



# Limiting Factors Affecting Reproductive and Demographic Indicators of Black Vulture (*Aegypius Monachus*)

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## ABSTRACT

Gradual decrease in reproductive and demographic indicators of black vultures in Azerbaijan territory has been observed during past several years. To study the reasons we researched the limiting factors that negatively affect the population of black vultures in Turyanchay National Reserve, one of their main settlements and the neighboring areas. It was revealed that shrinkage of food supply is the main reason for decrease in reproductive and demographic indicators of this species. By considering this we organized supplementary feeding for black vultures in the nature. This activity resulted in elimination of emigration, the number of individuals increased by 32% and breeding pairs by 58,4%. Breeding success rate of the population increased from 0,29% to 0,48%.

**KEYWORDS:** Azerbaijan, black vulture, limiting factors, food, breeding, size

## INTRODUCTION

Intensive anthropogenic transformation of landscapes and higher anthropogenic pressure have been causing loss of living places, decline in numbers and worsening of trophic conditions for black vultures like many other necrophage birds (*Gypaetus barbatulus*, *Neophron percnopterus*, *Gyps fulvus*). In XX century, lack of nesting in the Western part of their Eurasian aeriels (Sicily, Portugal, Marocco, Romania, Bulgaria, Moldova, Ukraine) [4,7,8,22,28], decrease in number Caucasus region [1,5,10,17,21], Central Asia [12,29], Primorye in Russia [18,19,20] of black vultures have been observed [Kulikova et al., 2003].

Starting from 1960's international nature protection organizations, states, various charity funds increased financial aid aimed at sustainable protection of black vultures intensified. Researches targeted at modelling of nest locations, limiting factors, food supply, bird migrations were successfully implemented.

The executed global 'griffon' programs resulted in restoration of both griffon vulture populations and number increases in South-West Europe (Portugal, Southern France and others) and Crimean peninsula [3,9,11,14,27]. Researches and measures for eliminating anthropogenic factors affecting the black vultures continue these days. Nevertheless, it is worth noting that efficient protection of this species in some of their aeriels is not observed. It is related to several reasons.

First of all, widening human economical activities produce new limiting factors in various territories of the aeriels. One example is negative effect of wide spread usage of anti-biotic used in treatment of pets (i.e. diclofenac usage affected diminishing of *Gyps bengalensis*, *Gyps indicus*, *Gyps tenuirostris* in South-East Asia and it is still in use in Spain, Italy and Kazakhstan) as well as negative impact of anti-parasites and toxic elements on necrophage birds [2,13,24,26].

Secondly, weaker studies on the conditions of black vulture in many aeriels provide insufficient information on their populations and development dynamics of the species. In such areas hidden and long-lasting limiting factors result in more hazardous outcomes. Because, black vultures, which possess narrow food adaptation (they feed with animal corpses that are infrequently located) and low breeding potential, easily react to changes through worsening reproduction, modifications of adaptation characteristics as well as decrease in numbers. Worsening demographic indicators may lead to population's degradation and eventual extinction in ecosystems [15,29, et al.]. Therefore, one of the methods for establishing efficient protection of species sensitive to hazards should be locating and elimination of concrete limiting factor affecting the species [6].

It should be noted that one of the black vulture populations nesting in Eurasia is located in Azerbaijan territory. During last ten years we have observed declining demographic indicators in this population. At present, black vultures are included in the Book of Endangered Animals of Azerbaijan Republic as an entry with status of "species expected to be given a degree of danger in near future". Current conditions of black vultures requires finding and elimination of factors that negatively affect the dynamics of their population's development. Considering all matters discussed above we started studying the factors affecting reproduction and demographic parameters, situation in food supply of black vultures, and determining ways and means for their neutralization in Azerbaijan territory.

## MATERIAL AND METHODS

The study was conducted during 2004-2014 in Turyanchay National Reserve and surrounding areas where 12 nests of black vultures are located. This reserve encompasses 22.500 ha area in South-East of Major Caucasian mountains on 400-650 m from sea level. There are Agdash-Bagala highway as well as Gabala and Yevlakh airports nearby. Also, many human settlements, villages, electrical lines, industrial facilities and tourist routes exist in a 5-30 km distance from their nesting camps. Starting from 2004 we studied origins and forms of factors that negatively affect the birds and nests both in the mentioned area and the places where griffons nest. As per their roles in population's

degradation the limiting factors were broken down into groups. Majority of the relatively 'obvious' and easily recognizable anthropogenic factors were eliminated during the research process. The reproductive and demographic indicators of the population did not better during the years following eradication of these factors, which chiefly result in loss of individuals as well as anthropobia. That's why we researched food factor's impact on the given indicators of the population.

Food norm that meets black vulture's needs has not been studied. Daily food norm of lammergeier (*Gypaetus barbatus*) is given as 1,5-1,7 kg in zoo conditions [25]. 74,9% of food objects of Egyptian vultures (*Neophron percnopterus*) in the south of Spain during 2000-2009 included wild animal corpses (62,3 mammals, 20,8 birds, 13,1 reptiles) [1]. One another reference discusses that as with predator birds the scavengers also consume food about 10% of their weight [4]. Different from these works we defined the quantity of food for each Black vulture in the territory under study. Registration of corpses was carried out with 35-50 km radius where birds feed themselves.

Firstly, the total mass of animal corpses not utilized by veterinary and sanitary services, and revealed and consumed by scavengers was determined. This operation was conducted during June-July, a period of feeding of nestlings (higher food demand). Within two months we found 60 animal corpses (2 cows, 1 donkey, 7 sheep, 12 wolves, 15 foxes, 2 dogs, 2 rabbits, 4 hedgehogs, 3 turtles, 7 snakes, 5 birds) died of various reasons (diseases, aging, fall from rocks, sinking in river, car hits, killing by wolves, trapping) in the reserve and surrounding areas. Numbers and total masses of Egyptian vultures as well as griffon vultures were also determined along with black vultures. By dividing the total masses of died animals by the total number of scavengers (Black vulture, Egyptian vulture and griffon vulture) we calculated food size per individual in the area (Table 1). While revealing corpses and food sizes we also referred to information supplied by veterinary agencies, reserve's staff and local residents.

In the second stage, we organized supplementary food for black vultures in the period of brooding, feeding of nestling and nest leaving. For feeding we used wastes from meat shops, meat and poultry processors as well as corpses of animals killed on highways and roads. The food was provided every 5-7 days during March, May, July, September, and October according to the quantity of black vultures, Egyptian as well as griffon vultures.

Table 1. Amount of food for each individual of black vultures, Egyptian vultures and griffon vultures per feeding session based on total corpse mass of died animals in the area

Total mass of dead animals, kg		Total mass of individuals gathered around a corpse, kg		Number of individuals in the area		Food amount per individual, kg		Live weight of a bird, kg
Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
350	600	205	750	30	110	0,80	1,70	Black vulture 9,0±2,0 Griffon vulture 7,0±1,0 Egyptian vulture 2,0±0,5

The amount of supplementary food was divided by the total number of scavengers and each individual was ensured 1,39-1,45 kg of food for each feeding (Table 2). When adding to this food amount the size per individual (0,8-1,7 kg+1,45-1,39 kg) then the total food for one individual makes 2,25-3,09 kg.

Supplementary feeding in nature was carried out based on our instructions considering eco-ethology as well as veterinary and sanitary requirements of griffons. That is, we considered adaptation of scavengers to artificial feeding, relations between species, hierarchy over corpse, eating durations and other terms. In order to avoid predator and rodents concentration in the feeding spots, the supplementary feeding was organized in different places and residuals were then utilized.

Table 2. Food amount per individual of black vultures, Egyptian and griffon vultures during supplementary feeding

Total mass of food brought to feeding zones, kg		Total mass of birds fed in the feeding zones, kg		Food amount for each individual per feeding session, kg	
Min.	Max.	Min.	Max.	Max.	Min.
900	1200	619	863	1,45	1,39

Impact of the mentioned limiting factors over biological parameters of black vultures were determined according to the number and breeding success indicators of the pairs engaged and not engaged in breeding as well as emigrating and dead individuals.

Stations, log spots and routes were noted on maps and entered to GPS device to simplify further repeat navigation. Devices used during the monitoring included Yukon 10x50 binocular and Kova TSN-601.20x 60 telescopes. As an on-site journal we used Alsten x2 portable recorder.

## RESULTS

As known, a steady (enduring) quantity dynamics is typical to black vultures populations. Starting from 2004 the quantity dynamics of black vulture's Turyanchay population has been decreasing in an unstable manner (fluctuating) (Table 3).

Table 3. Quantity Dynamics of black vultures populations in 2004-2014

Years	Number of individuals in population	Decrease (-) and increase (+) of numbers, individual	Number of dead individuals	Partook in breeding			Breeding success, %
				pairs	%	- decreased, + increased, individuals	
2004	36		2	12	66,6		0,7
2006	30	-6	2	9	60,0	-3	0,7
2007	20	-10	2	6	60,0	-3	0,8
2008	22	+2	1	6	54,5	0	0,6
2009	20	-2	-	6	60,0	0	0,6
2010	15	-5	2	4	53,3	-2	0,7
2011	14	-1	-	4	57,1	0	0,7
2012	17	+3	-	5	58,8	+1	0,6
2013	21	+4	-	9	85,7	+4	0,7
2014	25	+4	-	11	88,0	+2	0,8

During 2004-2012 the number of individuals in the population declined by 52,79%, breeding pairs by 51,34% and the breeding success felt from 0,7% to 0,6%.

Modification of the biological parameters that regulate quantities in population showed existence of negative processes against this species in their ecosystems. Analysis of the roles of those factors in population's degradation revealed below outcomes.

It was found out that the spectrum of negative factors on black vultures in the Turyanchay and neighboring areas is vast (Table 4). We can divide these limiting factors in two groups.

First group includes losses that lower living conditions of the population. These losses in the researched zone are killing by shootings, traps, contact with electric wires, hunting aged birds for commercial purposes and removal of nestlings from nests. Some people show off their 'skills' by shooting griffons gathered around corpses and resting on rocks. Poisoned traps set up against wolves in villages were also found. Not only black vultures but also Egyptian vultures and griffon vultures died on those traps. Certain educational activities held among residents could stop making the traps. Also, black vulture losses resulting from contact with electrical lines in the area surrounding the national reserve were found. The reasons for this was disposal of residual meat of horses illegally killed in the nearby village in the territory of electrical lines. Black and Egyptian vultures along with griffon vultures got killed while landing onto and lifting from the meat residuals. In 2013, dropping residual meats in the territory was stopped following charges against those individuals engaged in illegal activity.

The second group includes limiting factors of recreation, hunting in nest areas and pasturing, anxiety, noise and shrinkage of food supply that limit re-productiveness of the population. Natural beauty of the reserve, richness of avifauna and historic places boosted tourism in the region during 2000s. Unplanned tourism by various organizations and companies resulted in anxiety in nesting zones during breeding periods. Pasturing and illegal hunting (*Alectorischukar*, *Francolinus francolinus*, *Coturnixcoturnix*, *Phasianuscolchicus*, *Scolopaxrusticola*) in the nesting areas during March-May caused leavings of 3 nests. The nest eggs were lost because of the failed brooding. We revealed that 2 pairs of griffons left their nests settling in 5 km distance due to anthrophobia caused by trucks and stone processing plant nearby.

Table 4. Limiting factors found in the researched area

Limiting factors	Target objects
1. Killing by shooting	2 individuals
2. Death and injures on traps made for wolves and jackals	2 individuals
3. Losses due to contact with electrical lines	3 individuals
4. Catch of aged birds for commercial purposes	2 individuals
5. Failed breeding due to nets shootings	1 nest
6. Removal of nestlings for commercial purposes	3 individuals
7. Anxiety created by unplanned recreation, pasturing and illegal hunting	3 nest
8. Shootings birds while on corpses	2 corpse
9. Anthrophobia created by dusty fogs from nearby plant (2 km away), noise and active traffics	2 nest
10. Shrinking food supply	population

During 2013-2014, supplementary feeding was provided in the feeding zones of griffons according to the methodology described earlier. This supplementary food provided from the beginning of brooding resulted in an increase in the number of population individuals, breeding pairs as well as breeding success. Compared to year 2012 the number of population individuals in 2014 increased by 32% and breeding pairs by 58,4%.

## DISCUSSION

When discussing factors that cause decline of reproductive and demographic indicators of black vulture populations in in 2004-2012 one should highlight four main factors. First are the factors that cause loss of individuals in population. Second is existence of suitable biotopes for nesting. Third is the climate factors. Finally, the fourth is food supply conditions.

During 2004-2010 there was loss of only 12 individuals. Those factors that result in loss of 1,7 individual each year avoided becoming massive by being random. The factors that caused anthrophobia, anxiety and losses on nests and feeding places were relatively 'obvious' ones, hence got eliminated (by applying civil punishments, fines, planned tourism and involving local residents to protection process). Therefore, there was no observed loss of individual in the population in 2011-2014. Nevertheless, the number of population individuals,

breeding pairs and breeding success levels did not increase. It was clear that both anthropobia and minor individual losses are not main limiting factors that could bring the population to degradation level.

We also studied whether the suitable nesting biotopes in the area of population settlement are limiting factors. It should be noted that Turyanchay national reserve where black vultures inhabit was established for protection of juniper (*Juniperus L.*) forest. In Azerbaijan, black vultures nest only on juniper trees on 2-3 meters of altitude. Distance between the nests makes 500-2000 meters. Choice of juniper as nesting is not coincidence. That is, nests built on juniper trees on the hills with 28-35 degree sloppiness are far from catch of predator mammals (*Canus lupus*, *Felislynxdinniki*, *Felissilvestrislibica*). Moreover, 30 kg of phytoncide released by 1 ha of juniper forest plot within 24 hours create clean (healthy) environment in nests full of food remainders. Therefore, in none of 12 nests there were found any dead nestling died from parasites. Juniper forests covering 22.500 ha area creates suitable conditions for black vultures and is not considered a limiting factor.

Negative impact of climate factors over reproductive and demographic indicators of the population is not noted. Reasonable climate in the area (warm and hot in summer, dry in winter, with annual average temperature as 14,2 C) and fewer snowy and foggy days actually ensure appropriate living for the griffons.

The main limiting factor of worsening biological parameters for black vultures is gradual shrinkage of food supply. This is explained by following reasons. From ancient times the main food base for scavengers in Azerbaijan territory was comprised of corpses of wild artiodactyls as well as agricultural animals (camel, cow, buffalo, horse, donkey, sheep goat and pig). Shrinkage of food base took place in two fields. That is, illegal and unplanned hunting of wild animals (*Rupicaprarupicapra*, *Capra aegagrus*, *Cervuselaphus*, *Capreoluscapreolus*, *Ovisorientalis*), which make the food base of Black vultures has decreased due to illegal and unplanned hunting and loss of their living aeriels resulted in decrease of their aeriels by 30-50% and their numbers of 50-70%. At present, their numbers are very little, totaled at 160-650 individuals. They were entirely lost in central (Shirvan, Garabag, Mugan zones) and in south (Talış-Lankaran zone) Azerbaijan [23]. Opportunities of feeding with agricultural animals as their second food base also decreased. The reasons for this include illegal hunting of wild animals during collapse of USSR in 1990s, from military conflicts (including Azerbaijan) in Caucasus region as well as massive killings of agricultural animals. Furthermore, collective farms of Soviet times have been demolished. These processes happened in Azerbaijan, Russia, Ukraine, Georgia and Armenia where most Black vultures were settled [1,5,6,10,14,17,19]. Today, the number of low performing animals intentionally get reduced for the purpose of intensive development of cattle-breeding in Azerbaijan Republic. In return, lesser animals with higher productivity are preferred for keeping. These animals, which are kept in indoor complexes, receive quality veterinary services, those that die get utilized (disinfected and buried) and their remaining organs (head, legs, leather, intestines) are processed not being disposed in the nature. Due to economic development in the country during last 20 years, enhancement of construction, planting, road laying on natural landscapes also resulted in shrinkage of animals pasturing in those areas [30]. All these factors directly and immediately affected Black vultures' food supply.

It was found out that in such a condition of limited food supply the efficiency of mechanisms ensuring stable quantity dynamics has weakened, in return, mechanisms that safeguard decreasing in quantity have arisen. That is, mutual exchange of information between individuals through sophisticated signal system influences the physiological processes in bird organism via nerve and hormonal systems, hence directing the activity of population's individuals to right direction.

As a result, the number of pairs not engaged in breeding decreased in the population each year by 2-3 individuals, on contrary emigrants increased by 1-10 individuals (Table 3). During 2004-2012 the quantity dynamics in the population continued in a hesitating manner thanks to the biotic potential of the species.

Some young pairs and individuals that make the reserve group in the population did not participate in breeding by avoiding 'competition' with older individuals "in favor of" the population they belong to. The motive for such breeding strategy is about ensuring reasonable consumption of food reserves in the area. It also enables provision with food the developed babies till their maturing and breeding.

Those birds that 'refrain' from breeding and emigrate were mainly young pairs and individuals in their early nesting stage, with weak social connections and those with their nests located in colony periphery in a diffused way. These changes happening to the population's structure have led to weakening of pair development by individuals, social relations as well as positive "group effect". All these resulted in decline of black vulture populations (breeding pairs decreased from 12 to 5, total number of individuals declined from 36 to 17) whose breeding potential is not so high.

Improvement of reproductive and demographic indicators of black vultures during supplementary feeding in the nature once again evidenced that degradation is connected with shrinking food supply. Supplementary food helped eliminating emigration starting from 2012 and return of 4 individuals to the population each year. Compared to year 2012, in 2014 the number of population's individuals increased from 17 to 25 and breeding pairs from 5 to 11 (Table 3). Increase of individuals was due to return of emigrant birds to the colony. Joining of mature individuals of 'reserve group' to the breeding process resulted in an increase of breeding pairs. Monitoring showed pairs relocating to their previous and unused nests. In 2013-2014 relocation of 8-10 immature individuals as a group to 2-3 km distance from nesting camp was observed. We saw them feeding themselves along with older birds in the 'feeding zones'. Betterment in trophic conditions boosts not only strengthening the connection of those inexperienced individuals with the area but also joining the breeding process by developing pairs. By enhancing trophic connection with the area it is possible to stop emigration and losses while locating food in remote regions. Because, radio-telemetry revealed black vultures flying to Persian gulf and Arabian peninsula from South Caucasus for seeking food [16].

## FINDINGS

Gradual shrinkage of food supply is the main factor affecting reproductive and demographic indicators of black vulture population made of 12 nesting pairs. Existence of large poultry and cattle breeding enterprises as well as meat processors in the territories adjacent to the reserve accomplish supplementary feeding for black vultures. Degradation of black vulture population has been stopped by providing supplementary feeding in the nature taking into account the ecological characteristics and veterinary as well as sanitation requirements of

scavenger birds. Including the additional feeding as a biotechnical method in protection programs and using it within terms and rules enables stable development of black vultures in Azerbaijan. This also means integration to the protection of black vultures in global scale.

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