Khor Virap Sanctuary

Fire Risk Assessment

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Citation

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Disclaimer

Any opinion presented in this report belongs to the author and does not necessarily represent the views of the Caucasus Nature Fund.

Summary

Considering the uncontrolled burning of the reeds in Armenia, it was decided to investigate the phenomena of reedbed burning in Armenia. The study touched on the reasons for reedbed burning by the local rural populations, the benefits that people get from burning the reedbed, the negative aspects of reedbed burning for people, the consequences of reedbed burning for biodiversity, the input of reedbed burning into the global climate change, the current legislation that regulates the burning of dry vegetation, and the best practices that suggest alternatives for burning.

It was figured out that the reed burning could possibly affect the bird fauna of the brackish marshes of Armenia.

Among the birds, the Moustached Warbler declined critically due to the last reedbed burning in Khor Virap Sanctuary. It is especially important since this species is protected under the Bern Convention having a high density in Khor Virap Sanctuary. The main reason for the decline could be related to the burning of the wetlands.

The world practice says that the management of the reedbed is important for biodiversity, as it supports diversification of the habitats and therefore, supports in increase of biological diversity.

Again, the world practice suggests three general ways of reedbed management: careful burning, careful harvesting, and restricted grazing. Among those, careful burning should be excluded, as a method that contradicts the national legislation and consists of significant risks of losing control and spreading the fire. Careful harvesting of the reed can be used and has to be linked to some economic activities. For example, it can be used for the production of combined fodder of livestock or production of roofs. The introduction of such a mechanism can also solve the issue of burning the reed in canals, for cleaning the clogging, as will introduce a financial interest in harvesting and not burning. Such a direction requires a feasibility study, though. Careful grazing can also be used, although, for such areas, it is suggested to shift the livestock husbandry from cows to buffalo. The reed is a natural fodder for the buffalo, and the buffalo dairy production has exceptional quality. It opens opportunities for high-margin diary production if marketed as “Bird Friendly” or “Conservation Friendly”.

While the burning of dry vegetation, including reeds, is prohibited by national legislation, there is a need for nationwide awareness-raising campaigns about it.

The national legislation on burning dry vegetation should be reviewed and maybe an increase in penalties should be suggested.

Introduction

The burning of the dry vegetation in general and the reed burning in particular performed in Armenia traditionally. Even though burning dry vegetation was banned by the law in 2011 (Ministry of Nature Protection 2011), the people in rural communities continue this “traditional” duty.

Thus, in March of 2024, the fire caused by the reed burning that began on the outskirts of Pokr Vedi village spread to the area of Khor Virap Marshes and covered also Khor Virap State Sanctuary, causing complete damage to the reedbed in the Sanctuary (Figure 1).

At the same time, the world practice mentions contradictory statements about how useful or how harmful the burning of the reeds is (Cowie *et* al. 1992, Ditlhogo *et al*. 1992, Gaganis *et al*. 2024, Mester *et* al. 2015, Nemeth and Dvorak 2022).

Therefore, there is a need to implement a local study, which can through a light on the several questions:

1. What is the impact of reed burning on biological diversity?
2. What is the impact of the reed burning on the climate?
3. What are the main reasons for burning the reed?
4. What are the benefits of reed burning for rural communities?
5. What are the alternatives for reed burning in the process of reedbed management?

Figure 1. Khor Virap Wetlands after burning in 2024.

Background

Wetlands, together with forests, have been considered of the highest global importance for biodiversity conservation and the mitigation of climate change and therefore priority areas for restoration (Strassburg et al. 2020).

In Armenia the forests and wetlands host the highest level of biodiversity among other ecosystems (including a number of endemic species), play a crucial role in carbon sequestration, and contribute to the regulation of climate at the regional scale (UNFCCC 2020). Ararat Plain of Armenia was historically covered by over 30,000 ha of brackish marshes (Aghababyan 2024), which are of significant importance, not only as the home for unique biodiversity including waterfowl, but also as marshlands that don't produce peat (Jenderedjian 2004), and therefore carry a lower risk for Greenhouse Gas (GHG) emission, unlike the boreal bogs (Åhlén *et al*. 2023).

Despite that, wetland ecosystems are among the most vulnerable ones in Armenia. The wetlands of Armenia (according to Ramsar classification) make up 168,200 ha or 5.7% of the country's area (Jenderedjian 2005) and have been subject to overuse and purposeful draining, being traditionally considered a harmful biotope, that impeded the development of agriculture, and for the last century have been reduced purposefully and consistently (Adamian and Klem 1999). The brackish wetlands of Ararat Plain have been reduced via special drainage systems, and the mountain grassy marshes have been lost through increased water abstraction and the development of water reservoirs (Jenderedjian 2005; Jenderedjian *et al*. 2002, 2004). It has resulted in a serious decline in the biodiversity of wetlands (MOE 2020, USAID 2000, 2009) and their ability to store and release water resources, as well as their ability to sequester carbon.

Therefore, the restoration of wetlands in Armenia is of strategic importance, which will be beneficial for biodiversity and society and will contribute to the regulation of local climate and mitigation of global climate change. One such project is a small-scale pilot restoration of the wetlands in the part of Khor Virap Sanctuary, aimed at reconstruction of habitat for breeding and migratory waterbirds, as the birds can recolonize the restored wetlands rather quickly (Brawley *et al*. 1998).

Thus, during 2019-2021, a total of 1.46 ha of wetlands were restored in Khor Virap Sanctuary, a candidate Emerald Site, a Ramsar Site, and an international stopover point, protected under the African-Eurasian Waterbird Agreement. The restoration project was rather successful for the development of waterbirds community. Monitoring of the birds before and after the intervention (in 2017-2019 and 2020-2021) showed that the fauna of breeding birds changed from 38 to 55 species ($\chi2 = 32.9$, $p < 0.001$) and the fauna of migratory species changed from 31 to 61 species ($\chi2 = 10.6$, $p < 0.001$). The conservation value of the area increased as the number of species included in the IUCN Red List increased from 0 to 1 for breeding birds and from 0 to 4 for migratory ones, in the Red Book of Animals of Armenia from 1 to 3 and from 5 to 19, and in Resolution 6 of Bern Convention from 5 to 12 and from 6 to 22 respectively (Aghababyan and Grigoryan, in press).

Objectives of the Study

The objective as per TOR was formulated as: “The overall objective of the assignment is to investigate the reasons for fires, their consequences on biodiversity, and their prevention mechanisms in and around the Khor Virap Sanctuary”.

Considering the information provided in the introduction and background sections, it is proposed to reformulate the objective, and its components as follows.

The overall objective of the assignment is to investigate the phenomena of reedbed burning in Armenia. Specifically, we study the reasons for reedbed burning by the local rural populations, the benefits that people get from burning the reedbed, the negative aspects of reedbed burning for people, and the consequences of reedbed burning for biodiversity and the input of reedbed burning into the global climate change.

Also, we will study the legislation that regulates the burning of the natural ecosystems in Armenia and the best practices that suggest alternatives for burning.

Having all this information we will suggest measures and mechanisms to prevent the reedbed burning in and around the Protected Areas of Armenia, specifically for the Khor Virap Sanctuary.

Methods

Study area

The study area is considered the Khor Virap Sanctuary and its outskirts, specifically the Pokr Vedi and Lusarat villages (Figure 2).

Primary data collection

The primary data collection includes two major areas: data collection on the reasons for reed burning from the rural communities and data collection on the state of biodiversity in Khor Virap Sanctuary.

Surveys of Rural Communities

The surveys in rural communities have been conducted via open-ended interviews with the people who live in the Khor Virap and Lusarat villages. The interviews were kept confidential in order to get honest information. The main aim of the interview was to obtain information about the main reasons for burning reed and the benefits that the local people obtain (or think they obtain) from that burning.

Although the interview was open-ended, the following questions were articulated, in order to reach mentioned aim of the interview:

1. What is the reason for you to burn the reed?
2. What are the benefits that you get from burning the reed?
3. Do you ever heard that the law could prohibit the burning?

4. If yes, do you know about any penalties that can be anticipated due to burning the reed?
5. Do you know about any harm that reed burning can cause to biodiversity and climate?

In total, 11 people were questioned, including 6 people from Pokr Vedi and 5 people from Lusarat. Since the reed burning is a widespread issue, the same questions were asked in other parts of Ararat Plain too, specifically in total 5 people from Ararat, Surenavan, and Armash village.

Therefore, from the interviews conducted, we have been trying to extract the answers that could be grouped into the final set of answers. The analysis, therefore, is qualitative, rather than quantitative.

Surveys of Biodiversity

The surveys of biodiversity were conducted mainly on birds, considering the fact that the bird surveys were regularly conducted before and therefore provide the material for the comparison.

The study was conducted on the breeding birds (as part of the National Bird Monitoring Scheme implemented by BirdLinks Armenia NGO), before the mass reed burning in 2024 and after that.

Figure 2. Khor Virap Wetland area.

Usually, the data collection is implemented via standardized point counts and opportunistic observations, however, for this specific project we used the standardized count data only. For the comparison, we took the data from 2020 and 2021 (implemented immediately after the wetland restoration). The standardized point counts (conducted following a predefined protocol) have been implemented within the project area and in surroundings, at a distance of 0.5-1 km, mostly for surveying semi-desert habitats. The counts were made by professional ornithologists. For the current survey, point counts were used (Bibby et al. 2000), where observers counted all the birds within a

sector of a certain radius (200–500 m) and an angle of view (90° and 180°) during a fixed 30-minute. The surveys were made from sunrise until 11:00 h and then from 16:00 h – 17:00 h until dusk, usually (over 95% of the surveys) in favorable weather conditions (e.g., in the absence of rain and with light winds below Beaufort Force 3). Every year (in 2020, 2021, and 2024) the breeding bird surveys were conducted during 2 days in mid-May and included the following data: bird species, 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 (Voříšek *et al*. 2008). The counts were conducted from 2 points. The points for counting breeding birds were located at 1,035 m from each other in a way to avoid the overlapping of the sectors. All data was entered into a database and checked. After each data entry, one team member checked the information added to the database with the original record and corrected any errors that occurred.

Secondary data collection

The secondary data collection included a review of the existing scientific literature, including articles and technical reports on the impact of reed burning on biodiversity and climate. The search of the literature was conducted via keywords.

Data analysis

Bird Data

Since our surveys don't include specific nest searches (to avoid unnecessary disturbance of the birds), the breeding status of the species was determined according to the breeding code: the higher the breeding code, the higher the probability of the species breeding. Estimation of the total number of birds was implemented differently for the uniformly distributed and clustered birds, as the current guidelines for the National Bird Monitoring (BirdLinks Armenia 2019) already separated those. For uniformly distributed birds, such as the Great Reed Warbler (*Acrocephalus arundinaceus*) the area of the counting sector was calculated and then density per ha was computed from the observed number of singing males and the area of the sector. Then the lowest and highest densities were taken from two years – 2020 and 2021, and the densities were extrapolated on the entire project area by multiplying the project area by the density. For clustered birds, their numbers from the two counting points have been summarized. For comparison of the bird fauna before and after the intervention the abundance of the recorded species was used as a variable. Since, for most of the species for 2020-2021, the abundance was provided as a range, e.g., 2-3 breeding pairs of Kingfisher (*Alcedo atthis*), for testing, the average value was taken (2.5 in this case). For the species not recorded in one of the periods, the value 0 was considered. Then the non-parametric Chi-square test was applied to assess the difference in abundance of all the breeding species recorded before and after the intervention (Daniel and Cross 2013) using R-4.3.3 for Windows software. The difference was considered statistically significant at $p < 0.05$.

Results

Reasons of burning

Out of the conducted interviews the following typology of the reasons was possible to extract:

1. It is a useless plant that takes the place of other plants.
2. When we burn the reed, it recovers very quickly, so we do not see any problem.
3. The cows eat the young reed when it just emerges from the ground, but they hardly feed on the already-grown reed. Burning the reeds cleans the area and stimulates the growth of young reeds, which become fodder for the cows.
4. Burning the reeds near canals stimulates the growth of young reeds, which become a food source for the fish that live there.
5. Burning the reeds in canals helps in cleaning the clogged canals to maintain the irrigation water supply.
6. It was done traditionally.
7. Burning of other vegetation in the adjacent fields (mainly in lucerne fields that are used as cattle fodder) helps in the mineralization of the soil and pest control.

Indeed, all 16 questioned people (100%) stated for the reasons:

> Reason 1. It is a useless plant that takes the place of other plants.
>
> Reason 2. When we burn the reed, it recovers very quickly, so we do not see any problem.
>
> Reason 7. Burning of other vegetation in the adjacent fields (mainly in lucerne fields that are used as cattle fodder) helps in the mineralization of the soil and pest control.

The next popular reason articulated by nine people (56%), including one person from Ararat, two from Surenavan, two from Armash, two from Lusarat, and two from Pokr Vedi, was:

> Reason 3. The cows eat the young reed when it just emerges from the ground, but they hardly feed on the already-grown reed. Burning the reeds cleans the area and stimulates the growth of young reeds, which become fodder for the cows.

The next popular reason was stated by five people (31%), all of those located in Ararat Extended Community, namely one person from Ararat, two from Surenavan, and two from Armash. All these people have some relation to the extensive carp farming.

> Reason 4. Burning the reeds near canals stimulates the growth of young reeds, which become a food source for the fish that live there.

The next popular reason was stated by four people (25%), three from Lusarat, and one from Pokr Vedi.

> Reason 5. Burning the reeds in canals helps in cleaning the clogged canals to maintain the irrigation water supply.

Eventually, two people (13%), one from Armash and one from Pokr Vedi stated the least popular reason.

Reason 6. It was done traditionally.

None of the interviewed people was able to quantify the benefits which they obtain for whatever reason, and nevertheless they believe that burning is beneficial. All the interviewed people state that the method of burning was inherited from ancestors, and they do not see any reason to change it.

Only one of the questioned people (6%) heard about legal restrictions of burning but thought that the restriction was related to the pasturelands and not reedbeds. He assumed that some punishment should take place but doesn't know the real size of the punishment. Moreover, he never heard of someone from their region to be punished for reed burning.

None of the questioned people believe that reed burning can harm biodiversity, arguing that the reed recovers very quickly and so the biodiversity can again find home in it. When asked, what they understand under the biodiversity, they responded mostly about terrestrial mammals (Golden Jackal and Coypu) and birds (Ducks, Herons, and Cormorants).

None of the questioned people believe that reed burning can harm the climate, arguing that the smoke stays for just a couple of hours. None of them understood the link between the released carbon dioxide and the climate change, although all of them agreed that the climate in Armenia is gradually changing and they feel increase of the summer temperature and a frequency of the extreme atmospheric events, such as storms and hails.

Impact on biological diversity

The following impact on the bird fauna was documented. In general, the abundance of breeding waterbirds declined in comparison to the data from 2020-2021. Out of all the recorded birds, 30 species declined, seven species remained stable, and 18 species increased (Table 1).

Table 1. Change of bird fauna after reed burning.

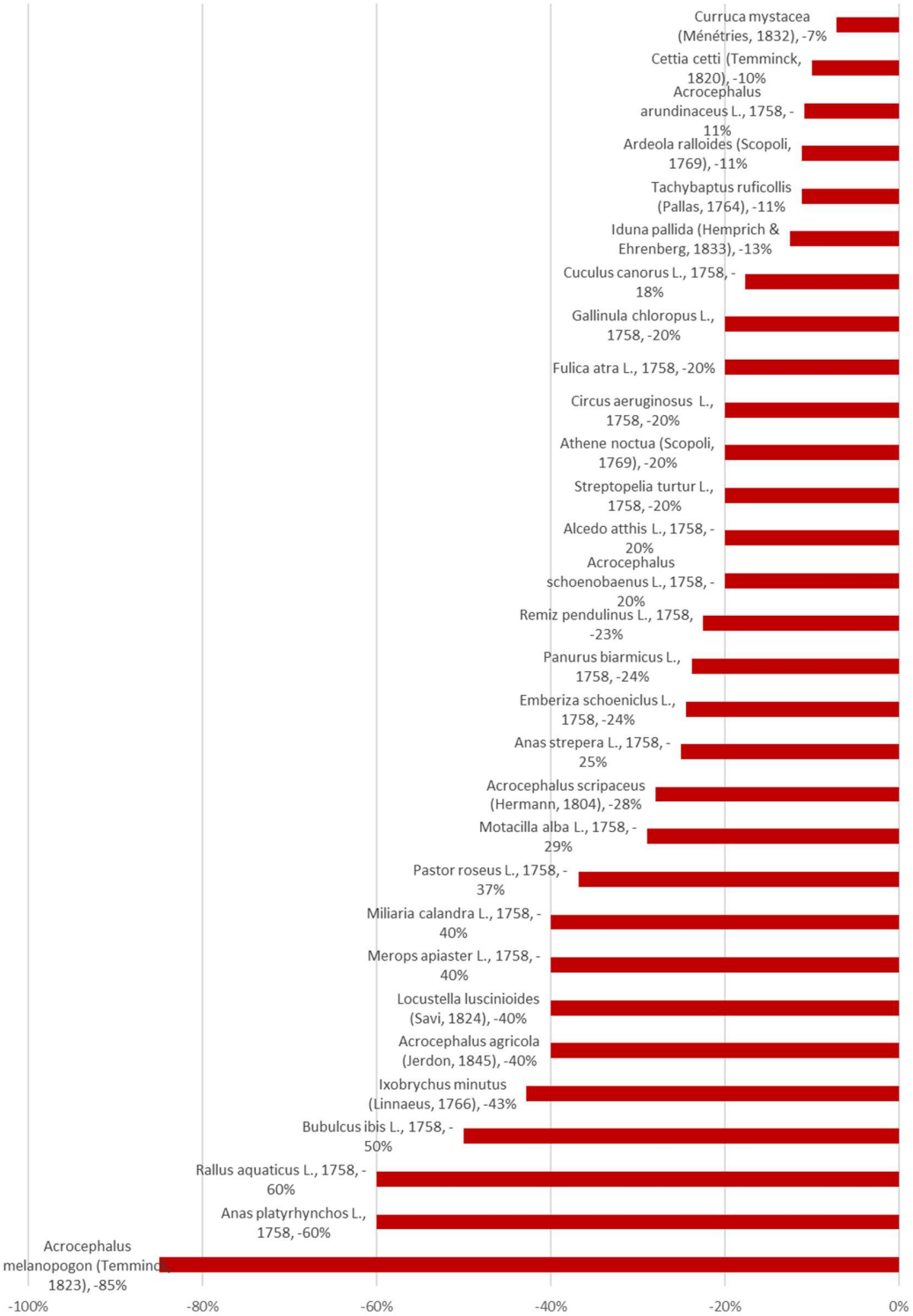
Latin names	English names	Estimated number in 2020-2021	Estimated number in 2024	Change in abundance		Habitat	Status in IUCN Red List	Status in Armenian Red Data Book	Bern Convention
Acrocephalus melanopogon (Temminck, 1823)	Moustached Warbler	16-24	3	Decrease	-85%	reedbeds	LC	NE	Res6
Anas platyrhynchos L., 1758	Mallard	2-3	1	Decrease	-60%	ponds	LC	NE	No
Rallus aquaticus L., 1758	Water Rail	4-6	2	Decrease	-60%	reedbeds	LC	NE	Res6
Bubulcus ibis L., 1758	Cattle Egret	1-2	1	Decrease	-50%	reedbeds	LC	NE	No
Ixobrychus minutus (Linnaeus, 1766)	Little Bittern	3-4	2	Decrease	-43%	reedbeds	LC	NE	Res6
Acrocephalus agricola (Jerdon, 1845)	Paddyfield Warbler	10-20	9	Decrease	-40%	reedbeds	LC	VU	No
Locustella luscinioides (Savi, 1824)	Savi's Warbler	8-12	6	Decrease	-40%	reedbeds	LC	VU	No
Merops apiaster L., 1758	European Bee-eater	20-30	15	Decrease	-40%	rocky semi-desert	LC	NE	No
Miliaria calandra L., 1758	Corn Bunting	20-50	21	Decrease	-40%	scrubs	LC	NE	No
Pastor roseus L., 1758	Rose-coloured Starling	400-1500	600	Decrease	-37%	rocky semi-desert	LC	NE	No
Motacilla alba L., 1758	White Wagtail	15-30	16	Decrease	-29%	clay banks	LC	NE	No
Acrocephalus scripaceus (Hermann, 1804)	Eurasian Reed-warbler	20-30	18	Decrease	-28%	reedbeds	LC	NE	No
Anas strepera L., 1758	Gadwall	3-5	3	Decrease	-25%	ponds	LC	NE	No
Emberiza schoeniclus L., 1758	Reed Bunting	15-30	17	Decrease	-24%	reedbeds	LC	NE	No
Panurus biarmicus L., 1758	Bearded Reedling	140-280	160	Decrease	-24%	reedbeds	LC	NE	No
Remiz pendulinus L., 1758	Eurasian Penduline-tit	30-50	31	Decrease	-23%	reedbeds	LC	NE	No
Acrocephalus schoenobaenus L., 1758	Sedge Warbler	6-14	8	Decrease	-20%	reedbeds	LC	NE	No
Alcedo atthis L., 1758	Common Kingfisher	2-3	2	Decrease	-20%	ponds	LC	NE	No
Streptopelia turtur L., 1758	European Turtle-dove	2-3	2	Decrease	-20%	scrubs	VU	NE	No
Athene noctua (Scopoli, 1769)	Little Owl	2-3	2	Decrease	-20%	rocky semi-desert	LC	NE	No
Circus aeruginosus L., 1758	Western Marsh-harrier	2-3	2	Decrease	-20%	reedbeds	LC	NE	No

Fulica atra L., 1758	Common Coot	15-20	14	Decrease	-20%	ponds	LC	NE	No
Gallinula chloropus L., 1758	Common Moorhen	8-12	8	Decrease	-20%	reedbeds	LC	NE	No
Cuculus canorus L., 1758	Common Cuckoo	6-11	7	Decrease	-18%	reedbeds	LC	NE	No
Iduna pallida (Hemprich & Ehrenberg, 1833)	Olivaceous Warbler	30-50	35	Decrease	-13%	scrubs	LC	NE	No
Tachybaptus ruficollis (Pallas, 1764)	Little Grebe	3-6	4	Decrease	-11%	ponds	LC	NE	No
Ardeola ralloides (Scopoli, 1769)	Squacco Heron	4-5	4	Decrease	-11%	reedbeds	LC	NE	No
Acrocephalus arundinaceus L., 1758	Great Reed-warbler	80-140	98	Decrease	-11%	reedbeds	LC	NE	No
Cettia cetti (Temminck, 1820)	Cetti's Warbler	30-50	36	Decrease	-10%	reedbeds	LC	NE	No
Curruca mystacea (Ménétries, 1832)	Menetries's Warbler	50-90	65	Decrease	-7%	scrubs	LC	NE	No
Buteo rufinus (Cretzschmar, 1829)	Long-legged Buzzard	1	1	Stable	0%	rocky semi-desert	LC	NE	Res6
Caprimulgus europaeus L., 1758	Eurasian Nightjar	3-5	4	Stable	0%	rocky semi-desert	LC	NE	Res6
Coloeus monedula L., 1758	Eurasian Jackdaw	30-50	40	Stable	0%	rocky semi-desert	LC	NE	No
Coracias garrulus L., 1758	European Roller	2-4	3	Stable	0%	rocky semi-desert	LC	NE	Res6
Corvus corone L., 1758	Carrion Crow	4-8	6	Stable	0%	settlements	LC	NE	No
Galerida cristata L., 1758	Crested Lark	40-60	50	Stable	0%	rocky semi-desert	LC	NE	No
Hirundo rustica L., 1758	Barn Swallow	30-50	40	Stable	0%	settlements	LC	NE	No
Microcarbo pygmeus (Pallas, 1773)	Pygmy Cormorant	10-25	18	Increase	3%	ponds	LC	NE	Res6
Phoenicurus ochruros (Gmelin, S.G., 1774)	Black Redstart	30-40	37	Increase	6%	rocky semi-desert	LC	NE	No
Cercotrichas galactotes (Temminck, 1820)	Rufous-tailed Scrub-robin	10-16	14	Increase	8%	rocky semi-desert	LC	NE	No
Ciconia ciconia L., 1758	White Stork	10-12	12	Increase	9%	settlements	LC	NE	No
Passer domesticus L., 1758	House Sparrow	150-400	300	Increase	9%	settlements	LC	NE	No
Upupa epops L., 1758	Eurasian Hoopoe	4-7	6	Increase	9%	rocky semi-desert	LC	NE	No
Riparia riparia L., 1758	Sand Martin	60-100	90	Increase	13%	clay banks	LC	NE	No

Emberiza melanocephala Scopoli, 1769	Black-headed Bunting	40-70	62	Increase	13%	scrubs	LC	NE	No
Apus apus L., 1758	Common Swift	20-50	40	Increase	14%	rocky semi-desert	LC	NE	No
Nycticorax nycticorax L., 1758	Black-crowned Night-heron	2-3	3	Increase	20%	reedbeds	LC	NE	Res6
Columba livia Gmelin, JF, 1789	Rock Dove	10-15	15	Increase	20%	rocky semi-desert	LC	NE	No
Columba oenas L., 1758	Stock Dove	15-20	21	Increase	20%	rocky semi-desert	LC	NE	No
Pica pica L., 1758	Black-billed Magpie	5-10	9	Increase	20%	scrubs	LC	NE	No
Ardea purpurea (Linnaeus, 1766)	Purple Heron	1-3	2	Increase	33%	reedbeds	LC	NE	Res6
Actitis hypoleucos L., 1758	Common Sandpiper	1-2	2	Increase	33%	clay banks	LC	NE	No
Falco tinnunculus L., 1758	Common Kestrel	1-2	2	Increase	33%	rocky semi-desert	LC	NE	No
Egretta garzetta (Linnaeus, 1766)	Little Egret	1-2	3	Increase	33%	reedbeds	LC	NE	No
Tringa ochropus L., 1758	Green Sandpiper	1-2	3	Increase	33%	clay banks	LC	NE	No

The diagram of the decline of different species is shown in Figure 3.

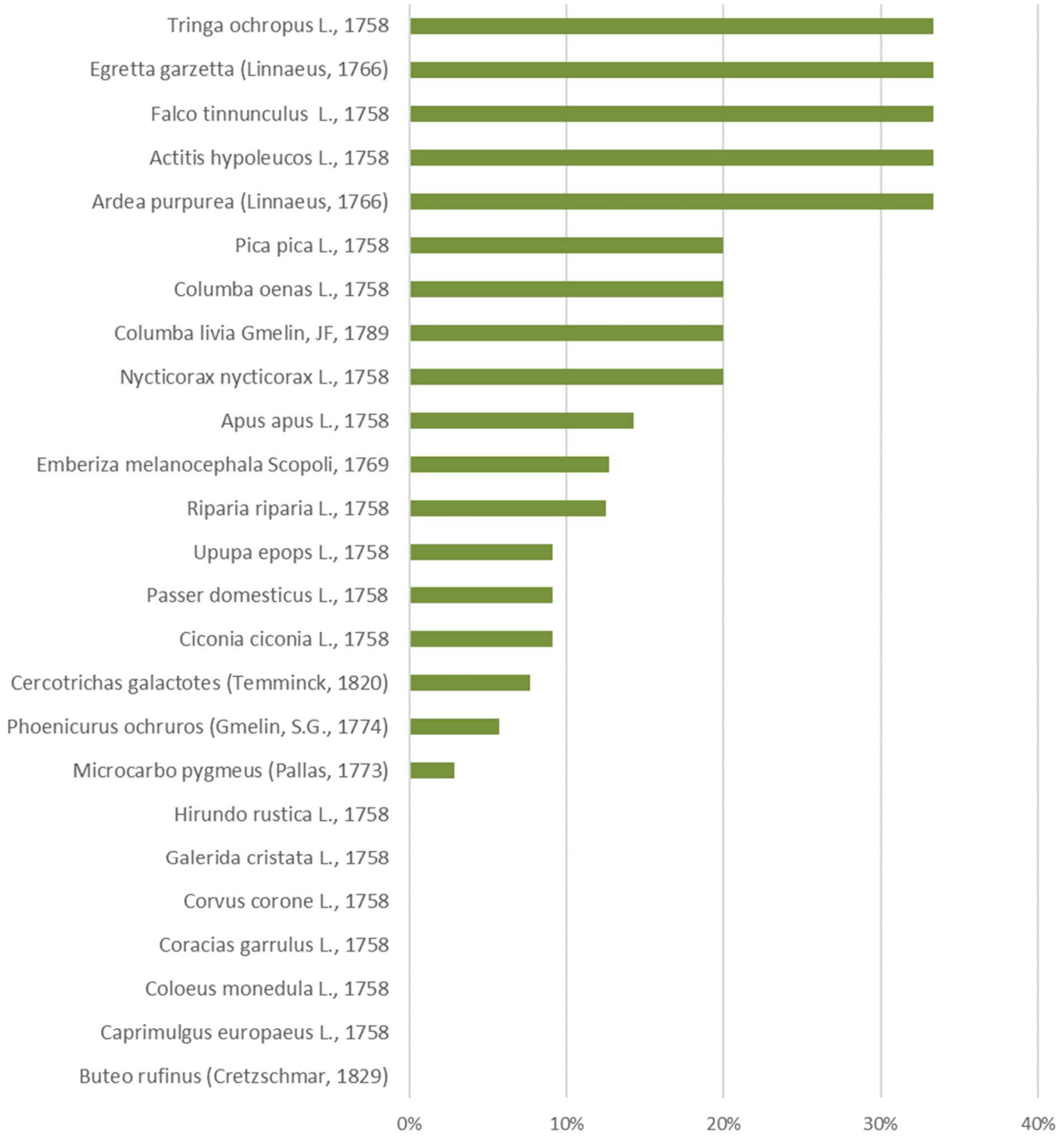
Figure 3. Species that declined after reed burning.



It presents that the population of one species declined by more than 75%; populations of two species declined by 51%-75%; populations of nine species declined by 26%-50%; populations of 16 species declined by 11%-25%; and populations of two species declined by 0%-10%. The species that shows a major decline (more than 75%) is the Moustached Warbler (*Acrocephalus melanopogon*), which is included in Resolution 6 of Bern Convention. Among the species, which show the next level of decline (51%-75%) there are Mallard (*Anas platyrhynchos*) and Water Rail (*Rallus aquaticus*). Among the species, which show a moderate decline (26%-50%) there are such protected species as Paddyfield Warbler (*Acrocephalus agricola*), Savi's Warbler (*Locustella luscinioides*), and Little Bittern (*Ixobrychus minutus*).

The diagram that illustrates the species which show population stability or even increase is presented on the Figure 4.

Figure 4. Species that didn't decline after reed burning.



The figure presents that the populations of 13 species didn't show significant changes and populations of 12 species show a moderate increase (26%-50%). Out of these birds, 18 are not waterbirds, and breed in the surrounding semideserts, like Crested Lark (*Galerida cristata*) or in the nearby settlements, like Barn Swallow (*Hirundo rustica*). The other seven species belong to waterbirds, but breed in the outskirts, such as Purple Heron (*Ardea purpurea*) and Little White Egret (*Egretta garzetta*).

Impact on climate change

The overall area of the reedbed that was burned, is around 340 ha. Estimation of the biomass that could be produced by the area (Baibagyssov *et al*. 2020) shows that at least 2,720 tons of reed were burned. Considering the average amount of CO2, which is being released during reed burning (Jasinskas *et al*. 2020, Kask *et al*. 2013), the total emission of CO2 can be estimated to be about 370 tons per annum.

Legislation

The recent Amendment to the Law "On Preservation of Atmospheric Air" prohibits burning vegetation remains and dry plants, vegetation in pastures and heydays, forests, and specially protected areas.

However, for over ten years, the Environmental Protection and Mining Inspection Body hasn't received any warnings or notifications of the burning. Moreover, the staff of the Inspection Body notes that even if they are notified by the general public, they usually cannot find the persons who broke the law due to a lack of evidence.

Discussions

Impact on biological diversity

The bird diversity and abundance improved after the implementation of the restoration. Moustached Warbler started colonizing the area after the restoration, and most probably its appearance resulted in the emergence of the open water surfaces. The density of Moustached Warbler was the highest for the whole of Armenia (data of National Bird Monitoring – BirdLinks Armenia NGO, unpublished). A preference for heterogeneous and stratified vegetation was shown for the Moustached Warbler (Monrós *et al*. 2023) and supposedly, it is related to the food items of the species, which live near water or grow in the water. Most of the population was concentrated around the restored wetland areas. The bird breeds in the reedbed, beginning its breeding earlier than the other warblers, and therefore, burning the reed could be critical for this species. Other warblers began breeding later when the reed started recovering after the burning. That is why the burning could have a less harmful effect on those species.

Considering the fact that burning in some extent happens almost every year, it is hard to link the observed declines to the burning directly. However, a couple of variances should be noted too. First, the burning in 2024 covered the entire area. Second, it was done in early March, and thus the reed had less time to recover. It is also possible that the burning scared away some populations, which didn't return this year but can possibly return next year. While some influence can be stated, the

question of the level of impact of the reed burning on the bird fauna is still a subject of a detailed study and following monitoring of the birds diversity and abundance is still required.

The E. Nemeth and M. Dvorak (2022) studied the reed die-back and it is influence on small reed birds at Lake Neusiedl of Austria, as the reed belt around Lake Neusiedl is one of the largest connected reed areas in Europe, which means that the area is of high conservation importance for the species depending on this type of habitat. In the several decades before 2022, the decline of reed harvesting has led to the formation of very old reed areas. Therefore, the authors investigated how the age and structure of degraded reed affected breeding bird species. They implemented extensive bird counts of eight species at 111 points to habitat measurements and reed age. Among those, the species differed in their preferred age class. For example, Great Reed Warblers *Acrocephalus arundinaceus* were found mainly in the reed stands, which were up to 4-year-old, while Little Crakes *Zapornia parva* were found in more than 14-year-old vegetation. The results demonstrated that large parts of the reed stands became too degraded even for these “old reed” specialists. Several bird species showed an inverse u-shaped relationship to habitat characteristics associated with reed die-back, e.g. accumulation of broken reed stems, occurrence of matted reed, low vegetation height, or open water areas. In their case, the harvested areas were small and burning of reed was prohibited, and therefore, the authors expect more reeds die-back with declining bird numbers. On another side, the missing ice cover in winter time because of climate warming prevented sustainable cutting of these very old reed stands. Concluding the study, the authors recommended a cautious introduction of fire management as a measure to secure the unique bird habitat.

Another group, M.K.M. Ditlhogo and co-authors (Ditljogo *et al*.1992) that studied the effects of conservation management of reed beds, stated that the burning of the reedbed at the wrong time of year, or burning of dry reed beds is likely to cause damage on the biodiversity.

Another group, C.M. Gaganis and co-authors (Gaganis *et al*. 2024) studied leveraging reed bed burnings as Indicators of wetland conversion in Modern Greece. They explored the historical occurrence of wetland ecosystems in Greece by using recurring reed burnings as an indicator. In Grece, the common reed is a plant that is closely associated with wetlands and thus provides good insights into wetland distribution. The authors established a substantial association between reed fires and historical wetland existence in Greece using geographical and statistical analysis, with these fires exhibiting remarkable constancy across time. Using Corine land-cover data, they extended the analysis into land-use dynamics, demonstrating that places with the highest reed-bed-fire rates were originally wetlands, particularly those converted into permanent irrigated land and areas with complex agriculture patterns. The authors found spatial commonalities between reed fires and past wetland existence by analyzing fire occurrence across three main categories: reed fires, agricultural land fires, and grassland fires. Some historical records of wetland conversion into agricultural land (or land reclamation works) in some of the locations gave additional context to the findings. Conducted visualizations confirmed the clustering of reed fires around these converted agricultural regions. Concluding the study, the authors offered a unique indicator based

on *Phragmites australis* burnings that can be used to identify previous wetland-type ecosystems, with Mediterranean-wide implications.

Another group, B. Mester and co-authors (Mester *et al*. 2015) studies the influence of variable management by grazing and burning on the marsh diversity and amphibians. Considering that ecosystem management often aims to maintain a diversity of habitats to benefit a large number of species within a landscape, they studied the effects of wetland management by low-intensity cattle-grazing and late-summer burning on marsh vegetation and globally declining anuran amphibians (frogs and toads) in a previously homogeneous reedbed. Burning effectively removed old reeds and increased the variability of reed cover and marsh vegetation by the next spring. However, reed grew back strong in areas burned 2 or 3 years before the study, indicating that fire rejuvenated reedbeds. In contrast, cattle grazing kept reed cover homogeneously low and created open water surfaces. The number of amphibian species and individuals decreased with mean reed cover and old reed density and increased with variability in reed cover. Correspondingly, amphibian richness and counts were found greatest in newly burned areas the next spring. In contrast, a year later, richness and counts were found greatest in grazed-only areas, with large decreases in newly burned and control areas. The results of the authors suggest that combined management with grazing and burning can create different habitat patches, some of which will be optimal for amphibians in one year, whereas other patches may become suitable in a subsequent year when successional changes alter previously optimal patches. The authors conclude that to maximize optimal habitats, mosaic management should repeat burning once every 2 or 3 years in a rotational manner, and also maintain low-intensity cattle grazing, which controls reeds and benefits amphibians more sustainably. Eventually, the authors conclude that their study supports spatiotemporally varied management to facilitate habitat heterogeneity and complexity in dynamic landscapes.

Thus, they managed a wetland to mimic historical wildfires and traditional cattle grazing. Early autumn they used the fire to eliminate old reeds but facilitate reed regrowth the next summer. They figured out that frogs and toads preferred newly burned areas but avoided old-burned patches. Also, they figured out that grazing broke up reedbeds and created shallow open water preferred by amphibians. Eventually, they found that mosaic management increased habitat diversity and greatly benefitted amphibians.

The study of W. Ostendorp (1995) was implemented to determine the impact of winter reed harvesting and burning on the nutrient economy in the reed beds at Lake Constance-Untersee. The fringing reeds at the Lake were mown or burnt in winter thereby drastically reducing the addition of decomposable organic matter to the sediment. The study tested whether or not this management significantly decreased the contents of organic matter and nutrients in the surface sediment layer and if the oxygen conditions in the nearly located water body improved. For testing the hypotheses, the author implemented monitoring of six treated reed beds and three reference fields over a period of up to four years. The author detected only slight, and mostly insignificant, differences between treated and untreated reeds. Therefore, the author concluded that the sediment/water system of reed beds is well buffered against the removal of the current year´s crop of dead Phragmites straw.

Hence, the author concluded that the benefit of winter reed harvesting to reduce nutrient overloading of the reed beds and the die-back of reeds remains dubious.

In addition, N.R. Cowie, and co-authors (Cowie *et al*. 1992) studied the effects of conservation management of reed beds by comparing pairs of adjacent cut and uncut reed beds at 12 sites, and by a randomized block experiment at a further site in which plots of reed were cut, burnt or left unmanaged. The authors determined that most plant species were more abundant in the managed reed beds than the unmanaged ones, and only three were more abundant in the unmanaged beds. At the same time, several plant species were more common in burnt than cut plots. In the cut or burnt areas, the reeds were shorter and at higher densities than in unmanaged areas. The proportion of reed flowering stems was highest in burnt plots. The rate of decomposition of the litter that is produced by the reeds' leaf at the experimental site was determined by weight loss from litter bags and leaf bundles. There was no difference in weight loss and no difference in associated soil invertebrates between the managed and unmanaged areas. However, the authors state that the weight loss was inversely related to water depth in the plots and after six weeks correlated with the number of Oligochaetes, Psychodid larvae, and some Coleoptera. Eventually, the authors state that cutting and burning positively affected floristic diversity and most marsh plants but had no effect on the rate of litter breakdown. Interestingly, the authors didn't include the birds in their study.

Impact on climate change

The process certainly has negative input on the process of global climate change. Moreover, the mentioned impact of the reed burning on climate change means a decrease in the National Determined Contribution. If burnt every year, such a process can continuously damage Armenia's green image in frames of the UNFCCC.

Benefits for population

To conclude from the reasons for burning, the following real benefits can be drawn.

1. Obtaining more fodder for the cows. The area is very scarce in vegetation and the reed can become a substitute for the grass for a couple of weeks. The quantity of the reed which is used by the cows is not calculated by the local inhabitants.
2. Food for the fish in the canals, which later can be caught by the anglers. The rural inhabitants state that there is a Crucian Carp (*Carassius aureus*) living in the canals, and they believe that the young reed is a part of their diet.
3. Cleaning the clogged canals to maintain the irrigation water supply. Burning makes the process of cleaning easier for the local people.
4. Mineralization of the soil and pest control. This benefit is not directly related to the reed burning, but when the burning of adjacent fields is implemented, the fire becomes spread by the wind and affects the reed as well.

Despite the listing of the benefits, none of them could be quantified at the moment. At the meantime, such a quantification could be crucial for the cost and benefit analysis of burning (and obtaining short-term benefits) versus non-burning (and obtaining long-term benefits).

Legislation

While the legislation exists and unambiguously prohibits the burning of dry vegetation including reeds, it obviously doesn't work. It appears that the main causes are the following:

1. There is a lack of a system of informing the responsible bodies (e.g., State Inspection Body) about the violations in general and the burning in particular.
2. The mechanism of establishing evidence is not well developed.
3. The rural communities mostly are not aware of the restrictions and the punishments. The others who are aware do not consider it as a real threat.

Conclusions and Recommendations

The following can be concluded from the materials described above.

1. After the reed burning there is a decline in the bird fauna of Khor Virap area.
2. The Moustached Warbler – a species protected under the Bern Convention, which had high density in Khor Virap Sanctuary, declined critically. The decline could be related to the burning of the reedbeds, although there is no direct evidence.
3. Management of the reed bed is important for biodiversity, as it supports diversification of the habitats and therefore, supports an increase of biological diversity.

There are following recommendations to reduce the risk of fires:

1. There are three general ways of reedbed management: careful burning, careful harvesting, and restricted grazing. Among those, careful burning should be excluded, as a method that contradicts the national legislation and consists of significant risks of losing control and spreading the fire. Careful harvesting of the reed can be used and has to be linked to some economic activities. For example, it can be used for the production of combined fodder of livestock or production of roofs. The introduction of such a mechanism can also solve the issue of burning the reed in canals, for cleaning the clogging, as will introduce a financial interest in harvesting and not burning. Such a direction requires a feasibility study, though. Careful grazing can also be used, although, for such areas, it is suggested to shift the livestock husbandry from cows to buffalo. The reed is a natural fodder for the buffalo, and the buffalo dairy production has exceptional quality. It opens opportunities for high-margin diary production if marketed as "Bird Friendly" or "Conservation Friendly".
2. There is a need for nationwide awareness-raising campaigns about prohibited burning of dry vegetation, including reed.

3. The national legislation on burning dry vegetation should be reviewed and maybe an increase in penalties should be suggested.
4. Efficient communication with locals and awareness raising activities by authorities are needed.

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