period though, from 2010 to 2019, saw the species undergo a steep decline.

The significant decline of Marbled Teal during the last decade in Armenia could be the result of several factors. First, the people managing the carp-farming ponds in the Armash Wetlands (which host most of the breeding population) began to annually burn the reedbeds in recent years to regenerate the reeds which are supposedly fed on by the reared Cyprinids. Reed burning results in the loss of breeding habitat for Marbled Teals and has contributed to the species' decline in a number of countries (BirdLife International 2024). Likewise, the species disappeared in those areas of Armash Wetlands which have been intensively burned every year. Second, hunters with a lack of knowledge and skillset in species identification can unintentionally shoot Marbled Teals during the hunting season, which begins in late August, overlapping with the period when Marbled Teals are still in the Armash Wetlands. This overlapping of hunting season and occurrence of many waterbirds in the wetlands, along with a lack of hunters' education coupled with poor control over unintentional shooting appear to be responsible for the decline of some other waterbirds, such as Common Pochard, White-tailed Lapwing *Vanellus leucurus*, and Northern Lapwing *Vanellus vanellus* (Aghababyan 2021; Aghababyan et al. 2021a, b). Similarly, illegal hunting has led to an increase in the mortality of Marbled Teals in El Hondo National Park in Spain, where the hunting grounds overlap with the national park's area (Pérez-García et al. 2024). A third factor could be the relatively new practice of draining fish-farming ponds every 2–3 years and using these as agricultural fields for watermelon. This can result in a decrease of nutrients in the ponds and lead to a decline in food resources available for Marbled Teal. Such a factor
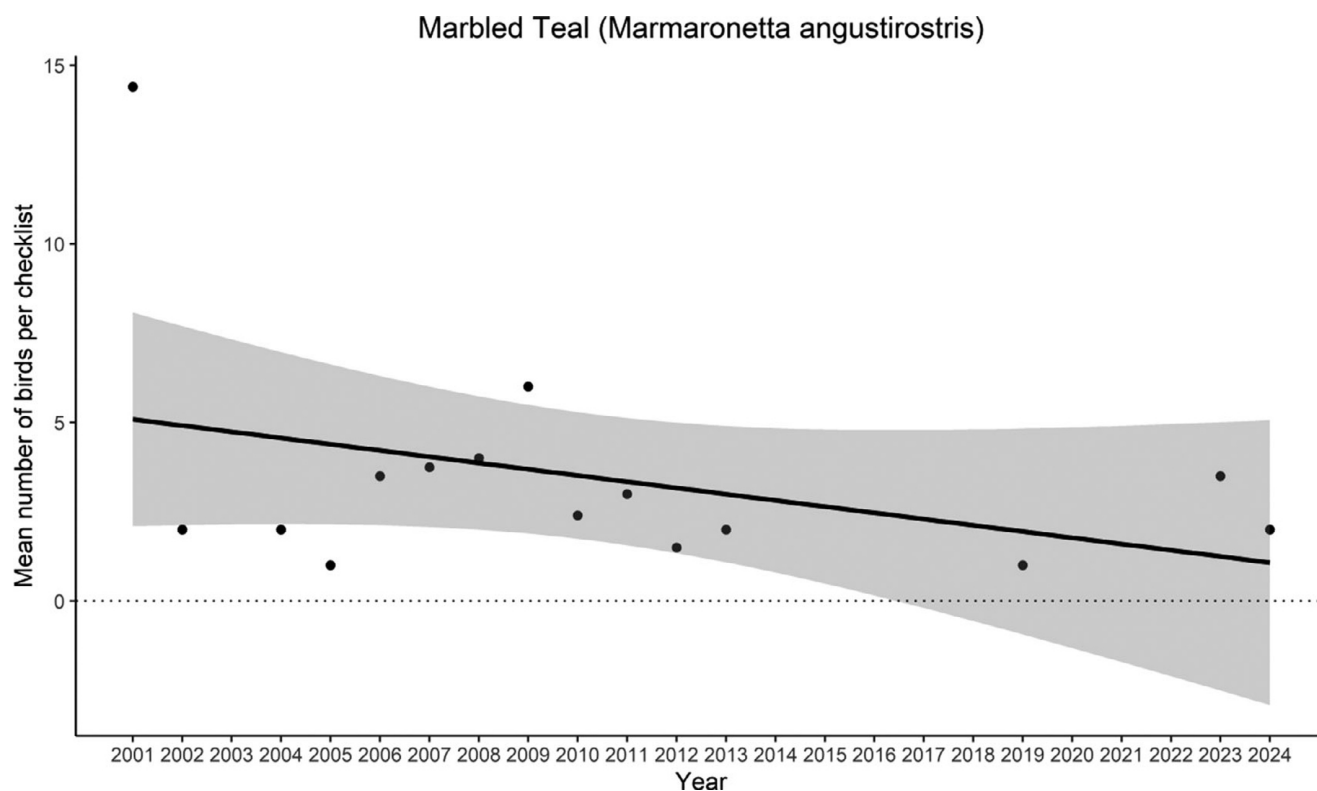
Marbled Teal (Marmaronetta angustirostris)

Figure 6. The abundance (number of observed individuals) of Marbled Teal from submitted eBird checklists in Türkiye between 2001 and 2024. The species underwent a negative but near-significant change in abundance across the period (-1.270 ± 0.597, z = -2.130, P = 0.053). The 95% confidence envelope is depicted in grey around the generalised linear model (GLM) trendline of the species.

can theoretically be exacerbated by an increase in the proportion of Grass Carp *Ctenopharyngodon idella* among fish in the wetlands. Finally, wetlands could be polluted by lead from surrounding waste dumps and the tailing ponds of gold mines. Lead contamination is known to create high mortality among Marbled Teals (Mateo et al. 1998, 2001; Svanberg et al. 2006) and could potentially play a role in Armenia as well.

The population of Marbled Teal in Türkiye has steadily declined from a maximum count of 2,660 in 1968 and an estimated 150–250 breeding pairs in the early 1990s (Green 1993) due to a combination of hunting (Gürpınar and Wilkinson 1970), extensive drainage of wetlands (especially Lake Amik, the Aynaz wetlands, and in the Çukurova Delta and Göksu Delta; Green 1993), detrimental irrigation schemes, uncontrolled dam construction, housing development, intensive grazing, use of agricultural chemicals, eutrophication, reed burning by locals, and significant reductions in the area of key wetlands that were exacerbated by climate change (Boyla et al. 2019; Dervisoglu 2022; Green 1993). A 1995 survey of Marbled Teal's last known stronghold in Göksu Delta recorded 31 breeding pairs, which declined to 4–7 breeding pairs by 2010, then to a single breeding pair between 2011 and 2013, with no breeding recorded in the Göksu Delta since 2014 (Boyla et al. 2019). Extensive field surveys conducted for Türkiye's first breeding bird atlas also failed to find the species (Boyla et al. 2019).

Marbled Teal is not the first duck species thought to become functionally extinct in Türkiye as a breeding species this century. In fact, the Caucasian population of Velvet Scoter *Melanitta fusca* that used to breed on high-elevation lakes in the north-eastern part of the country became extirpated around a decade ago (Altunok 2019; Kittelberger et al. 2023), though it still breeds elsewhere in the region (eBird 2024). While Marbled Teal was detected after an

absence in Türkiye twice in late 2023 and once in early 2024 (eBird 2024), these individuals are likely wandering individuals rather than breeding birds that have flown from the south looking for suitable wetland habitat. Nevertheless, the recent records of Marbled Teal in the country highlight the importance of conserving existing wetlands now, which could be used by scattered individual teals in the future to help re-establish and recover populations in the country and region as a whole.

For Armenia, we propose that the conservation status of Marbled Teal should be changed from "Endangered" to "Critically Endangered", according to the IUCN criteria A1a+C1+D (IUCN 2019). For Türkiye, we also propose that the conservation status of the species be changed from "Endangered" to "Critically Endangered". It is possible that the population of the species could be rescued via emigration from neighbouring countries, i.e. southern Russia, northern Syria, Azerbaijan, and the Caucasus part of Iran (BirdLife International 2022; Carboneras and Kirwan 2020), but the probability of such a rescue is hard to estimate and also requires that suitable habitat already exists for emigrating birds. While there have been recent occurrences of Marbled Teal in the southern part of Armenia in recent years, these visits have clearly not yet resulted in a re-establishment of a breeding population. Furthermore, our study suggests that based on the timing of recent records, Marbled Teal has likely not bred in Türkiye in the past decade.

Conclusions

The status of Marbled Teal populations in Armenia and Türkiye is especially dire and requires immediate attention and action, a full understanding of the causes of the species' collapse, and urgent

development of a regional action plan, especially with an emphasis on reducing human-induced mortality and pressure resulting from hunting (Pérez-García et al. 2024). In this study, we showed that this waterfowl species has declined significantly across parts of the Caucasus in both countries, with the likely extirpation of the bird as a breeding species in Türkiye. Taking into account the current and potential threats the species is known to (and likely does) face, we propose the following conservation measures for Marbled Teal in the region, particularly in countries like Armenia where the species is still confirmed to breed: (1) the development of regional and country-specific action plans for Marbled Teal; (2) recognition of the breeding range of the species as protected areas; (3) official adoption of the candidate Emerald Sites in Armenia and development of management plans for those sites; (4) changing hunters' licensing criteria in Armenia with the introduction of an obligatory test on game species identification; (5) exclusion of the species' known locations from public hunting lands; (6) preserving and conserving wetlands in general and improving the quality and productivity of these areas for Marbled Teal; (7) restoring degraded wetlands, taking into consideration the breeding habitat requirements of Marbled Teals; (8) implementing a feasibility study of its possible reintroduction in Türkiye. For the latter proposal, this is especially important for waterfowl species at large across the entire region, as wetlands in countries like Türkiye are under severe anthropogenic pressures (Kittelberger et al. 2023). These conservation measures should be supported by the continuous monitoring of the species with two purposes: (1) to track its population trend further, and (2) to measure the effectiveness of conservation measures being undertaken. Through consistent and focused conservation efforts of the species and its habitat, the decline of Marbled Teal may be halted and even reversed.

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