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Research Article

NORTHERN BALD IBIS POPULATION DYNAMICS-BİRECİK-TÜRKİYE (2012-2022)

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Abstract *This research was carried out to determine the reproduction, death, and loss numbers of Northern Bald Ibises living in Birecik (Şanlıurfa). The research was continued for 11 years. Northern Bald Ibises are an endangered species. Northern Bald Ibises breed freely in nature in Birecik. They are placed in cages at the end of June. They live in a cage for eight months. The reproductive ability of the population is high (2012-2022: 782 offspring). But the total number of the population is increasing very slowly. The number of offspring deaths is high (2012-2022: 267 dead offspring). Mortality occurs in the first two weeks of the offspring. Adult deaths and losses occur for different reasons (2012-2022: 246 adult individuals). Measures to be taken can prevent offspring deaths. There is a need for regulation in feeding and cage conditions. A second Northern Bald Ibis breeding station should be established. In order to keep the population alive, the aim should be to increase the number of Northern Bald Ibises. Allowing Northern Bald Ibises to migrate causes individuals to perish. Scientific methods need to be applied to accustom people to migration. Expert personnel (biologists or veterinarian) should be assigned to the station throughout the year.*

Keywords: *Northern Bald Ibis, Geronticus eremita, number of offspring, offspring deaths, adult losses*

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1. Introduction

Northern Bald Ibises are an endangered species. There is one large populations in Morocco and a semi-wild population in Türkiye. A captive population is maintained in Germany, Austria and Italy. There are 1995 Northern Bald Ibises in 92 zoos in the United States, Japan and Europe [1]. Northern Bald Ibises in zoos are of Moroccan origin [2].

Northern Bald Ibis colonies were detected in Türkiye, Syria and Iraq 200 years ago [3]. The first written source reporting Northern Bald Ibises in Birecik (Şanlıurfa) belongs to Ainsworth (1842) [3]. The drug DDT used in agriculture caused the mass death of Northern Bald Ibises [4, 5, 6]. Habitat change can lead to a decrease in the feeding and breeding areas of particularly sensitive species, which may result in a decline or even extinction of their populations [7]. The last Northern Bald Ibis living in nature in Birecik was seen in 1989 [8]. In 1990, the Northern Bald Ibis became extinct in nature in Birecik [9]. At the Birecik Northern Bald Ibis Breeding Station, 156 chicks were added to the population between 2000 and 2009 [10]. In Türkiye, 18 Northern Bald Ibises were placed in three zoos in 2016 [2]. Based on satellite transmitter records one of the tracked Northern Bald Ibis traveled 3300 km from Birecik to Ethiopia [11]. It has been determined that Northern Bald Ibises in Morocco have problems such as human disturbance and distance to food areas [12].

After many years, a wild population (seven individuals) was detected in Palmyra (Syria) in the Middle East [13]. Between 2002 and 2007, Northern Bald Ibises raised 24 chicks in Syria [14].

A correct correlation was determined between the number of offspring and the number of breeding pairs in the breeding area of Tamri in Morocco. In the other breeding area, Souss-Massa National Park, no correlation was observed between the number of offspring and the number of breeding pairs [15]. Between 1 and 22 individuals were identified migrating between Morocco and Spain between 2010 and 2017 [16]. There are 708 Northern Bald Ibises living in Morocco [1].

The increase in the number of breeding pairs in Morocco from 59 to 147, the reappearance of Northern Bald Ibises in Syria, the survival of the semi-wild population in Turkey, and the efforts to settle Northern Bald Ibises in Southern Europe are considered successful [17]. Due to these studies, the IUCN red list status of Northern Bald Ibises has been reduced from "critically endangered" to "endangered" [18,19].

Birecik-Şanlıurfa, on the banks of the Euphrates River, is located in the continental climate zone - winters are mild and summers are hot.

This research aims to contribute to preventing the extinction of the Northern Bald Ibis and increasing its number.

2. Material and Methods

This research was carried out on free-breeding Northern Bbald Ibises in Birecik (Şanlıurfa). Observations lasted 11 (2012-2022) years. Research started in mid-February every year and continued until the end of the breeding season (June). Observations were made 1-2 days each week. Observations lasted 2 - 10 hours during the day. Observations were made outside the breeding station, 50-150 m away from the nests. Thus, Northern Bald Ibises were prevented from being affected by the research. Binoculars, telescopes, cameras, and video cameras were used to see the eggs and hatchlings in the nest.

A chi-square statistical test was used in this study. Statistical evaluations were considered significant for $p<0,05$.

3. Results and Discussion

Northern Bald Ibises are released from the cage in mid-February. At the end of the breeding season (June), they are put back into cages. They breed in wooden nests placed on the rocks next to the cage. In 2018, 12 more wooden nests were added to the Birecik breeding station, in addition to the existing nests in previous years. The number of artificial (wooden) nests was 48. In 2020, 20 more artificial nests were added. In 2022, the number of wooden nests was 68. Besides these, there are five more nests carved into the rock (by the officials). Northern Bald Ibises also nest in suitable places on rocks every year (natural nest). The number of these natural nests varied between 10-15 each year. In addition, the roofs of wooden nests were also used as nesting places. Some of the different nest types remained empty and were not preferred as incubation sites (Table 1).

Table 1. Population Dynamics of Northern Bald Ibis (n)

	Years										
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
A-Released from the Cage (February)	126	152	163	185	205	209	241	261	241	278	301
B-Number of Offspring (April)	45	60	66	74	59	58	71	116	75	95	63
C-Loss of offspring in the Nest	3	21	20	17	21	3	0	71	0	1	7
D-Number of Offspring (May)	42	39	46	57	38	55	71	45	75	94	56
E-Number of Young in the Cage	33	34	42	52	38	47	65	25	68	72	39
F-Number of Adults Taken into the Cage (June)	126	131	147	157	179	198	208	218	217	253	282
G-Total Number in the Cage (June) (E+F)	159 (33+126)	165 (34+131)	189 (42+147)	209 (52+157)	217 (38+179)	245 (47+198)	273 (65+208)	243 (25+218)	285 (68+217)	325 (72+253)	321 (39+282)
H-Annual Number Increase (G- A)	33 (159-126) (5 that cannot be taken into the cage)	13 (165-152) (Released with 6 NBI satellite + radio receivers)	26 (189-163)	24 (209-185)	12 (217-205)	36 (245-209)	32 (273-241)	-18 (243-261)	44 (285 - 241)	47 (325-278) (Left to Migration 15 NBI)	20 (321-301) (Left to Migration 30 NBI)
I-Dying, Lost Young (B-E)	12 (45-33)	26 (60-34)	24 (66-42)	22 (74-52)	21 (59-38)	11 (58-47)	6 (71-65)	91 (116-25)	7 (75 - 68)	23 (95-72)	24 (63-39)
J-Dead, Disappeared Adult (A-F)	0 (126-126)	21 (152-131)	16 (163-147)	28 (185-157)	26 (205-179)	11 (209-198)	33 (241-208)	43 (261-218)	24 (241 - 217)	25 (278-253)	19 (301-282)
K-Deaths Disappeared Total (I + J)	12 (12+0)	47 (26+21)	40 (24+16)	50 (22+28)	47 (21+26)	22 (11+11)	39 (6+33)	134 (91+43)	31 (7+24)	48 (23+25)	43 (24+19)
L-Number of Incubations	23	34	35	46	41	49	64	73	67	85	70
M-Per Incubation Number of Offspring (B÷L)	1,95 (45÷23)	1,76 (60÷34)	1,88 (66÷35)	1,60 (74 ÷ 46)	1,43 (59 ÷ 41)	1,18 (58 ÷ 49)	1,10 (71 ÷ 64)	1,58 (116÷73)	1,11 (75 ÷ 67)	1,11 (95 ÷ 85)	0,90 (63 ÷ 70)
N-Per Incubation Number of Flying Chicken (E÷L)	1.43 (33÷23)	1.00 (34÷34)	1.20 (42÷35)	1.13 (52÷46)	0.92 (38÷41)	0.95 (47÷49)	1.01 (65÷64)	0.34 (25÷73)	1.01 (68÷67)	0.84 (72÷85)	0.55 (39÷70)

The number of offspring varies in April, May and June (Table 2). The reason for this change is offspring mortality. There is a difference in the comparison of the number of offspring in April, May and June in 2013, 2014, 2016, 2017, 2019 (Table 2). It was statistically determined that there was no difference between the number of offspring in April, May and June in 2012, 2015, 2018, 2020, 2021 and 2022 (Table 2).

Table 2. Calculations for the Number of Offspring (Quarterly changes over the years)

Years	Months	n	Chi-square	p
2012	April	45		
	May	42	1,950	0,377
	June	33		
2013	April	60		
	May	39	8,586	**0,014**
	June	34		
2014	April	66		
	May	46	6,442	**0,040**
	June	42		
2015	April	74		
	May	57	4,361	0,113
	June	52		
2016	April	59		
	May	38	6,533	**0,038**
	June	38		
2017	April	58		
	May	55	1,213	**0,545**
	June	47		
2018	April	71		
	May	71	0,348	0,840
	June	65		
2019	April	116		
	May	45	73,774	**0,000**
	June	25		
2020	April	75		
	May	75	0,450	0,799
	June	68		
2021	April	95		
	May	94	3,885	0,143
	June	72		
2022	April	63		
	May	56	5,785	0,055
	June	39		

The change in the number of offspring by month between 2012 and 2022 is shown in Figure 1. The number of offspring increased to a maximum in 2019. However, the highest loss of offspring occurred in 2019. Deaths occur due to competition between offsprings. That's why the number of offsprings in June decreases. (Figure 1).

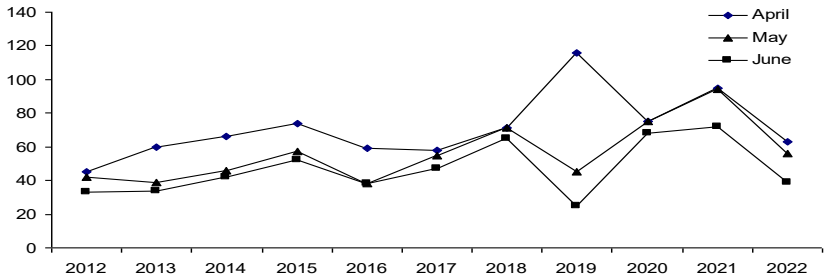

Figure 1. Distribution of the Number of Offspring by Years.

The number of offspring varies in April, May, and June (Figure 1). This difference continued in a similar way every year. The number of offspring is highest in April. Competition is very intense between the 2-3 siblings in the nest. Food is mostly taken by the eldest sibling. In all nests, the youngest chick who hatches the latest has a low chance of survival. The youngest chick that receives little food becomes weak and shows developmental delays. Also, the older sibling/s constantly pecks the younger sibling. The youngest offspring is kept under pressure before food intake. Offspring deaths occur in the nest. The parent does not prevent fights between offspring.

There is a slight increase in the total number of offspring between 2012 and 2022 (Figure 1). When the total number of offspring of the eleven-year (2012-2022) months of April, May and June is examined, it is seen that there is a statistically significant difference (Table 3).

Table 3. Calculations for the Number of Offspring (11-year changes by months).

Months	Years	n	Chi-square	p
April	2012	45	53,803	**0,000**
	2013	60		
	2014	66		
	2015	74		
	2016	59		
	2017	58		
	2018	71		
	2019	116		
	2020	75		
	2021	95		
	2022	63		
	∑	782		
May	2012	42	54,495	**0,000**
	2013	39		
	2014	46		
	2015	57		
	2016	38		
	2017	55		
	2018	71		
	2019	45		
	2020	75		
	2021	94		
	2022	56		
	∑	618		
June	2012	33	51,981	**0,000**
	2013	34		
	2014	42		
	2015	52		
	2016	38		
	2017	47		
	2018	65		
	2019	25		
	2020	68		
	2021	72		
	2022	39		
	∑	515		

Figure 2 shows the comparative histogram of April, May and June. Since offspring deaths are less in April, the number of offsprings is high. Due to chick mortality, the number of offsprings is low in June (Figure 2).

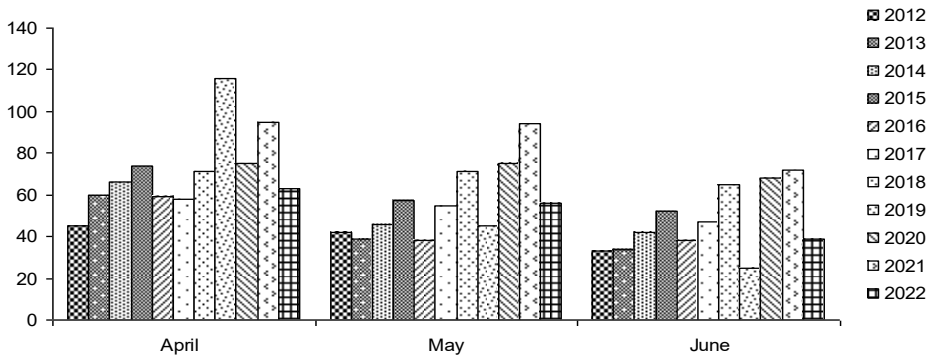

Figure 2. Distribution of the number of offspring by years.

A decrease was detected when the number of adults released from cages at the beginning of the breeding season (February) was compared with the number of adults taken into the cage at the end of the breeding season. However, no statistical difference was observed (Table 4). In 2019, the total number of individuals decreased due to juvenile deaths and adult losses and a difference was detected (Table 4).

Table 4. Comparison of the Number Released from the Cage (February) and the Number of Adults Caged (June) by Years.

Years	Parameters	n	Chi-square	p
2012	Released from the Cage	126	0,00	1,000
	Number of Adults Taken into the Cage	126		
2013	Released from the Cage	152	1,558	0,212
	Number of Adults Taken into the Cage	131		
2014	Released from the Cage	163	0,826	0,363
	Number of Adults Taken into the Cage	147		
2015	Released from the Cage	185	2,292	0,130
	Number of Adults Taken into the Cage	157		
2016	Released from the Cage	205	1,760	0,185
	Number of Adults Taken into the Cage	179		
2017	Released from the Cage	209	0,297	0,586
	Number of Adults Taken into the Cage	198		
2018	Released from the Cage	241	2,425	0,119
	Number of Adults Taken into the Cage	208		
2019	Released from the Cage	261	3,860	**0,049**
	Number of Adults Taken into the Cage	218		
2020	Released from the Cage	241	1,258	0,262
	Number of Adults Taken into the Cage	217		
2021	Released from the Cage	278	1,177	0,278
	Number of Adults Taken into the Cage	253		
2022	Released from the Cage	301	0,619	0,431
	Number of Adults Taken into the Cage	282		

The number of adult Northern Bald Ibises removed from cages (in February) is higher than the number of adults taken into cages (in June) (Figure 3, Tables 4, 5). The low number of adults taken into cages was not statistically significant (Table 5). Every year, on average (246 (n) ÷ 11 (year) =) 22.36 adult Northern Bald Ibises die and/or disappear.

Table 5. Comparison of the Number of Adults Released from the Cage and Taken into the Cage.

	Years										
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Released from the Cage (February)	126	152	163	185	205	209	241	261	241	278	301
Number of Adults Taken into the Cage	126	131	147	157	179	198	208	218	217	253	282
Chi-Square=2,156; p=0,976											

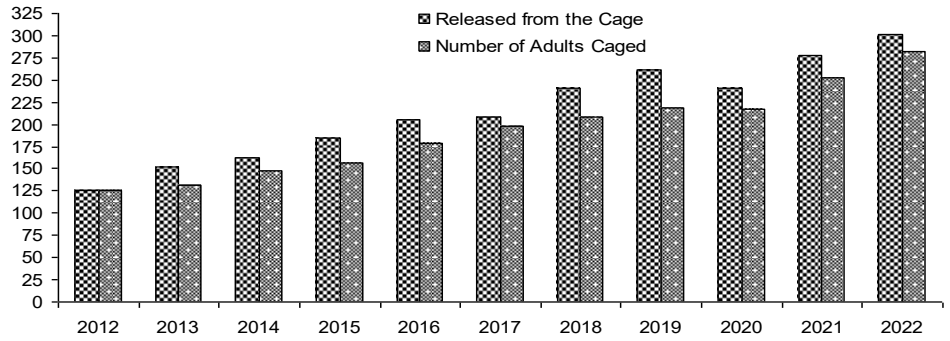

Figure 3. Comparison of the Number of Adults Released from the Cage and Caged Adults.

Adults do not die only in nature. Deaths were also detected in cages (Table 1). As can be seen in the data in Table 1, the number of Northern Bald Ibises spending the winter in cages is decreasing. Between 2012 and 2022, a total of 55 Northern Bald Ibises decreased in cages.

The number of adult Northern Bald Ibises released into the wild at the beginning of the breeding season and the total number of adults and young birds taken into cages at the end of the breeding season are compared statistically in Table 6. According to Table 6, it is revealed that there is no difference in the total number of Northern Bald Ibises before and after breeding.

Table 6. Comparison of the Number Released from Cages (February) and the Number Caged (June) by Years

Years	Parameters	n	Chi-square	p
2012	Released from the Cage Number of Adults Taken into the Cage	126 159	3,821	0,051
2013	Released from the Cage Number of Adults Taken into the Cage	152 165	0,533	0,465
2014	Released from the Cage Number of Adults Taken into the Cage	163 189	1,920	0,166
2015	Released from the Cage Number of Adults Taken into the Cage	185 209	1,462	0,227
2016	Released from the Cage Number of Adults Taken into the Cage	205 217	0,341	0,559
2017	Released from the Cage Number of Adults Taken into the Cage	209 245	2,855	0,091
2018	Released from the Cage Number of Adults Taken into the Cage	241 273	1,992	0,158
2019	Released from the Cage Number of Adults Taken into the Cage	261 243	0,643	0,423
2020	Released from the Cage Number of Adults Taken into the Cage	241 285	3,681	0,055
2021	Released from the Cage Number of Adults Taken into the Cage	278 325	3,663	0,056
2022	Released from the Cage Number of Adults Taken into the Cage	301 321	0,643	0,423

The total number of Northern Bald Ibises released from the cage and taken into the cage at the end of the breeding period between 2012 and 2022 was evaluated statistically (Chi-square = 7.083; p = 0.718) (Table 7). No statistical increase can be expressed for 11 years.

Table 7. Comparison of the Number Released from the Cage and the Number Caged by Years (n)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Released from the Cage (February)	126	152	163	185	205	209	241	261	241	278	301
Number of Adults Taken into the Cage (June)	159	165	189	209	217	245	273	243	285	325	321
Chi-Square = 7,083 ; p = 0,718											

Every year, hatchlings join the population. Out of the three eggs in the nest, all three hatchlings can hatch. In some nests, two or one offspring can be seen. Offspring deaths occur in the first weeks. At the end of the breeding season, young birds and adults are returned to the cage. There was a statistical difference in the number of hatchlings hatched in April from the number of hatchlings that died or disappeared that year (Table 8).

Table 8. Comparison of Number of Offsprings (April) and Number of Dead-Missing Offsprings by Years

Years	Parameters	n	Chi-square	p
2012	Number of Offspring (April)	45	19,105	**0,000**
	Dying, Lost Young	12		
2013	Number of Offspring (April)	60	13,442	**0,000**
	Dying, Lost Young	26		
2014	Number of Offspring (April)	66	19,600	**0,000**
	Dying, Lost Young	24		
2015	Number of Offspring (April)	74	28,167	**0,000**
	Dying, Lost Young	22		
2016	Number of Offspring (April)	59	18,050	**0,000**
	Dying, Lost Young	21		
2017	Number of Offspring (April)	58	32,014	**0,000**
	Dying, Lost Young	11		
2018	Number of Offspring (April)	71	54,870	**0,000**
	Dying, Lost Young	6		
2019	Number of Offspring (April)	116	3,019	**0,082**
	Dying, Lost Young	91		
2020	Number of Offspring (April)	75	56,390	**0,000**
	Dying, Lost Young	7		
2021	Number of Offspring (April)	95	43,932	**0,000**
	Dying, Lost Young	23		
2022	Number of Offspring (April)	63	17,483	**0,000**
	Dying, Lost Young	24		

In Table 9, the number of dead-lost offspring of all observation years (2012-2022) and the total number of offspring in April are compared statistically, and it is seen that the difference has changed significantly. The number of offsprings in April was different from the number of offsprings that died (Table 9 and Figure 4).

Table 9. Comparison of Total Number of Offsprings (April) and Number of Dead-Missing Offsprings by Years.

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Number of Offsprings (April)	45	60	66	74	59	58	71	116	75	95	63
Dying, Lost Offsprings	12	26	24	22	21	11	6	91	7	23	24
Chi-Square=70,143 ; p=0,000											

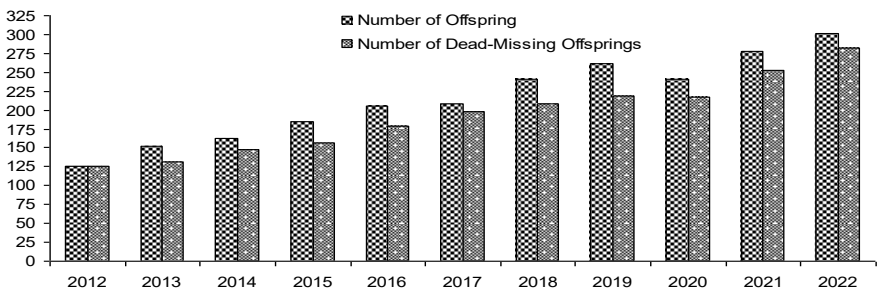

Figure 4. Comparison of Number of Offsprings (April) and Number of Dead-Missing Offsprings

The number of adult individuals released from the cage into the wild and the total annual number of offspring + adults that died or disappeared until the end of the breeding season were compared statistically (Table 10). It is calculated separately for each year in Table 10. It was revealed that the number of adults released from the cage in all years of observation was different from the number of dead or missing (adults + young birds) (Table 10).

Table 10. Number of Adults Released from the Cage by Years Comparisons of Total Number of Death- Lost Hatchlings + Adults

Years	Parameters	n	Chi-square	p
2012	Released from the Cage (February) Deaths Disappeared Total	126 12	94,174	**0,000**
2013	Released from the Cage (February) Deaths Disappeared Total	152 47	55,402	**0,000**
2014	Released from the Cage (February) Deaths Disappeared Total	163 40	74,527	**0,000**
2015	Released from the Cage (February) Deaths Disappeared Total	185 50	77,553	**0,000**
2016	Released from the Cage (February) Deaths Disappeared Total	205 47	99,063	**0,000**
2017	Released from the Cage (February) Deaths Disappeared Total	209 22	151,381	**0,000**
2018	Released from the Cage (February) Deaths Disappeared Total	241 39	145,729	**0,000**
2019	Released from the Cage (February) Deaths Disappeared Total	261 134	40,833	**0,000**
2020	Released from the Cage (February) Deaths Disappeared Total	241 31	162,132	**0,000**
2021	Released from the Cage (February) Deaths Disappeared Total	278 48	162,270	**0,000**
2022	Released from the Cage (February) Deaths Disappeared Total	301 43	193,500	**0,000**

According to the eleven-year evaluation, the number of individuals released from the cage was found to be statistically different from the total number of dead and missing individuals (Table 11).

Table 11. Comparison of the Number of Adults Released from the Cage and the Total Number of Dead-Missing Hatchlings + Adults by Years.

	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Released from the Cage (February)	126	152	163	185	205	209	241	261	241	278	301
Deaths-Missings Total (June)	12	47	40	50	47	22	39	134	31	48	43
Chi-Square=114,970 ; **p=0,000**											

A comparative histogram of the annual number of deaths and losses and the number of Northern Bald Ibises released from the cage between 2012 and 2022 is shown in Figure 5. According to Figure 5, the total number of individuals released from the cage appears to have increased regularly. According to Figure 5, the annual number of dead or missing individuals continues without any major change.

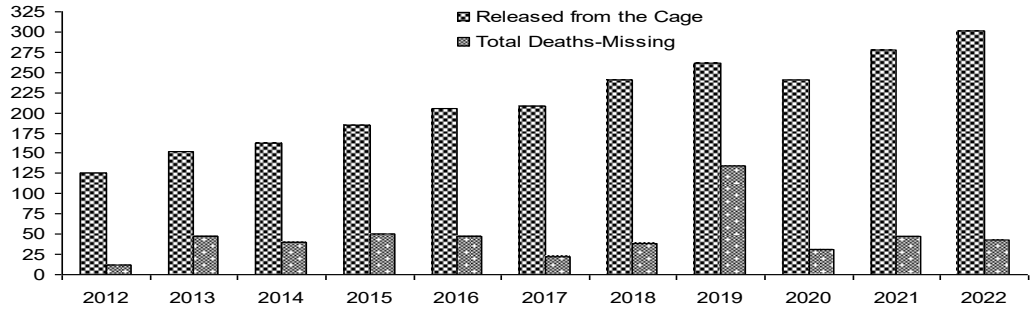

Figure 5. Histogram comparing the number of individuals released from the cage and the total number of dead-missing individuals

A different number of broods (n = 23–85) (Table 1) occurred each year. The number of incubated chicks (April) has decreased over the years (Figure 6).

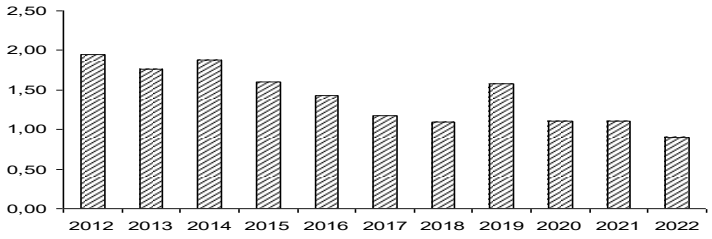

Figure 6. Number of Offspring per Brood (in April)

The number of hatchlings per brood (between 2012-2022) is shown in Figure 7. As seen in Figure 7, the number of flying chicks is decreasing on average.

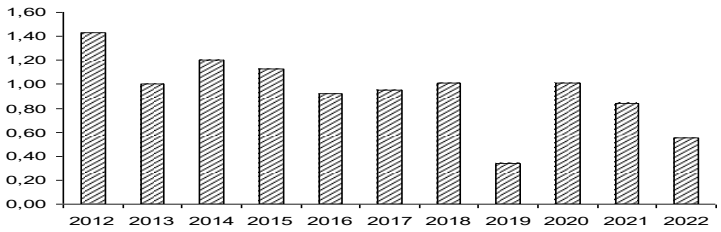

Figure 7. Number of Hatchlings flying per Brood (in May)

Although the breeding potential is high, deaths and losses are high in juvenile and adult Northern Bald Ibises. Offspring deaths are more common in the first weeks. During this period, offspring loss varies between 8-78%. Adult deaths and losses were determined as 0-16% of the population. Total losses and deaths in the population have varied between 7-35% over the years (2012-2022).

The wooden nests mounted on the rocks at the Northern Bald Ibis breeding station are covered with roof insulation material. This situation prevents the ventilation of the nests. During the extremely hot breeding season, the temperature in wooden nests increases even more. The slope of the wooden nest roofs has been steepened. It has become difficult to stand on roofs due to the extreme slope. Northern Bald Ibises, which nested on wooden nest roofs in previous years, have lost this opportunity. In wooden nests, Northern Bald Ibises cannot see each other. However, Northern Bald Ibises incubate close to each other in nature. Successful incubation and baby care are achieved by influencing each

other. Their nesting places in separate boxes do not allow them to see each other. Therefore, they are prevented from influencing each other positively.

In the joint project of Germany-Austria-Italy, 84 Northern Bald Iibises lost their lives due to different reasons (hunting, electric cable shock, etc.) between 2014 and 2016. In 2017, electric shocks accounted for 23% of the causes of Northern Bald Ibis deaths, and disappearances accounted for 51% [17]. The number of Northern Bald Ibises reached 102 in Rosegg, Kuchl (Austria) and Burghausen, Überlingen (Germany) in 2018 [17]. In 2018, the number of offspring deaths was determined as 46 individuals. Predation and electrocution are the causes of losses. There are also losses of Northern Bald Ibises due to hunters [17].

In 1996, 38 individuals (of different ages) died in Morocco. The cause of death could not be determined [20].

Quevedo Muñoz et al [21] reported that 24 Northern Bald Ibises died and 8 disappeared due to hunters, power lines and other reasons in 2004-2005 in the Proyecto Eremita-Almeria (Spain) project, it was determined that six individuals died due to electric shock in 2006, 39.4% of 190 individuals (75 young birds and adults) died between 2004 and 2009. It was determined that those who died were mostly offsprings [22]. It is known that deaths by electric shock also occur from Northern Bald Ibises in Birecik [23].

The disappearance of Northern Bald Ibises in Birecik was also reported by different researchers in previous years. It was determined that 67 individuals disappeared in Birecik between 1981 and 1988 [8]. It was recorded that many individuals were lost before the Northern Bald Ibises were taken into cages [24, 25]. Özbağdatlı [26] found that 32 northern bald ibises disappeared and 21 of them died between 2000 and 2006. Between 2000 and 2009, 25 chicks died and 53 individuals were found to have disappeared at the Birecik Northern Bald Ibis Breeding Station [10]. Pesticides and high voltage lines used in agricultural areas in Birecik have been identified as problems faced by Northern Bald Ibises [27].

These losses and deaths can be prevented [28, 29, 30]. During our observations (2012-2022), it was determined that deaths and losses occurred due to indifference [31, 32]. In 2019, the highest number of juvenile and adult losses occurred in Birecik. In 2019, 91 offsprings died or disappeared. Dead offsprings have been detected in the nests. In the same year, 43 adults were lost. Northern Bald Ibis Breeding Station officials declared that the pesticides used in the surrounding fields may be effective. In our research, the total loss of offspring in Birecik between 2012 and 2022 is 267. The average number of offspring deaths and losses each year was 24 (6-91). In addition, a total of 246 adult Northern Bald Ibises were lost annually between 2012 and 2022. An average of 22 (0-43) adult Northern Bald Ibises were lost each year.

It is stated that the Northern Bald Ibis colony in Syria may consist of Birecik Northern Bald Ibises [33]. The annual loss of adults in our research in Birecik supports this view. Detailed studies are needed on losses of adult Northern Bald Ibises. It is thought that some of the northern bald ibises may have settled in one of the Middle Eastern countries (Syria, Saudi Arabia, Israel or Jordan).

Özbağdatlı [26] reports that 1.4-1.9 offsprings per nest were raised in Birecik between 2000 and 2006. Yeniyurt et al [34] reported that the average productivity of northern bald ibises in Birecik from 2009 to 2015 was 1.12 offspring per nesting pair (0.96-1.19). When two studies [26, 34] are evaluated together, Northern Bald Ibises raise fewer offspring. The values we obtained as a result of our research are as follows: The number of offspring per incubation (in April) was calculated as 1.41 (1.95-0.90), and the number of offspring flying per incubation was calculated as 0.94 (1.43-0.34). These findings differ from Özbağdatlı [26] and Yeniyurt et al [34].

Serra and Peske [35] reported that free-living bald ibises in Palmyra (Syria) raised 20 chicks between 2002 and 2006. 1-3 offsprings per nest were raised here.

A total of 59-77 pairs bred in two different regions in Morocco between 1994 and 2002 [36]. In Parc National de Souss-Massa (PNSM) (Morocco), between 1995 and 1999, 289 hatchlings emerged from 354 eggs in 123 nests. The hatching percentage is 81.6. In Tamri, between 1995 and 1999, 179 hatchlings emerged from 216 eggs in 79 nests. The hatching percentage is 82.9 [37]. El Bekkay et al [38] reported the number of offspring (reproduction) in the nest in Morocco between 1994 and 2004 as 0.61-2.27 in Massa and 0.54-1.47 in Tamri. Between 1980 and 2007, 48-105 eggs were produced each year in Morocco. It has been determined that 0.39-1.80 offspring are raised per nest pair here [39]. Oubrou & El Bekkay [40] reported that 122 pairs of Northern Bald Ibises raised 152 offspring in two localities in Morocco (Souss-Massa National Park and Tamri), with 1.2 offspring per nest. An increase in the number of couples was observed in two separate colonies in Morocco between 2006 and 2018. The number of Northern Bald Ibises reached 147 pairs [15]. Two new breeding colonies have been identified on the Atlantic Ocean coast in Morocco. 11-15 individuals were detected in these two new colonies [41]. The results regarding the number of offspring reported from Morocco are higher than the values in Birecik.

Nests with and without access to water were compared in the Agadir (Morocco) region between 1998 and 2002. The number of offspring per nest has been reported as 1.16-2.41 (with water) and 1.00-2.27 (without water). It is reported that access to water resources positively affects reproduction [42]. Breeding values in Birecik are calculated to be lower than in the Agadir (Morocco) region. It was calculated that an average of 0.8-3.0 chicks were raised per nest in Northern Bald Ibises in Germany and Austria between 2011 and 2016 [43]. These values are higher than the breeding values in Morocco and Birecik.

Murray & Shaw-2006 [44] found that in White Bald Ibises, the success rate was 47.9% in incubation, 60.3% in raising offspring, and 28.9% in flight size.

The values given by Yeniyurt et al [34] in their study (Table 1) are clearly different from the values given in our study (Table 1). Böhm et al [1] The breeding values of Northern Bald Ibises in Birecik in 2012-2018 (Table 3) differ from our research.

The genetic structure of Northern Bald Ibises in European Zoos is different from the Eastern population [45]. That's why the Northern Bald Ibises in Birecik need to be protected.

Böhm [2] states that the Northern Bald Ibises detected in Saudi Arabia are not of Turkish origin. However, the wild Northern Bald Ibis colony in Palmyra (Syria) is located a few hundred kilometers south of Birecik [2]. Adult Northern Bald Ibises from Birecik (Türkiye) disappear every year (Table 1).

There is a possibility of new colonies appearing in Syria. Because there is a loss of Northern Bald Ibises in Birecik every year (Table 1). In the pictures in Serra [46] and [47], Northern Bald Ibises can be seen wearing colorful leg rings. These Northern Bald Ibises are thought to be the ones leaving Birecik (Türkiye).

Many Northern Bald Ibises are disappearing. It has not been determined whether these losses were due to death or migration. Different reasons can be considered for losses. Some Northern Bald Ibises may have headed south (towards Syria). It is highly likely that the natural colony identified in Syria [13, 14] originates from Turkey. No Northern Bald Ibis hunting has been detected in Birecik. Because Northern Bald Ibises are considered sacred in Birecik.

According to Tables 4 and 6, it is revealed that there is no statistically significant increase in numbers between the beginning and the end of the breeding season. Adult losses and offspring deaths are thought to be the determinants of this situation. When the data in Table 6 is examined, it is seen that there is no statistical increase in annual reproduction. According to Table 7, it is shown that there is no change in the total number before breeding and at the end of the breeding season (Chi-Square = 7.083; $p = 0.718$).

Between 2012 and 2022, there was a decrease of 55 individuals in cages. There is an average of (55÷11=5) 5 Northern Bald Ibis birds decreasing every year. Northern Bald Ibis breeding station officials will inform the scientific world about this issue.

The number of incubations increased steadily from 2012 to 2022 (Table 1). However, the number of offspring per brood tends to decrease regularly. The decrease in the number of hatchlings hatched during incubation may be due to different reasons. One of these is lack of food. Parental ability may be an important factor affecting offspring rearing. In addition, stress in the population due to inbreeding, hunting, biocides, and congeneric environment may be effective.

Dead chicks have been seen in Northern Bald Ibis nests. In our observations, it was determined that in some nests, the dead chick was tried to be swallowed by the parent.

4. Conclusion

Northern Bald Ibis rescue activity has been continuing for 45 years (1977-2022). The protected status of endangered Northern Bald Ibises is sensitive. It is essential to increase their numbers. Expert support is needed to keep the offspring alive during the breeding period. It has been determined that some adults died from electricity poles. Not enough information could be obtained about the deaths and losses of adults. There is also a need to re-evaluate nutrition and shelter conditions. Instead of chicken feed, a diet based on grasshoppers, insects and caterpillars should be preferred. A sandy and grassy ground should be prepared in the cage. The environment in which earthworms will survive should be arranged on the ground.

It is recommended to establish a second station for the survival and protection of Northern Bald Ibises [48, 49]. Since in-breeding involves risks, a second breeding station is deemed necessary due to the possibility of epidemics and different threats. It is recommended that the younger ones in the nest be left in nests that do not have chicks. The one that hatches late and is younger than its siblings can be kept alive.

It is reported by the Birecik Northern Bald Ibis Breeding Station officials that 75 Northern Bald Ibis chicks were sent to migration between 2021 and 2023 [50, 51]. Young individuals do not know migration routes. These young Northern Bald Ibises do not know where to eat or stay. Releasing young Northern Bald Ibises into the wild in this way will cause them to perish. There are no adult Northern Bald Ibises that know the migration route. Migration should be regulated like in Europe [43]. It is wrong to leave Northern Bald Ibis chicks outside without teaching them the migration route.

Ethical statement

The author declare that this document does not require ethics committee approval or any special permission.

Conflicts of Interest

The authors confirm that this article's content has no conflict of interest.

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Author Contributions

A.K: Writing - Original draft preparation

E.U: Statistical analysis

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